Rhy

DRAFT: June 14, 2024

Edwin Harkins

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Introduction

For about 40 years Ed Harkins taught a graduate-level seminar at the University of California, San Diego, that he called "advanced rhythm reading." This book is a collection of exercises Ed wrote and used in these classes. The classes would consist of Ed writing an exercise on a whiteboard (sometimes stopping to enjoy the fumes from his dry-erase markers) and/or, later, projecting one from his computer. The class would then try to clap, tap, or vocalize the rhythm, almost always with uneven results. As time permitted we would copy some of them down in our notebooks and practice them between classes.

Although on the surface these exercises would seem to be primarily useful to performers who might be called on to perform rhythmically complex music, they also show many inventive ways notation can be bent to communicate rhythmic ideas that will be of use to composers. Many of the rhythmic ideas themselves might inspire ideas in composers (Ed himself studied composition). They often carry fascinating implications about rhythmic perception. Ed's classes were followed by musicians and music scholars of all kinds.

The 500-ish students who have taken Ed's seminar over the years (and, probably, some of the thousands of undergraduate students in his musicianship classes) will know what to do with these exercises, but other readers might need some explanations. To somewhat oversimplify, the exercises both demonstrate and encourage musicians to develop many different ideas and strategies for analyzing and performing difficult rhythms. These ideas and strategies come with shorthand names such as **Nudged Rats** and **BAMO**. These are used as tags in this collection and are collected as an index in the back matter. (You might picture a seedy-looking man in an ice cream truck saying, "You want the regular **Noodgie** or the **Noodgie w/ Rats**?)

Where possible and appropriate, each tag can be traced back to a defining exercise with a description of the tag's meaning. Some of the tags apply to many of the exercises, and in these cases the index can be used to find all the others. (If you are reading this on a screen this is supported with links.)

This book's title, "Rhy" is another shorthand, which Ed pronounces as "rye" or "wry". It appears in the captions for two exercises in chapter 3 as "Easy Rhy, Hard Pi".

There are sound recordings of many of the exercises, which you can download separately, or, if you have downloaded them together with a PDF, or if you are reading this on a web browser, should be playable as additional links marked "play audio".

Example: seven against five in gory detail

To illustrate Ed's teaching approach, suppose we want to perform seven events in the time of five beats. (If this would be too easy for you, imagine doing this on an accelerando, or against dotted quarters, or further subdividing the middle three events, or whatnot. It is hard to imagine being so good at 7:5 that this is never worth revisiting.)

To start with, we pull out what is probably the most frequently used concept in the book: the **HAMn** (pronounced "ham"), an acronym for Harkins' Alignment MNemonic. This is a sequence of numbers that count how many (equally-spaced) events should fall on or after each of the five beats. If there are, for instance, 60 beats per minute (at 1, 2, $\cdots$, 5 seconds), the events should approximately fall at times 1, 1.71, 2.42, 3.14, 3.86, 4.57, and 5.28. The **pnob**, or Presumed Next On-Beat (the acronym is pronounced with the "P" silent) arrives at 6 seconds. The **HAMn** is 21211, that is, there are 2 events on or after the first beat (1 and 1.71), one after the second, two after the third, and one each after the last two.

To perform this we can start by performing 3:2 (Hamn 21) followed immediately by 4:3 (Hamn 211). This isn't exact but is close enough that many listeners won't hear the difference (one year when Ed demonstrated this, only one student out of about 12 heard the truth). Specifically, the fourth event of the seven falls at time 3 instead of 3.17, 1/7 beat early. The first four are spaced too closely together and the last five (from 3 to the **pnob** at 6) are too far apart. We fix this with a **noodgie** (nudge): simply perform the 3:2 a bit slower and catch up during the 4:3. Once you get the eight time points (the seven onsets plus the **pnob**) evenly spaced, you have mastered 7 against five.

This is not quite as easy as it sounds since it involves carrying out two tasks (performing 3:2 and 4:3 inexactly, while simultaneously listening for the even spacing of the eight attacks). Developing this ability to listen simultaneously to two or more aspects of a rhythm, in real time, is a central aspect of the technique that Ed's book seeks to impart. For example, in the the book's first exercise (106, Pat 1st), although the left hand plays a steady beat, that beat is

unfortunately a dotted eighth note so that everything in the right hand sounds as triplets—including two written triplets which are four and two ninths of a beat. If there were three of you, one could be listening to the dotted eighths and the bar lines, another in duple time (4.5 beats per measure except for one 6-beat one), and a third could verify the uniformity of, first, the repeating 5-quarter-note figure that hockets against the bar lines in measures 5-8, and later the 2:1 division of the first triplet compared to the second one.

Ed himself can pick up any of these exercises and perform it on call, as a student can learn by referring to any one of them out of context. Before the conversation proceeds Ed will helpfully freshen our memory of it.

What this book contains

Over the decades Ed has made some six hundred exercises, most without names, but each with a serial number. The numbering is loosely chronological but Ed has continually made revisions and offshoots. Different ones were used during different years of the seminar, in different orders. To compose this book Ed chose his favorite ones (a mere 347 of them) and organized them into eight chapters. The chapters are not in any clear progression; the student can start as well at chapter 8 as 1.

Each chapter is divided into four sections, originally called “fun”, “blow your mind”, “long”, and “neat,” but now appearing simply as ”1.1” and so on. The various tags, and the ideas or strategies behind them, recur at odd intervals through the various chapters and sections, except that each last (“neat”) section focuses down on one concept area. For example, section 1.4 is an extended study on the rhythmic ratio 17:11, and section 3.4 examines two measures of a piece by Brian Ferneyhough from many possible points of view, and section 8.4 offers a deep dive into HAMns.

What to do with it

Ed’s primary pedagogical aim is to show you how you can perform difficult rhythms, either by tapping or vocalizing them, or on a musical instrument. In order for the time onsets to be correct, you have to be able to hear whether they are right or not. When you are performing the rhythm correctly, you also must *know* that you are performing it correctly. In one of Ed’s classes I learned that, when you are rehearsing in a group with a conductor and the conductor asks you whether you played a rhythm correctly or not, your correct answer is, tautologically, “yes”.

Some of the examples ask you to listen for *ESPIT*: equally spaced onsets in time. Others ask you to notice that complicated-looking rhythms are often well approximated by much simpler ones. Yet others require a sort of figure/ground reversal in which one rhythm (regular or not) becomes the beat against which another rhythm is played. There is sometimes a *puline* (punch line) - a complicated-looking rhythm is in fact ESPIT, or two very different-looking examples are identical as sounded.

There is usually more than one possible strategy for performing a rhythm, and as mentioned above, it often pays to learn to employ more than one strategy simultaneously. In some complicated situations it pays to re-notate a rhythm in a variety of ways, both approximate and exact, in order to find a way of understanding the rhythm that allows you to verify the correctness of your performance. On many occasions the same rhythmic fragment is examined from several different points of view. Not all of them will be useful to any one practitioner, but an open-minded performer will find many possible paths to explore on their way to mastering a difficult rhythm.

Editorial notes

Rather than attempt to mold the contents of this book into any fixed editorial style, I've preferred to treat the examples, along with their titles and tags, as primary material. Some of the examples come with text descriptions, which are mostly my own recollections of Ed's observations. Otherwise I've hewed closely to Ed's original text, all the way down to the inconsistent spellings, capitalizations, and punctuation.

A few of the examples are adapted from elsewhere: one each by Jörgen Jersild, Peter Magadini, and Arthur Weisberg (the latter for an analytical re-telling of a measure by Ralph Shapey). There are also three excerpts from Ferneyhough, including very dirty reproductions from manuscript scores. We don't yet have formal permission to reproduce these. Although they certainly fall under fair-use rules we plan to be polite and ask permission before publishing this manuscript in final form.

Many of the examples have one or more keywords, such as "Odd Evening" or simply "fun". These are collected in an index of tags so that the reader can use them to find other examples that share the same tag. In some cases the tags deserve a bit of explanation, and for these, one of the examples was selected to introduce the tag with a bit of explanatory text; these tag-explainer examples are listed first in the tag's index entry. Readers of the electronic version can click on the tags to navigate between the examples and the tag index.

In addition, many examples come with soundfiles. In the printed version there

is a comment below the printed example giving the soundfile's index number; to hear it the reader will have to chase it down on a computer. If reading a digital version, it should be possible to hear the example just by clicking on the "AUDIO" link below the displayed score.

Special thanks are due to Andrew ("Drew") Allen, who developed a Pure Data patch to generate one of the examples, out of which Ed derived several related ones. Drew's patch still mostly works and once I've got it back in shape I'll distribute it.

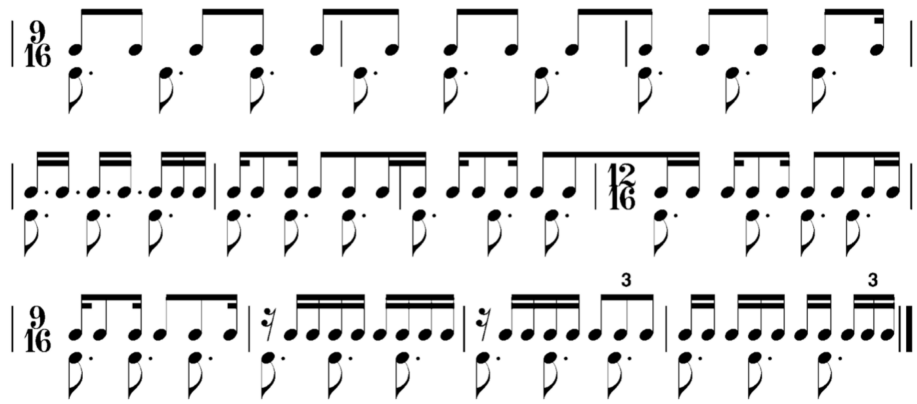
Thanks also to Trevor Henthorn, who data-mined a massive collection of digital slide shows to extract the hundreds of images and soundfiles that made it possible to assemble this book.

—Miller Puckette

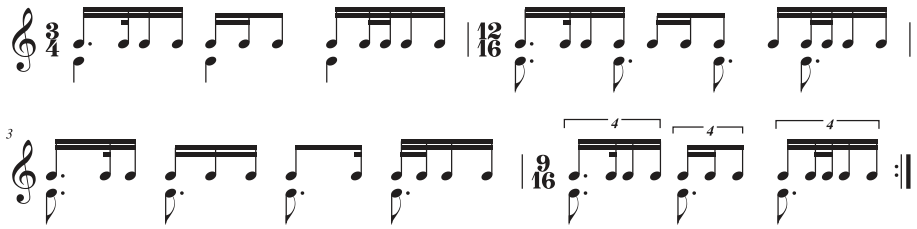
Chapter 1

1.1

106. Pat 1st

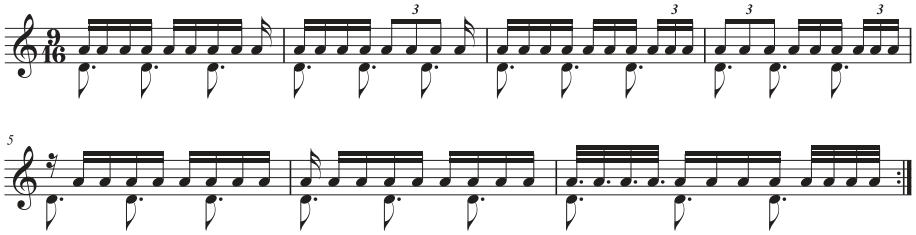


108b. With beat, Patt 1st



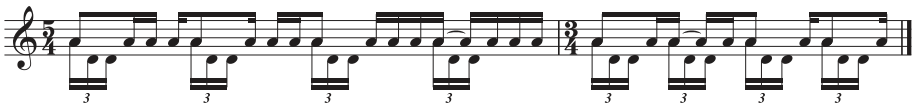
Tag: ***Fun***. Audio example number 15014.

107a. ReGroup



Tag: ***ReGroup***. Refers to exercises in which a fixed time duration (in this case sixteenth notes) are grouped differently from measure to measure, sometimes purely notationally (which could imply phrasing but could also just be psychological), and sometimes in order to apply transformations such as tuplets or dotting. In this exercise, over the space of nine measures the top line is grouped 4+4+1, then 4+3+2, then 1+4+4, then 3+4+2. See also: 105b; 62; 508; 112; 455; 442; 524; 104. Audio example number 23010.

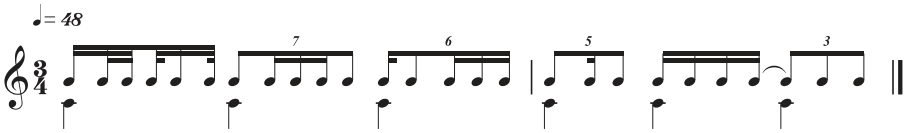
89b. Tibet



Tag: ***Tibet***. Short for *Tie Betweens*. Other tag: ***Duplex***. Audio example number 19014.

1.2

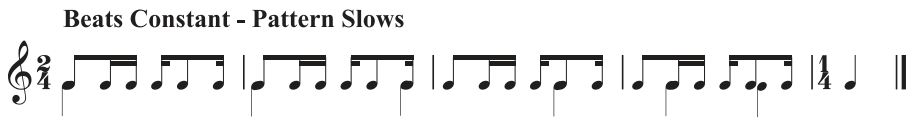
43a. Different Rat/same speed



Tag: ***Different Rat/same speed***.

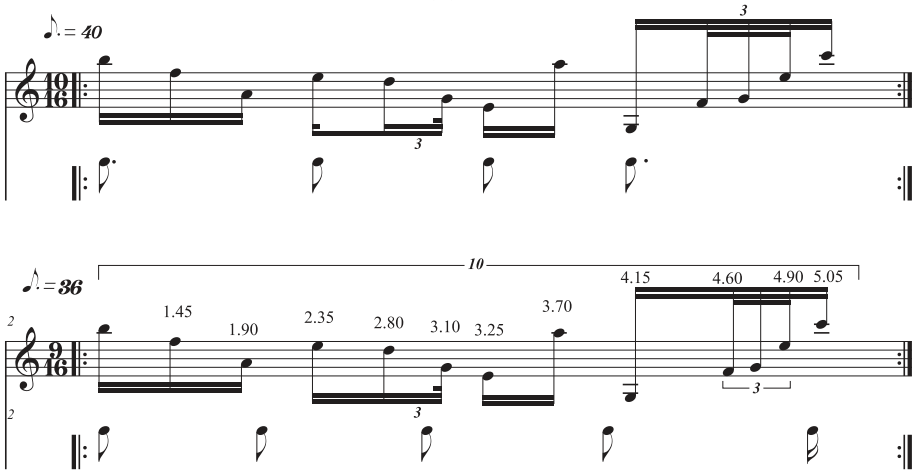
The same 6-attack sequence is played more and more slowly against the steady quarter notes. You can also play this example with an increasing tempo so that the sequence repeats at the same speed (and the quarter notes accelerate).
See also: 182. Audio example number 20002.

44b. Patt 1st Rit Oblique



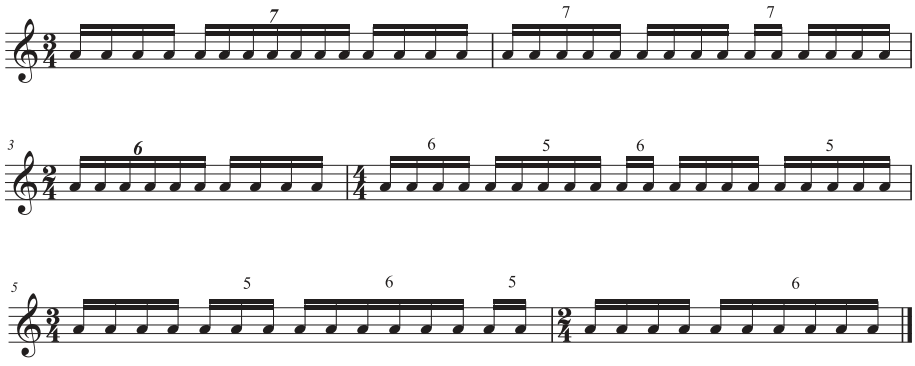
This is what 43a becomes when accelerated to even out the top line. The bottom-line quarter notes are placed as they sound against the the top.
tag: ***Short-Hand/Patt 1st***

604. 10:9



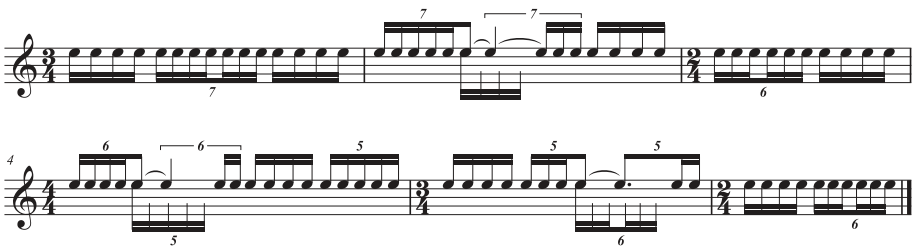
Audio example number 20002.

80e. Part rat



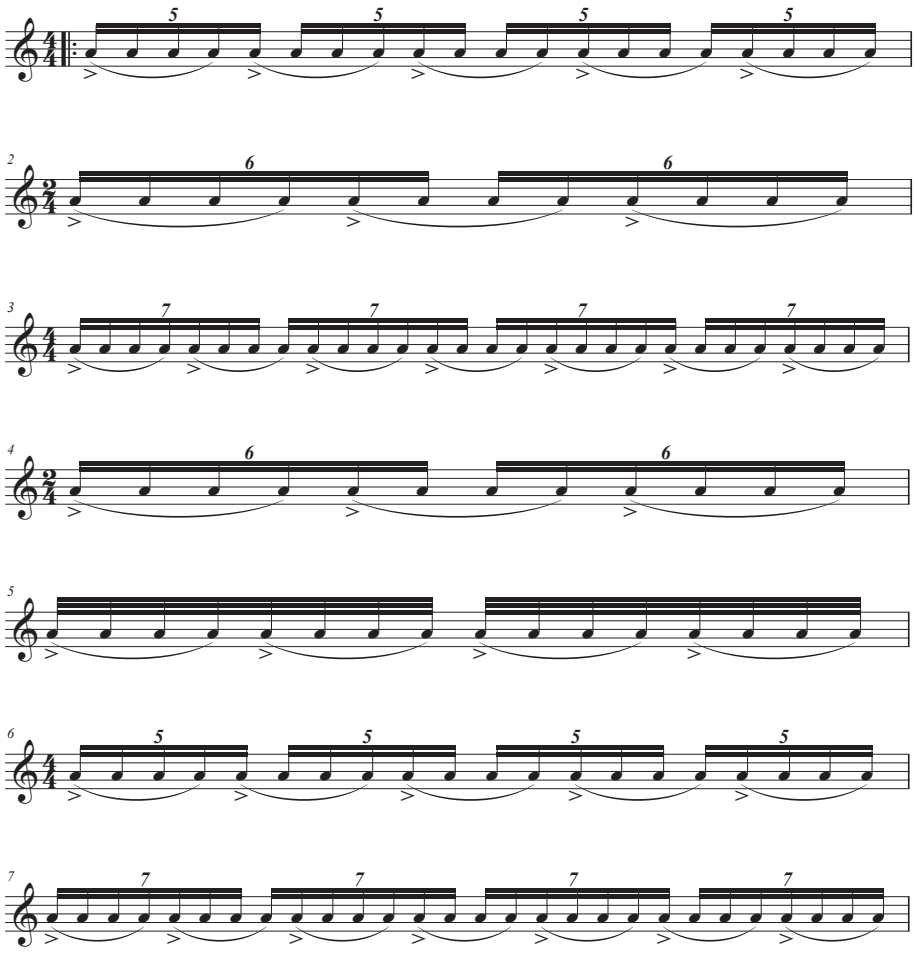
Audio example number 20002.

80b. Odd dupl



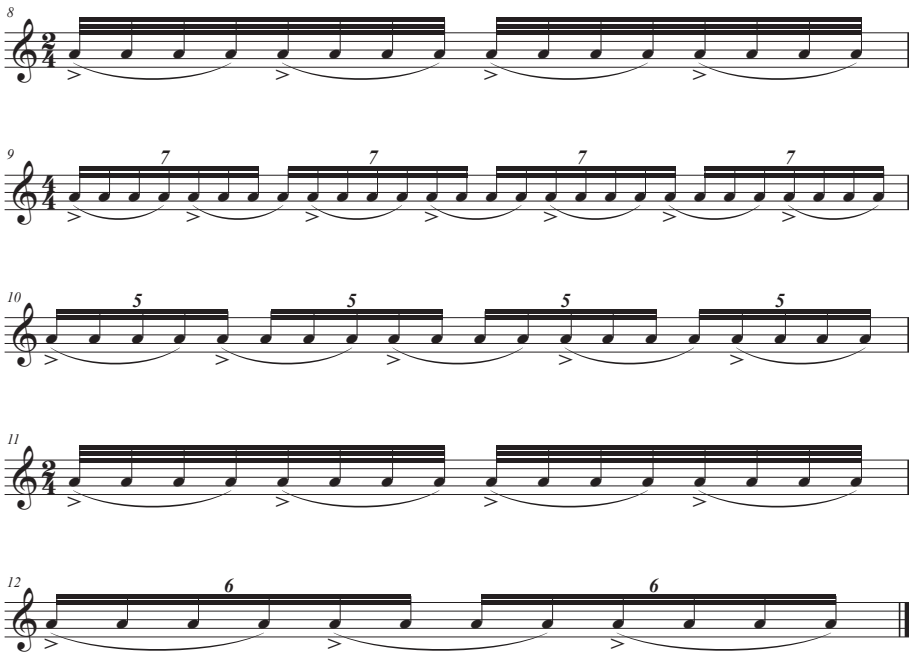
tag: ***Duplex***.

105b. Indian ReGroup

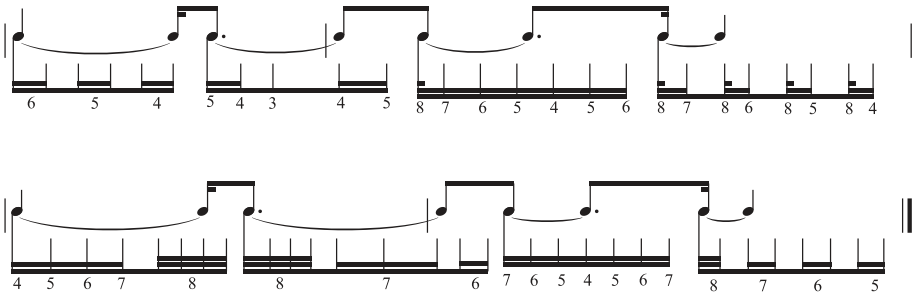


(Continued on next page.) tag: ***ReGroup***. Audio example number 21012.

105b. Indian ReGroup (Continued from previous page)



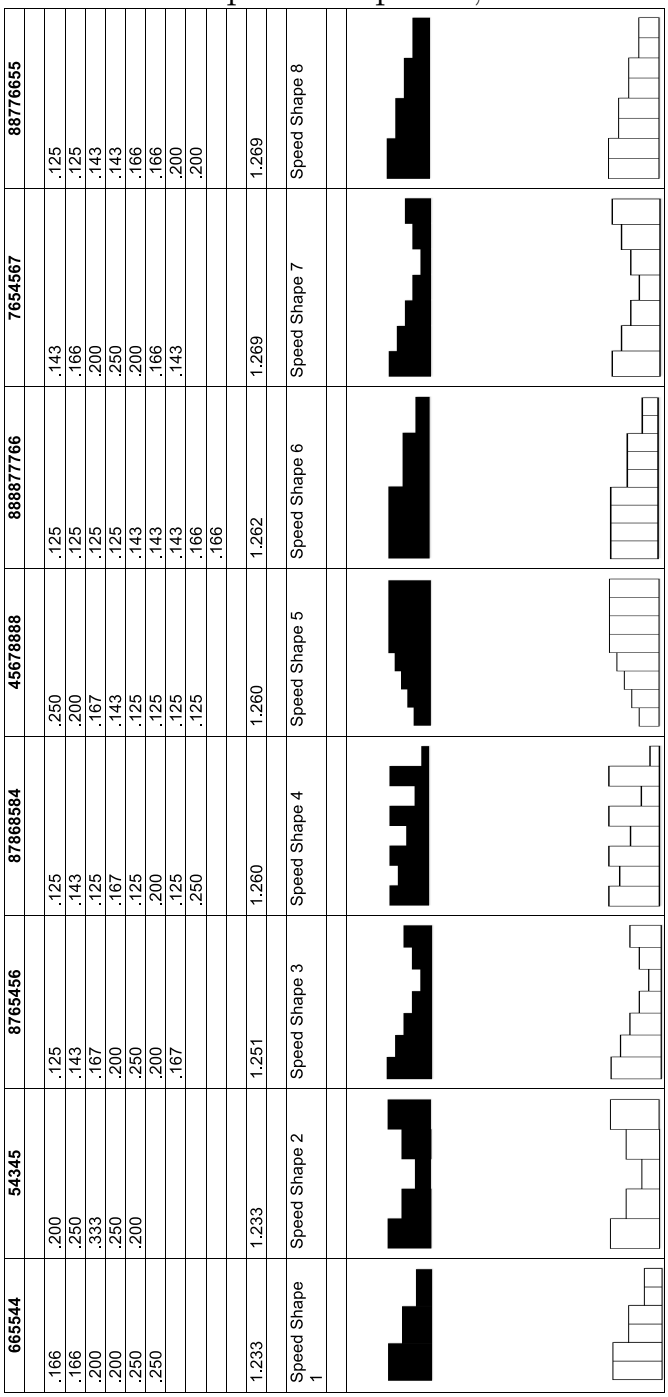
114. Extreme partial AproPo



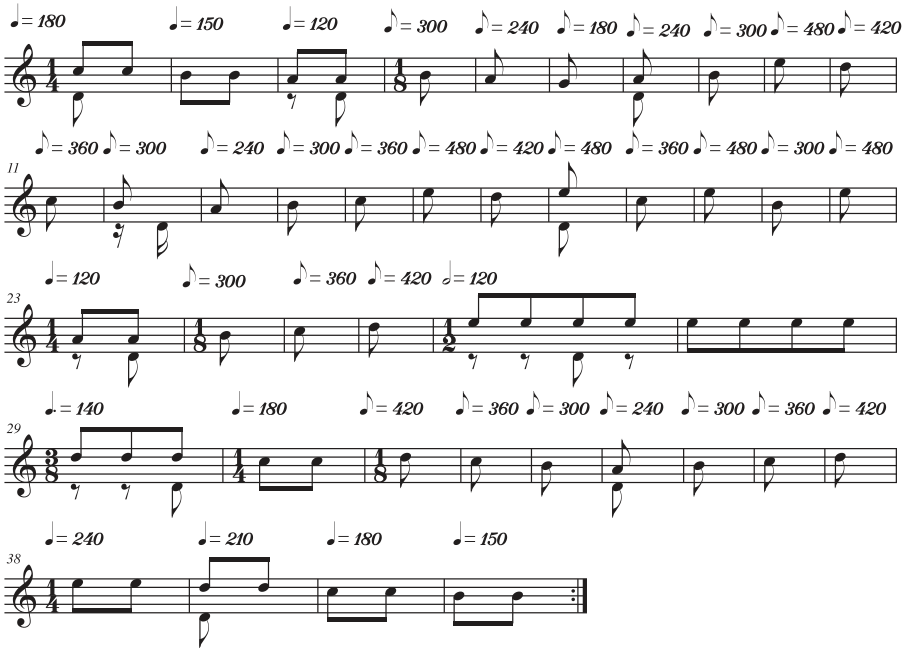
tags: ***AproPo***; ***Partial Rats***.
Audio example number 26002.

114. Extreme partial AproPo, as numbers

665544		54345		8765456		87868584		45678888		88877766		7654567		88776655	
.166		.200		.125		.125		.250		.125		.143		.125	
.166		.250		.143		.143		.200		.125		.166		.125	
.200		.333		.167		.125		.167		.125		.200		.143	
.200		.250		.200		.167		.143		.125		.250		.143	
.250		.200		.250		.125		.125		.143		.200		.166	
.250				.200		.200		.125		.143		.166		.166	
				.167		.125		.125		.143		.143		.200	
						.250		.125		.166				.200	
										.166					
1.233		1.233		1.251		1.260		1.260		1.262		1.269		1.269	
Speed Shape 1		Speed Shape 2		Speed Shape 3		Speed Shape 4		Speed Shape 5		Speed Shape 6		Speed Shape 7		Speed Shape 8	

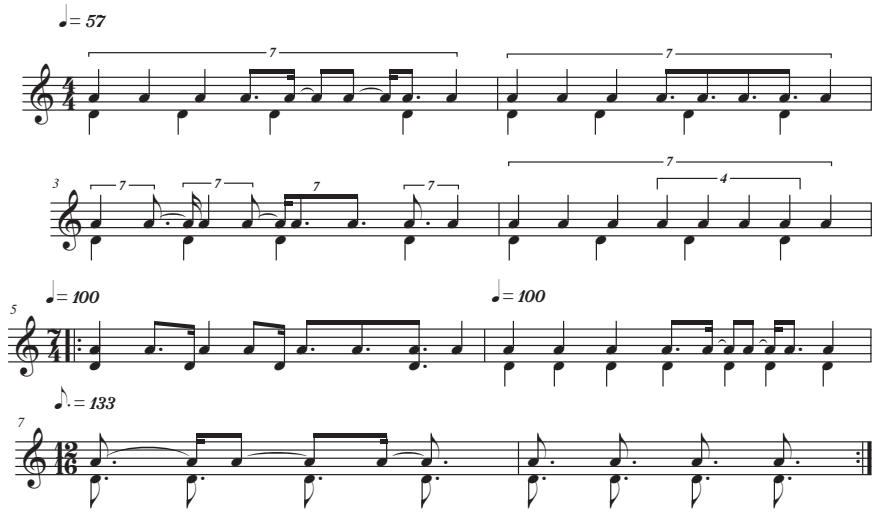


114. Extreme partial AproPo, as it sounds



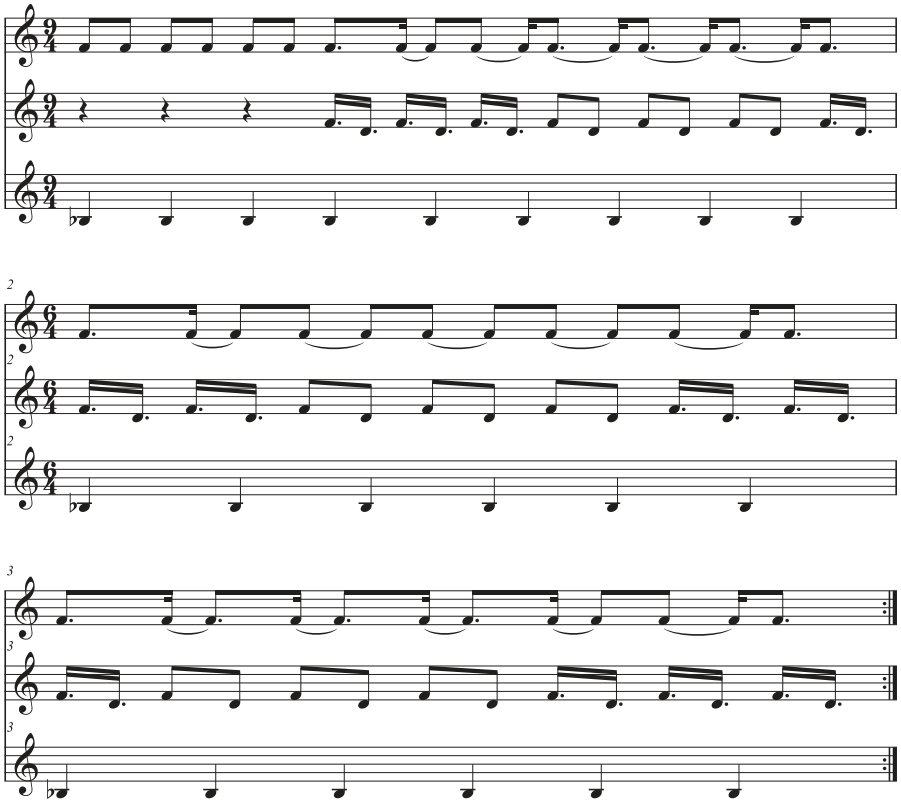
1.3

76c. ReTempo/reRatio



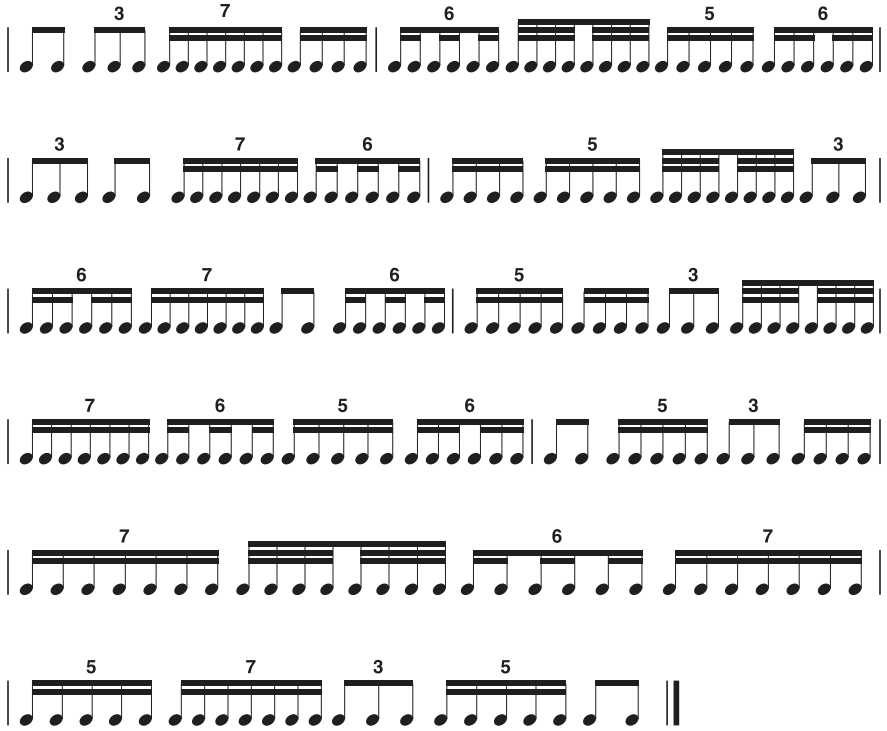
Audio example number 18017.

90b. Duplex



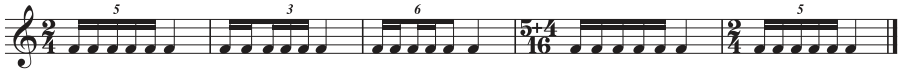
Tag: ***Duplex***. See also: 89b; 80b; 78; 95; 112; 583. Audio example number 14010.

33. same patt/dif rat



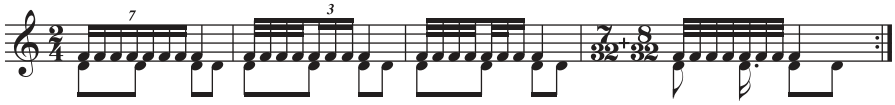
Tag: ***Same Patt/Differ Rat***. See also: 471; 538a; 560. Audio example number 18015.

2. typical mist



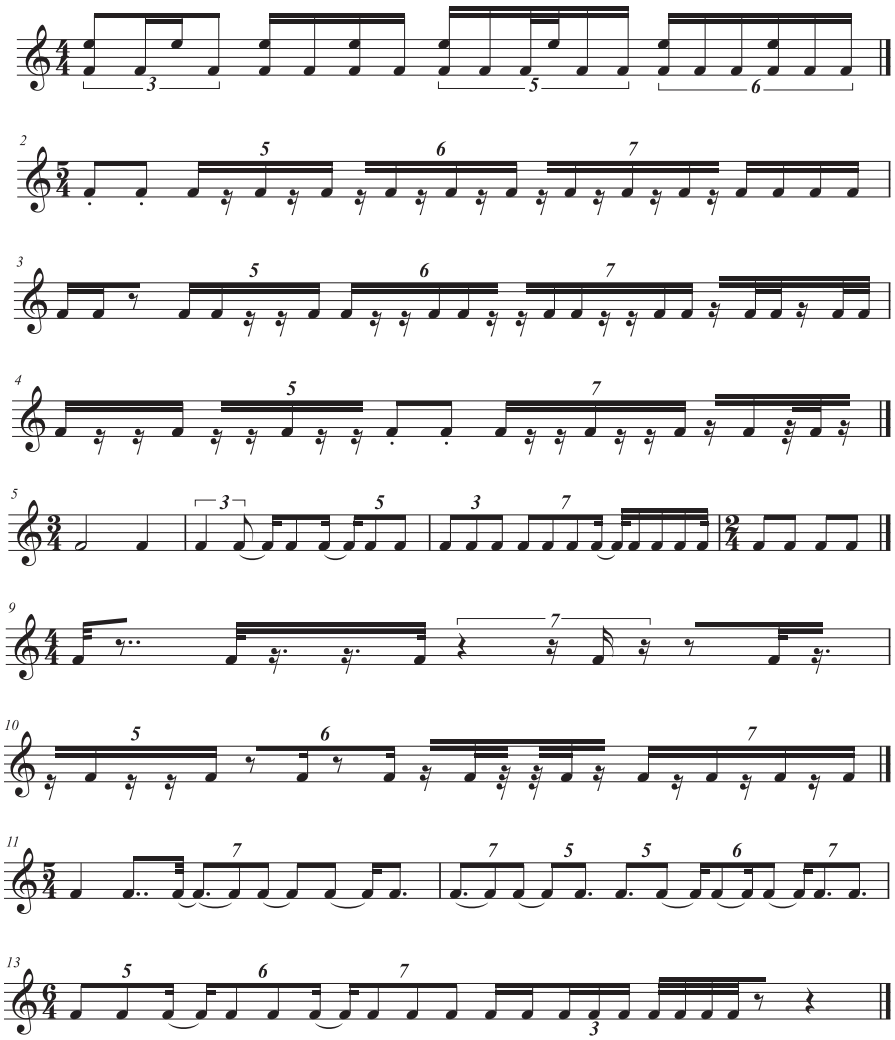
Tag: ***Typical Myst***. See also: 444; 505; 513. Audio example number 18015.

444. 7s typ mist



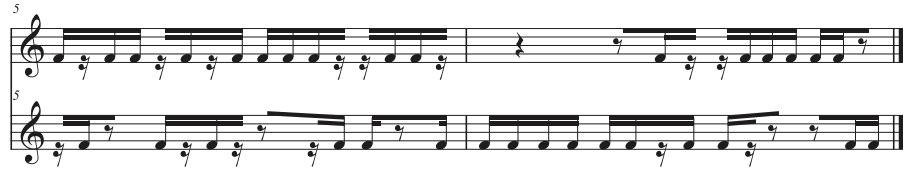
tag: ***Typical Myst***.

22-26. accels



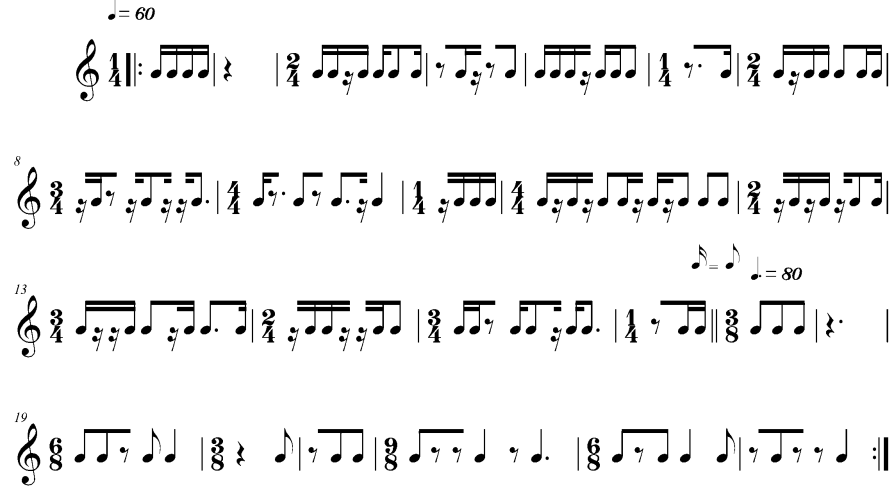
Audio example number 3014.

46. 4:1 APs-Hocket, each/once



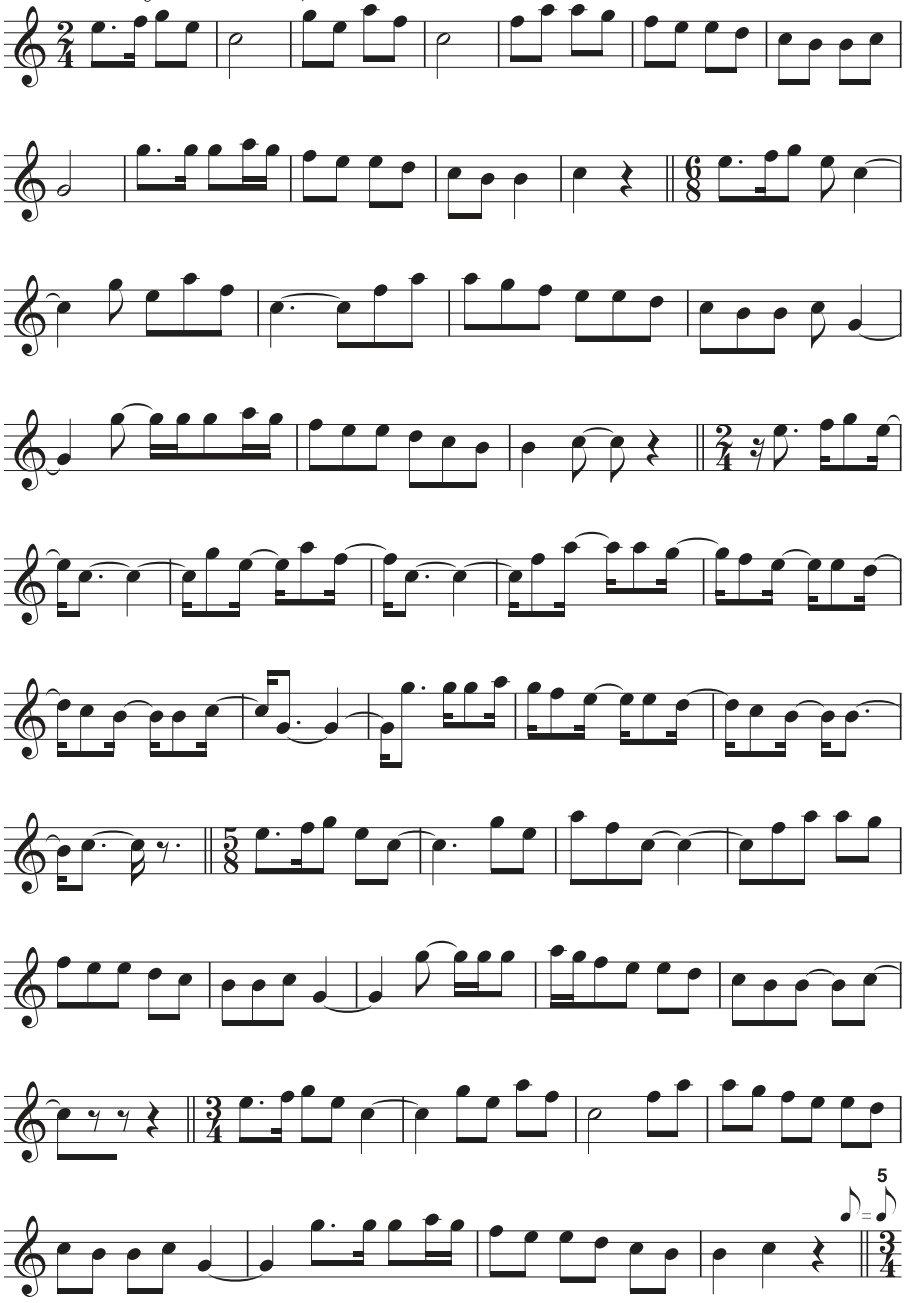
tags: ***Class Representatives***; ***Each/Once/(Spread)***

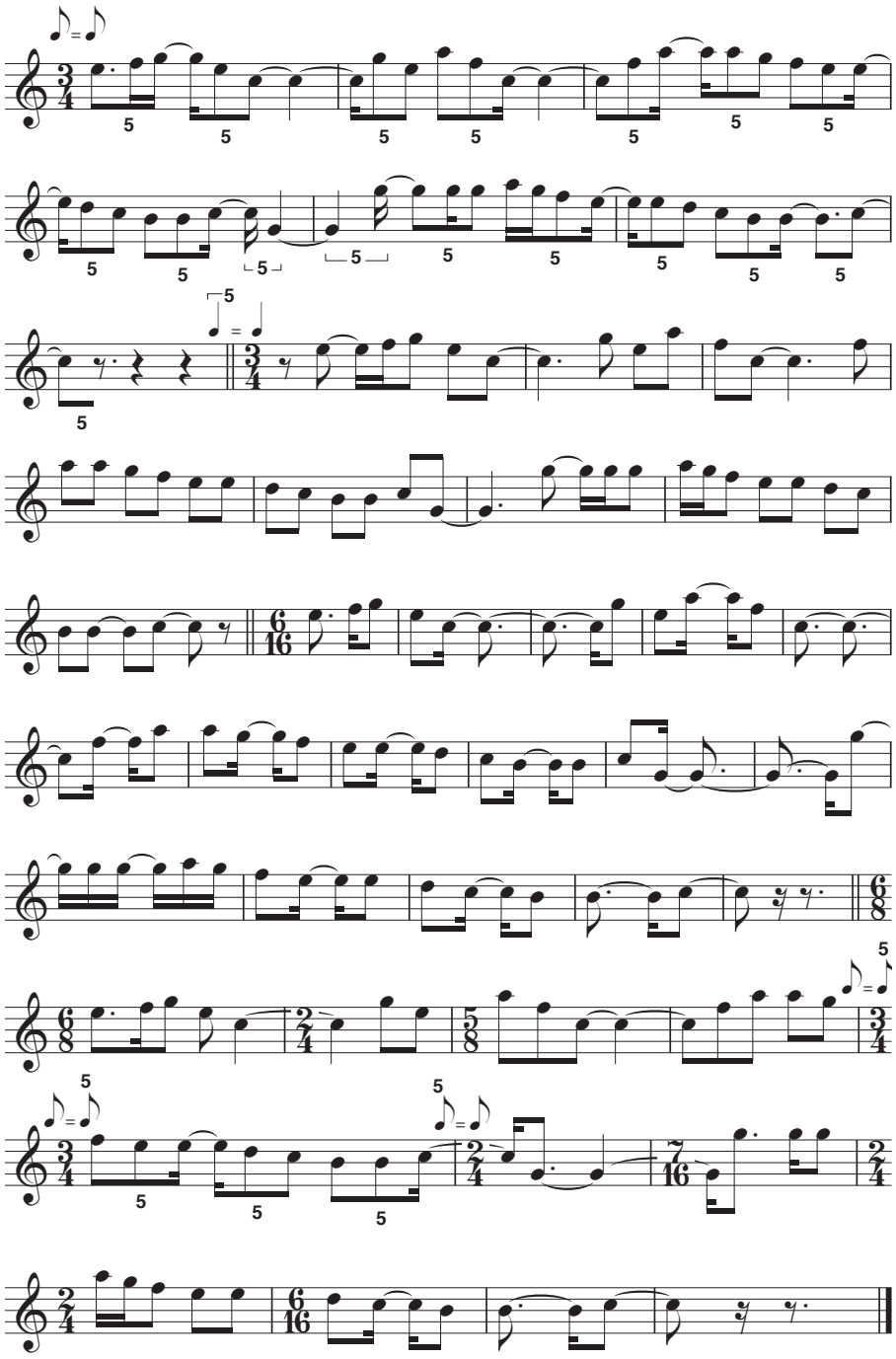
388. 4 & 3:1 AP/dur-All



tags: ***Class Representatives***; ***Each/Once/(Spread)***; ***Fun***; ***door mat (d'Order matters)***

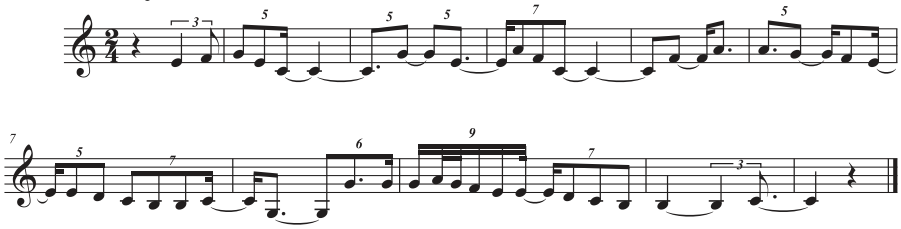
260. Haydn - 331, 583G





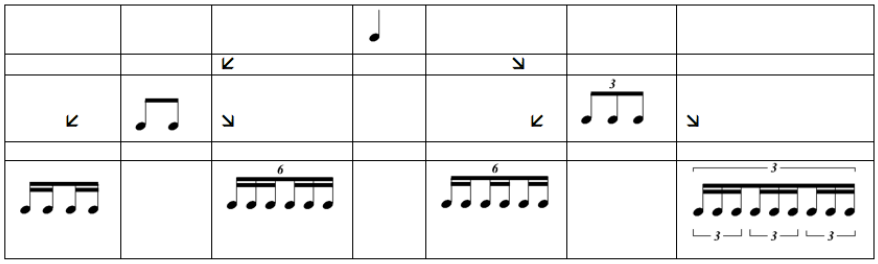
tags: ***Known Tune/Wrong Rhy***; ***Fun***. Audio example number 5008.

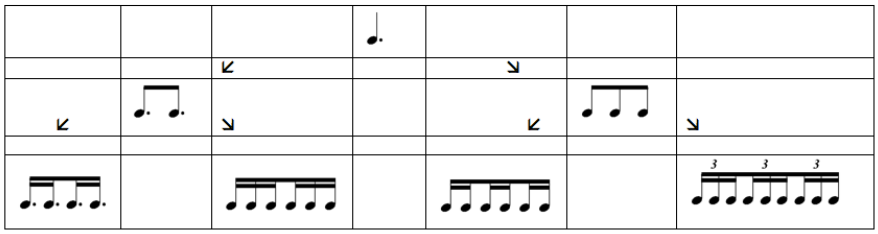
331. Haydn rat



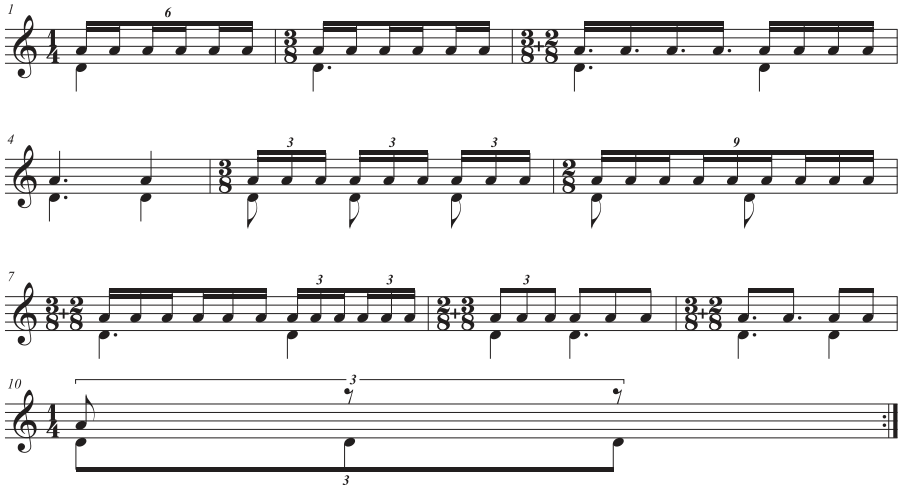
Audio example number 5009.

187. Magic 14 chart

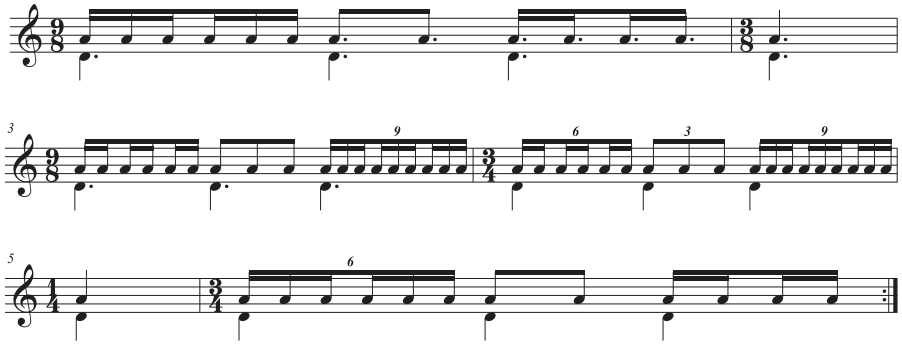




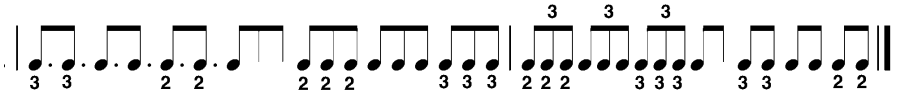
187b. 187 score



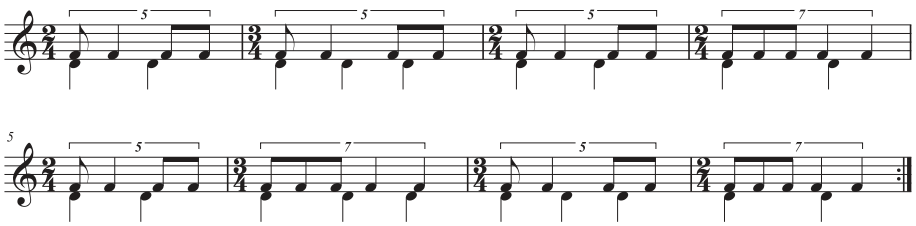
188



189

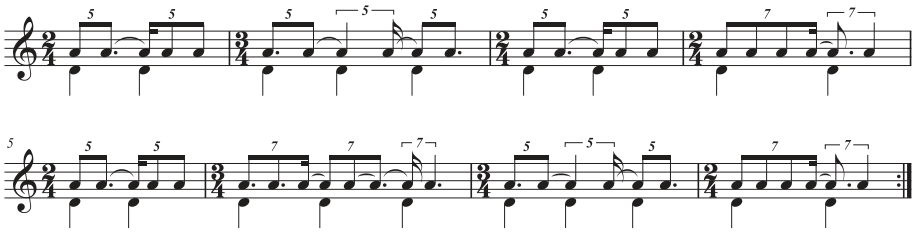


68. look simp/not



tags: ***Long-Hand***, ***Look Diffic/Are Easy*** Audio example number 28008.

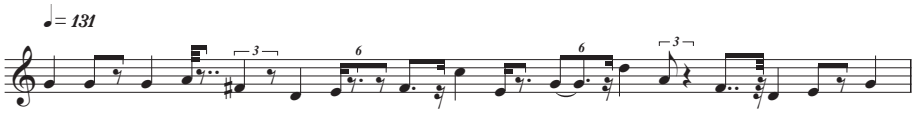
68b. look simp/not



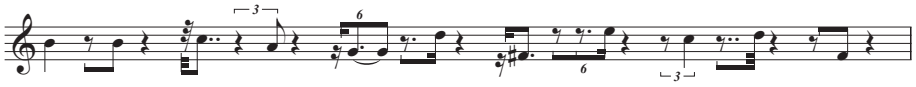
tags: ***Long-Hand***, ***Look Diffic/Are Easy*** Audio example number 28009.

1.4

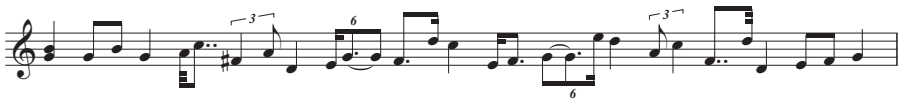
570. tun 1a



570. tun 1b

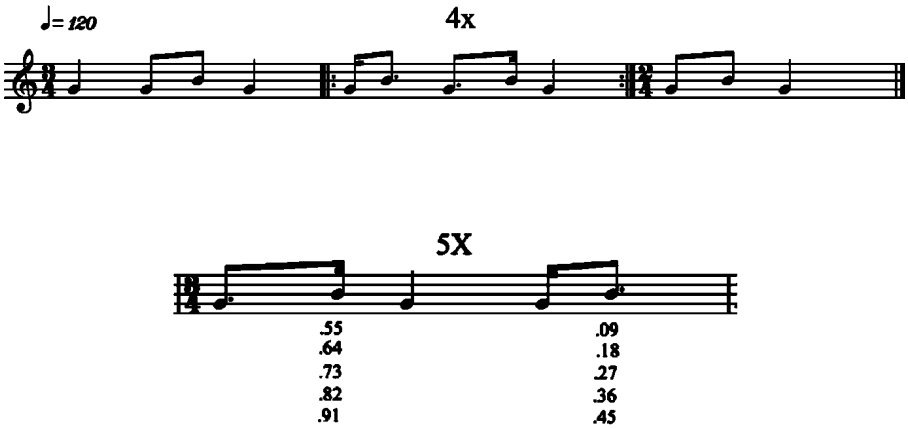


570. hocket 1



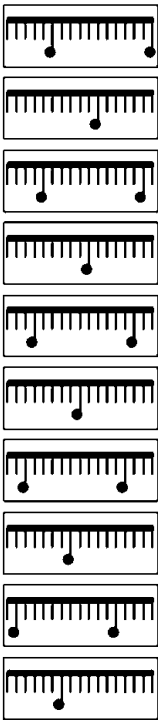
Audio example number 13015.

570. compos (Patt w dec-composite patt)

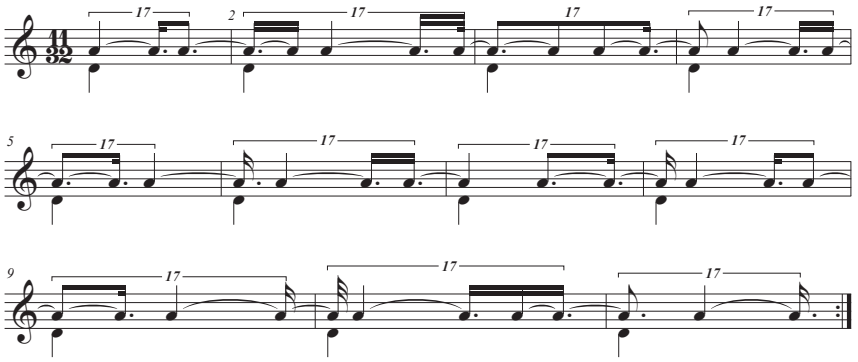


Audio example number 13007.

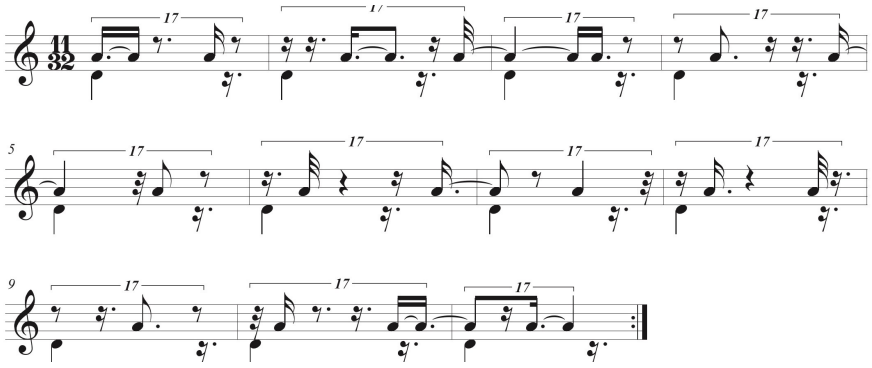
570. 17:11 Lolli-HAM



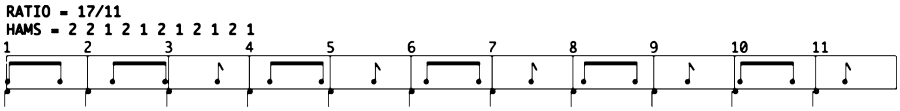
570. conventch



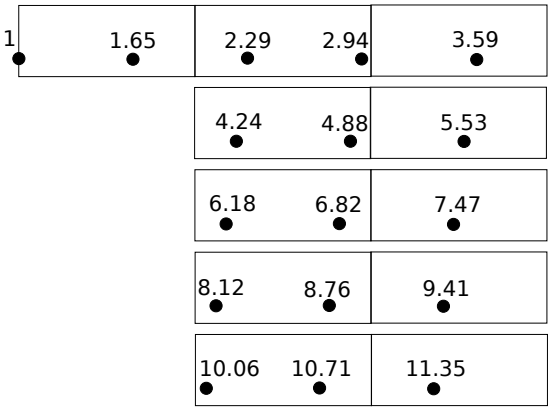
570. conventch not ful-dur



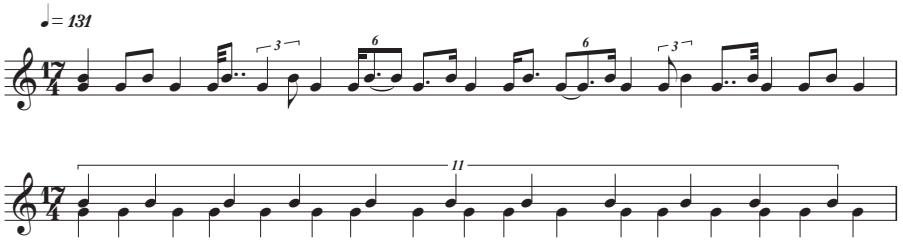
570. propor



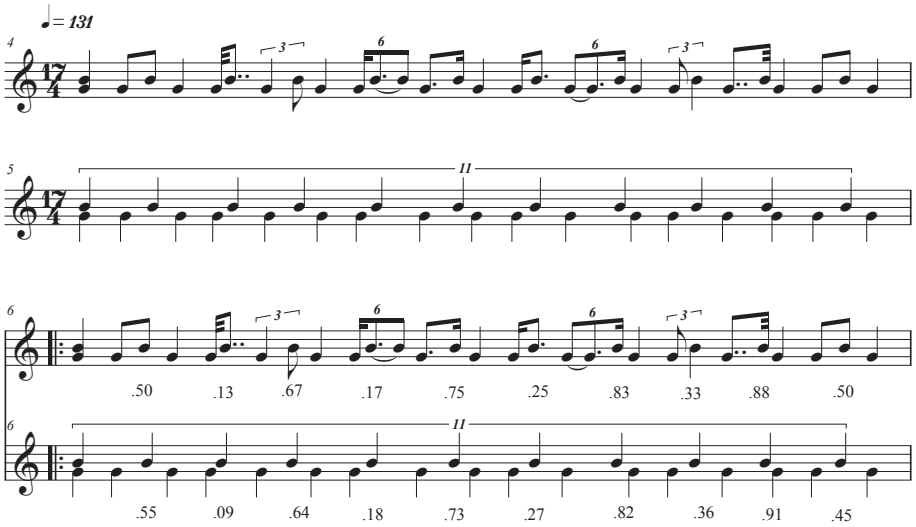
570. vert (17:11 decimals vert)



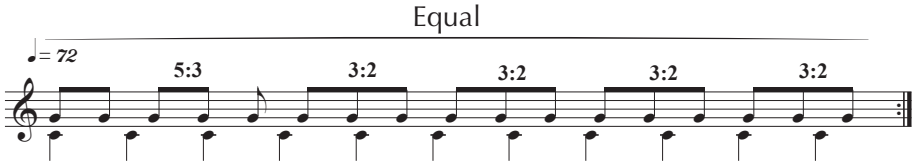
570. invert



570. seq/simul

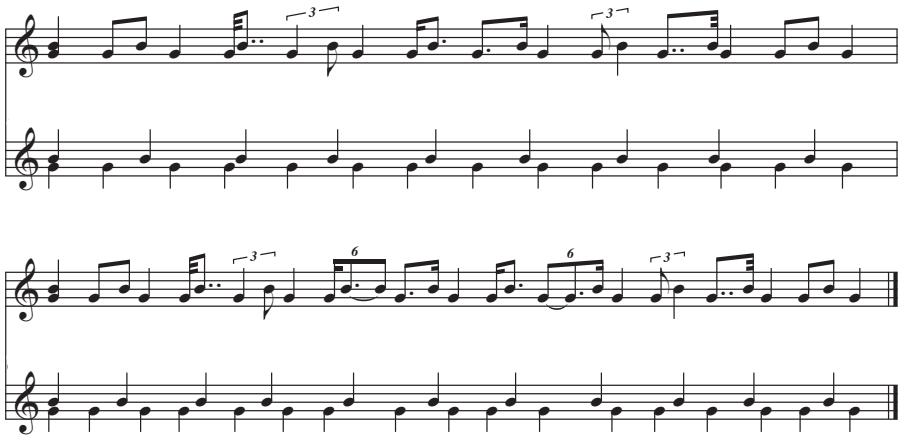


570. noodgie w/rats



Audio example number 13008.

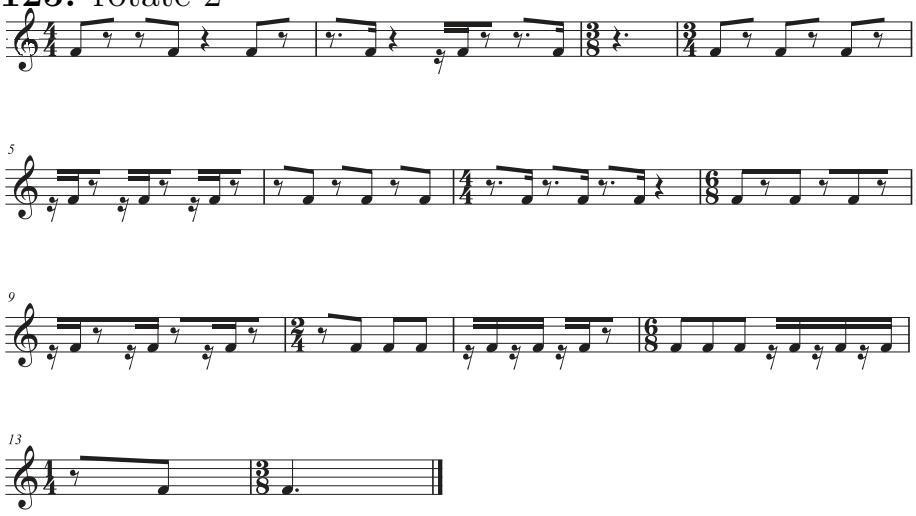
570. 14:9



Chapter 2

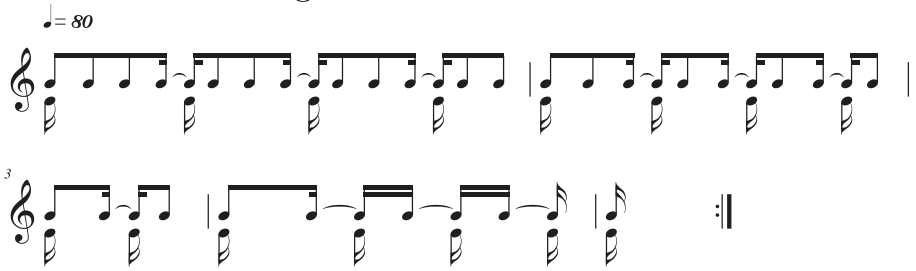
2.1

125. rotate 2



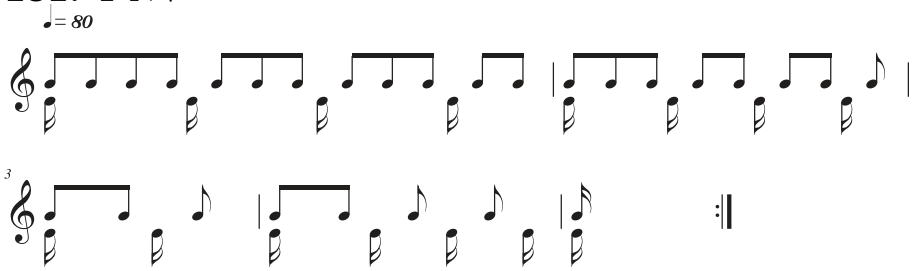
tags: ***Rotation***; ***Fun***. Audio example number 19008.

131. Odd Evening



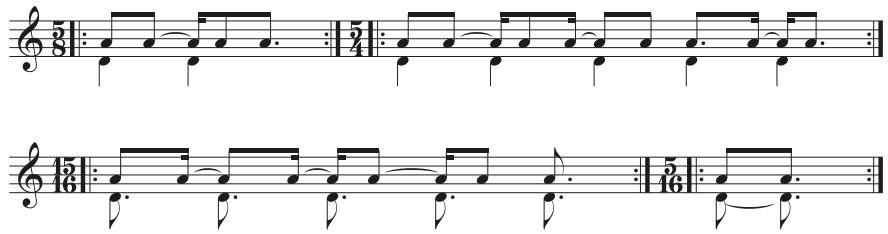
tags: ***Odd Evening***; ***Fun***. Audio example number 29008.

131. 1 NV



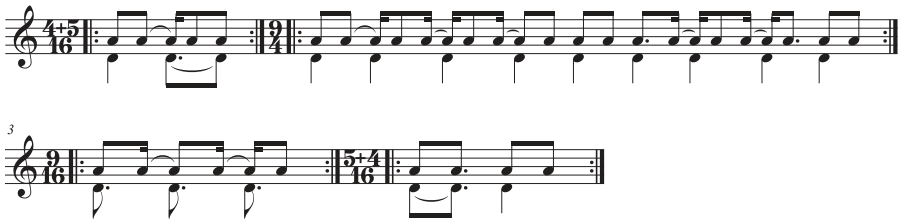
tags: ***Odd Evening***; ***Fun***. Audio example number 29009.

141. 2/3-All Contexts (369)



tags: ***Fun***. Audio example number 24015.

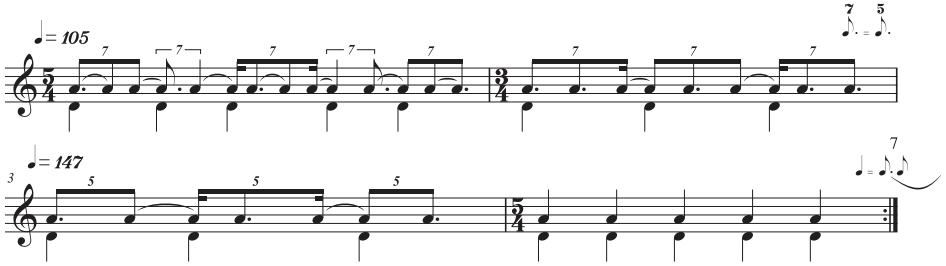
142. 2/3-All Contexts (369)



tags: ***Rotation***. Audio example number 24016.

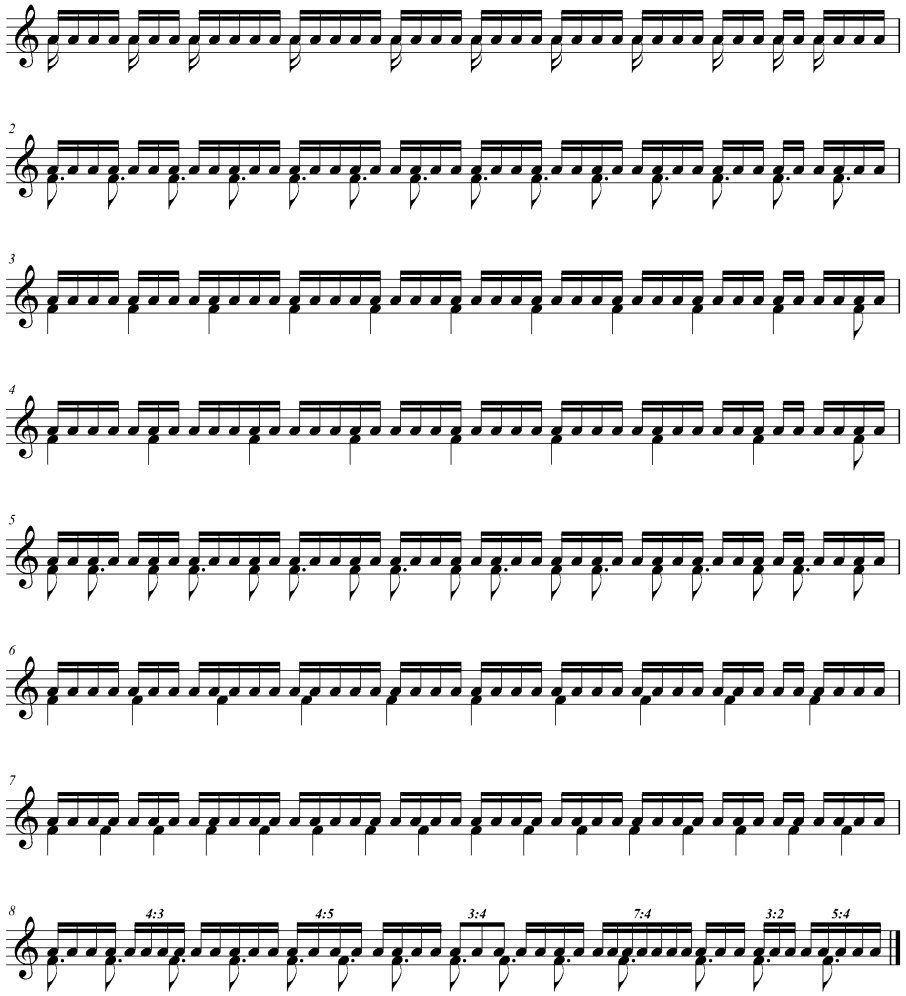
2.2

473. rats-met mod



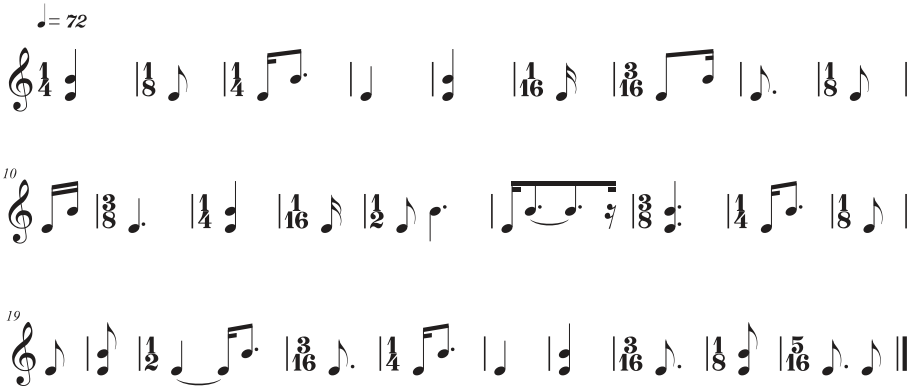
tags: ***Met Mod***. Audio example number 5015.

508. Grouping



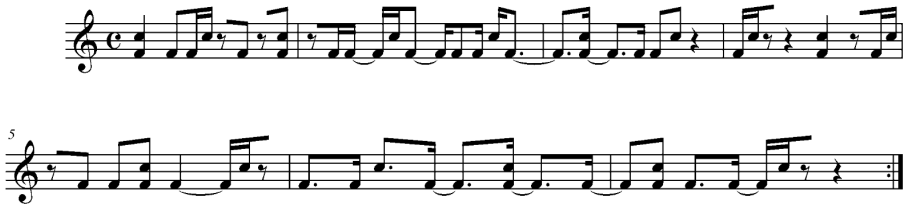
tags: ***ReGroup***. Audio example number 20010.

127. Two-hands



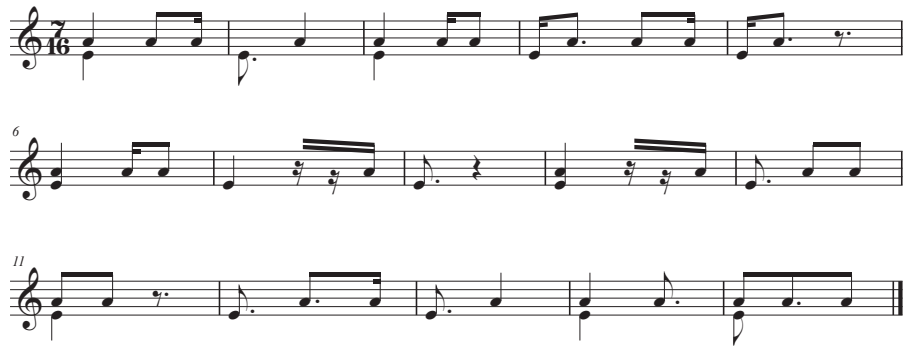
tags: ***THE***. Audio example number 15004.

415B. in 4/4



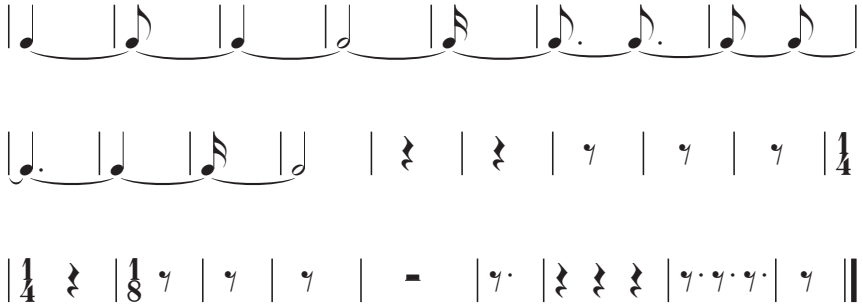
tags: ***THE***.

415g3. in 7



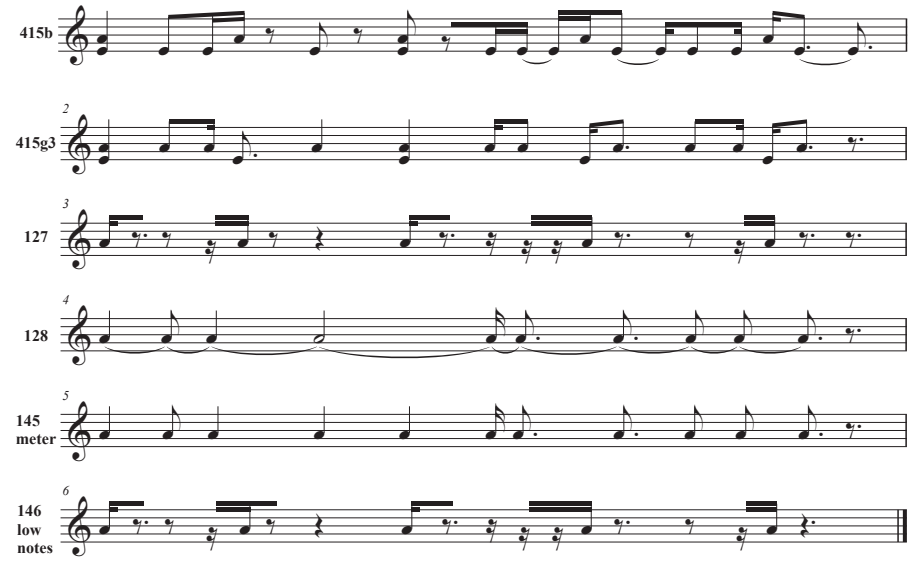
tags: ***THE***; ***Invert***; ***Look Differ/Are Same***. Audio example number 15008.

128. THE held



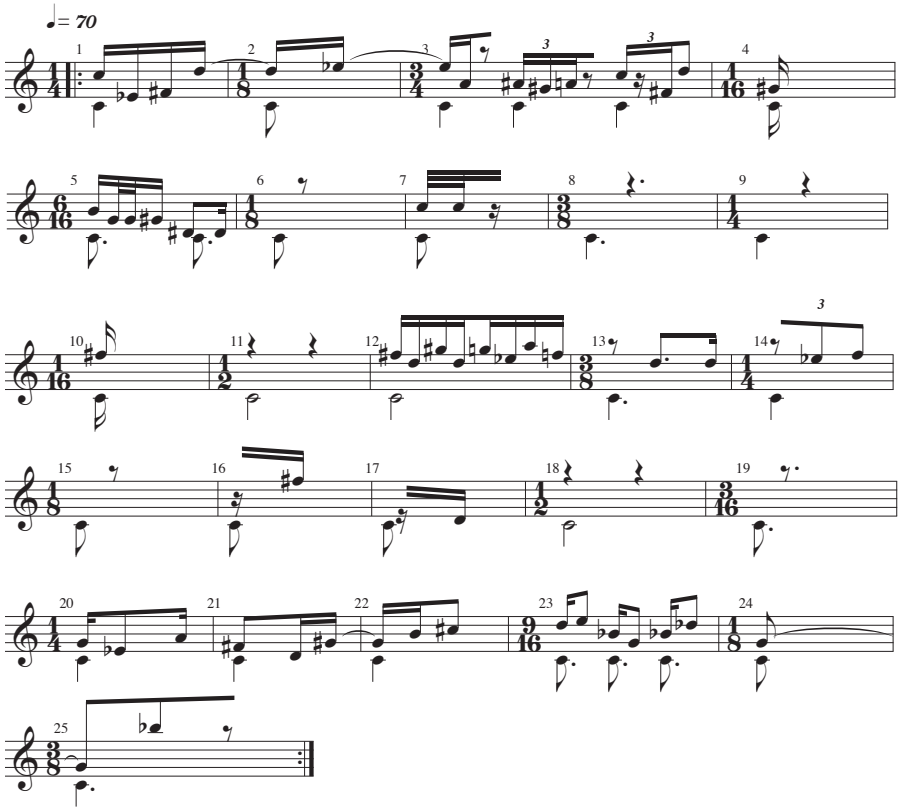
tags: ***THE***; ***All are ties***; ***All are silent***.

127. All 6



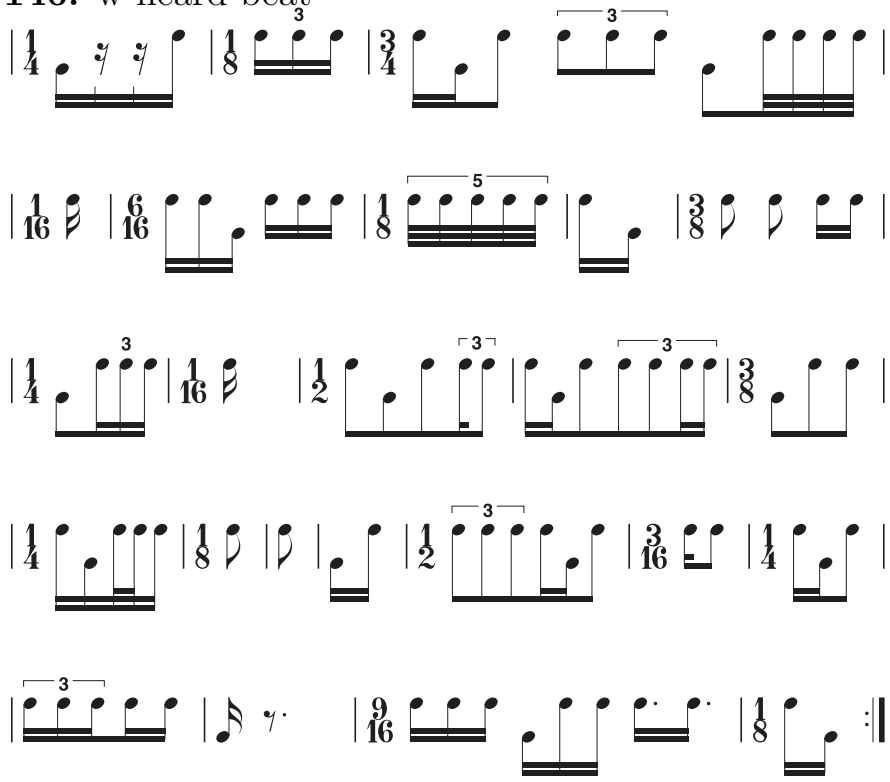
tags: ***THE***; ***Invert***; ***Look Differ/Are Same***.

145. THE Rhythm



tags: ***THE***. Audio example number 15002.

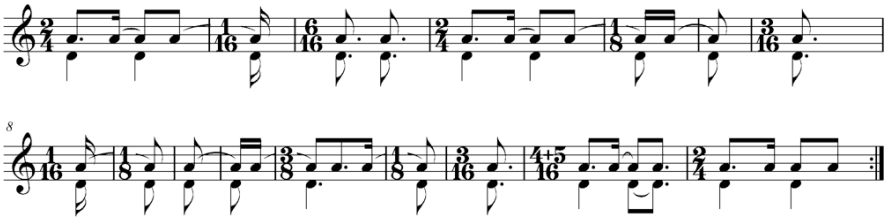
146. w heard beat



tags: ***THE***. Audio example number 15006.

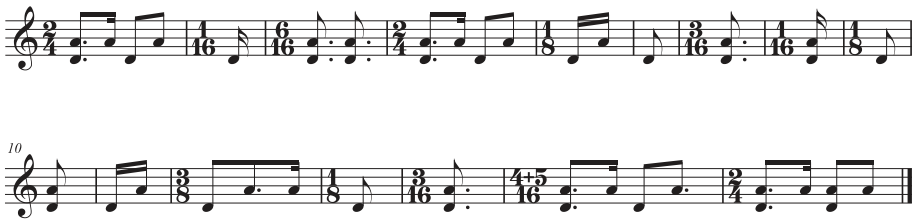
2.3

133. Music 2



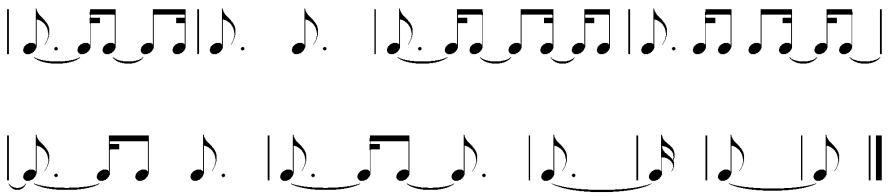
tags: ***Yeasty***. Audio example number 10003.

133b. 2-Hands



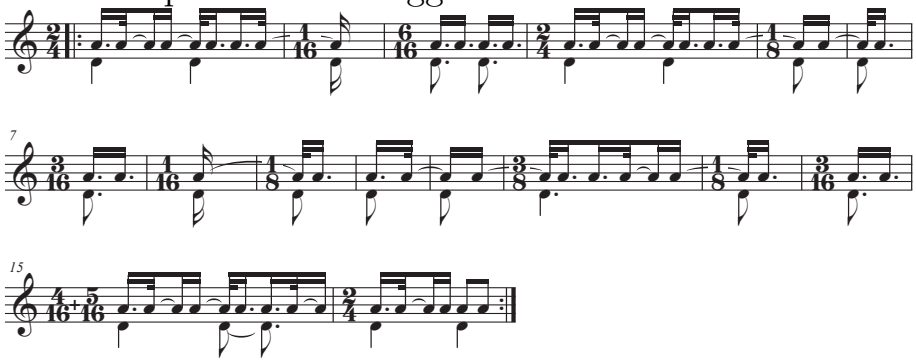
Tag: ***2-Hands***. Other tag: ***Yeasty***.

294. Invert



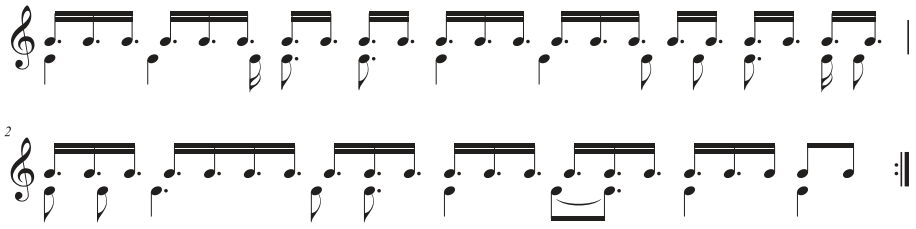
Tag: ***Invert***.

371. 2x speed w bashnaggles

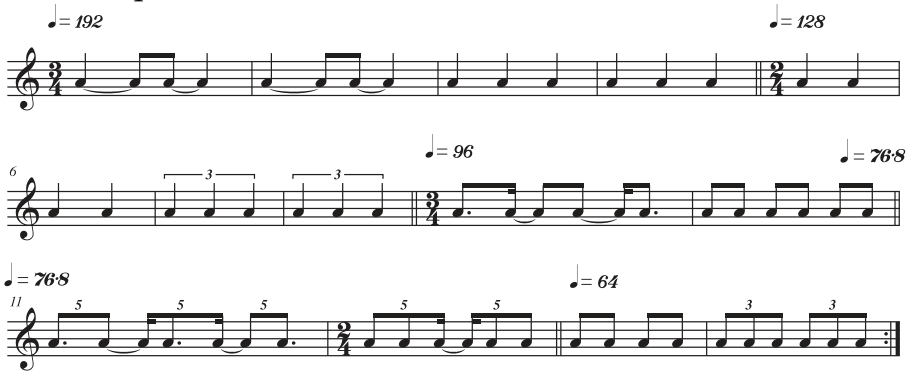


tags: ***Divide into two***.

371. One NV

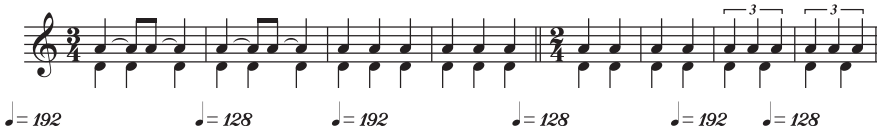


166. Eq Rats



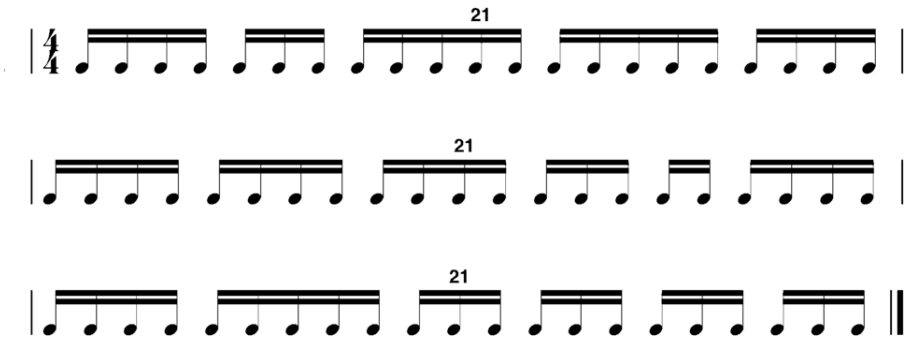
tags: ***2-ways***; ***Equiv Ratio Pairs***. Audio example number 11009.

168. Eq Rats2 (fast w beat)



tags: ***2-ways***; ***Equiv Ratio Pairs***. Audio example number 11010.

62. 21:4 regr



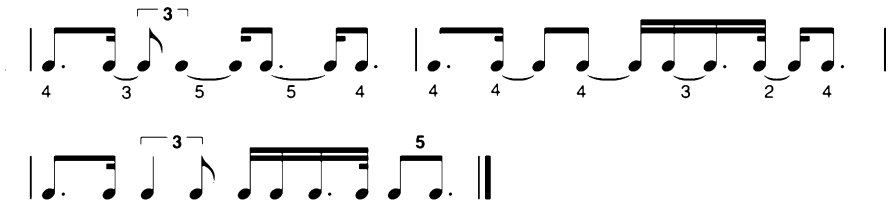
tags: ***Near Rats***; ***ReGroup***; ***Yeasty***; ***AproPo***. Audio example number 9015.

63a. w decimals 21:4

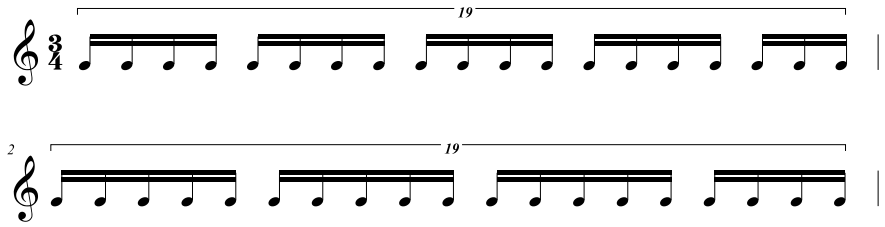
21:4 – each = .1905	# 63		
attacks at	Conventch - Bars 1, eg	wrong by	
1.00	1.0		
1.19			
1.38	4		
1.57			
1.76	1.75	.01	E
1.95 6	3		
2.14			
2.33	2.33	.00	O
2.52			
2.71	5		
2.91 5			
3.10			
3.29	3.25	.04	E
3.48			
3.67	5		
3.86 5			
4.05			
4.24	4.25	.01	L
4.43	4		
4.62		bar 1 total = .06	
4.81 5		= .015 avg wrong	
HAM = 6555		bar 2 =.020 avg	
		bar 3 = .028	

Tag: ***Decimals***.

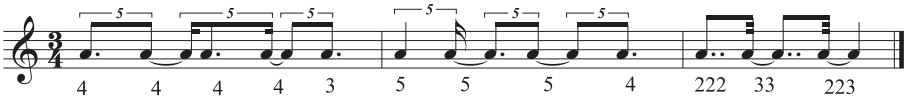
63. same AproPo, Groupings below dur



66. 2 versions

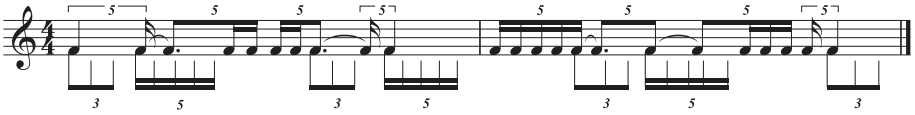


67. div with #s



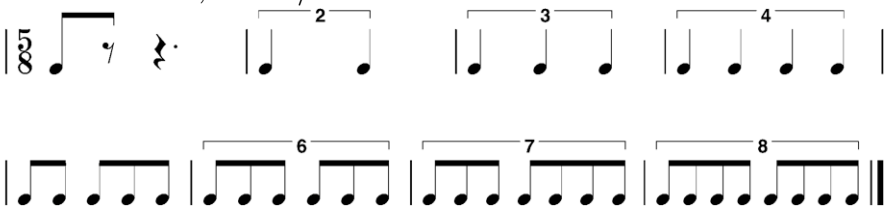
Audio example number 9018.

78. 3-5-4



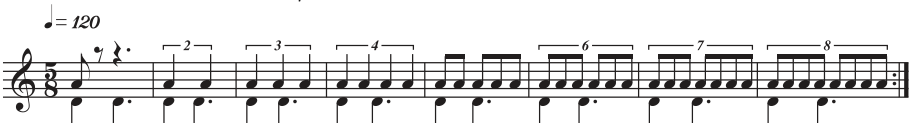
tags: ***Duplex***. Audio example number 7014.

171. x:Odd, ratio/5-8



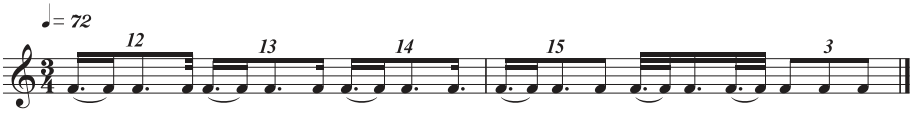
Audio example number 3009.

171. x:Odd, ratio/5-8



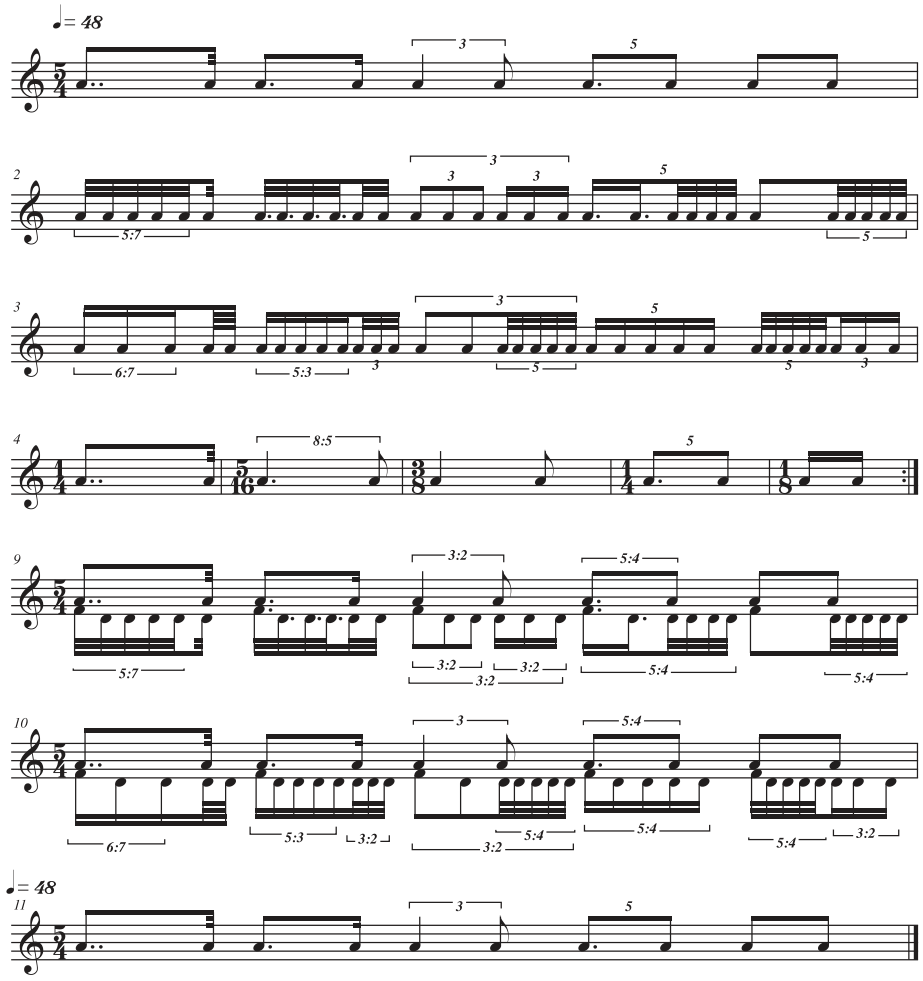
tags: ***Const x/change y***; ***x:5/8 & all 5/8's***. Audio example number 3009.

217. Transform Into



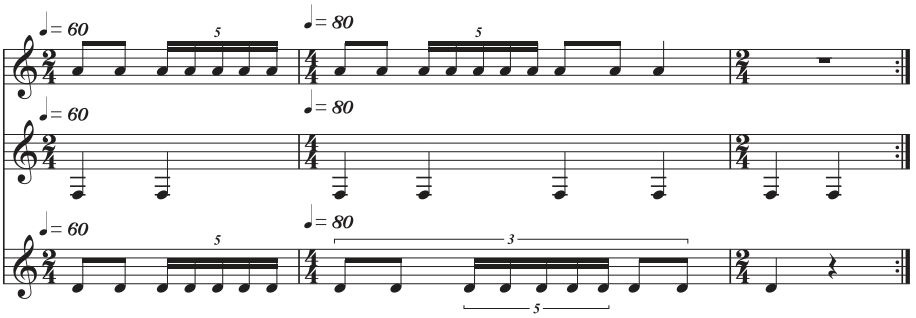
tags: ***Transform Into***. Audio example number 7016.

217. Ferney (excerpt from Brian Ferneyhough)



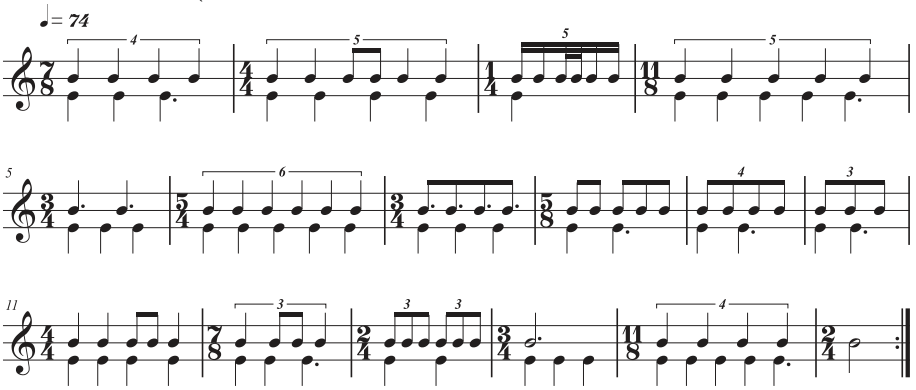
Audio example number 26006.

253. Maintain



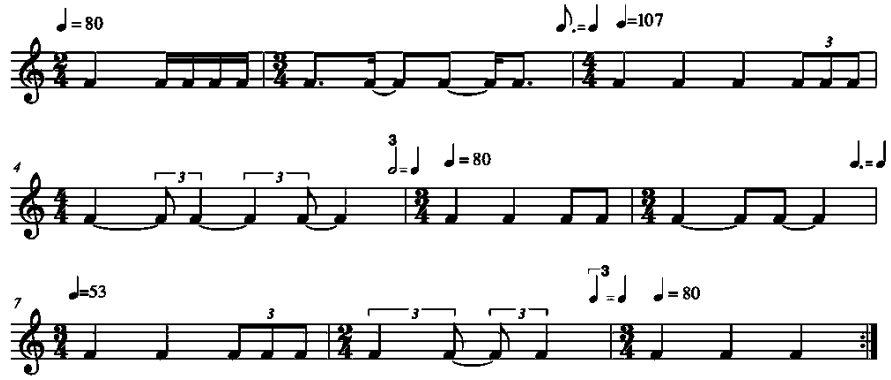
tags: ***Met Mod***; ***Met Mod Maintain***; ***Offsets***.

309. Q Q. (Excerpt from *Paraphrases* by Milton Babbitt)



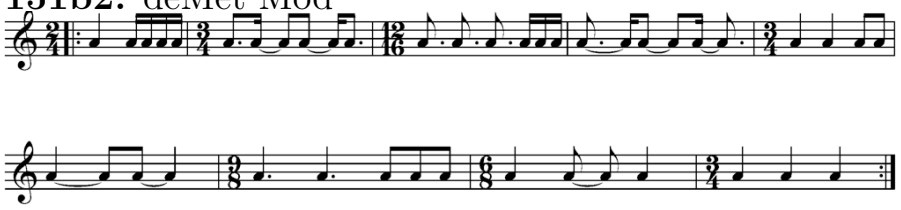
tags: ***Long-Hand***; ***Q Q.***. Audio example number 19013.

151. Met Mod



tag: ***Met Mod***. Audio example number 20016.

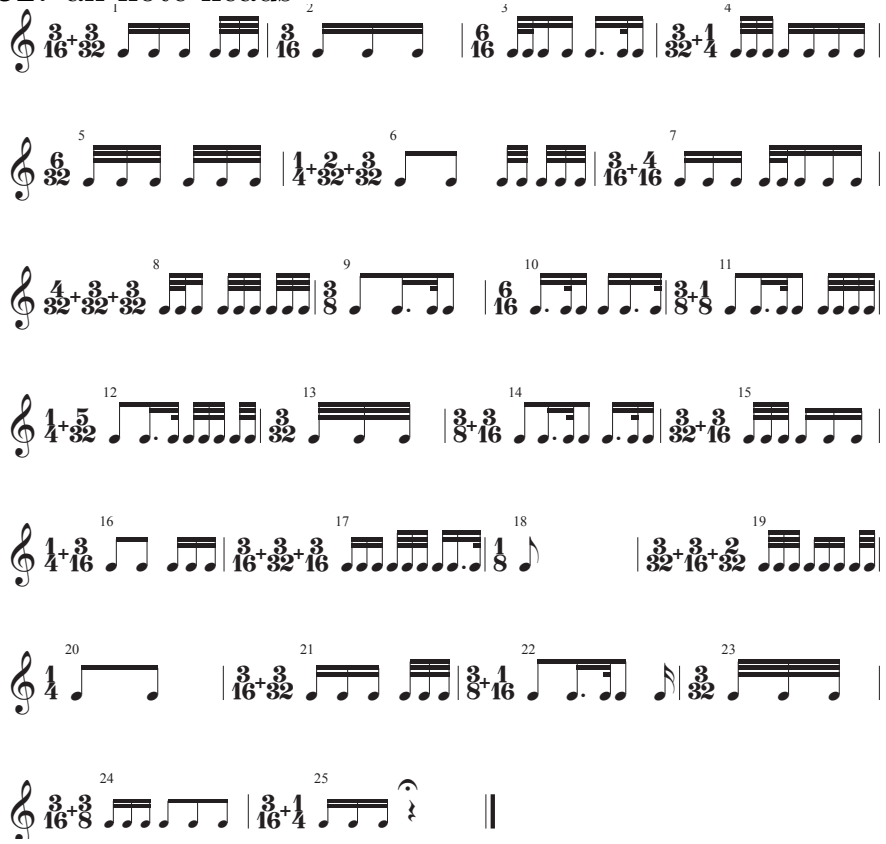
151b2. deMet Mod



tag: ***Met Mod***.

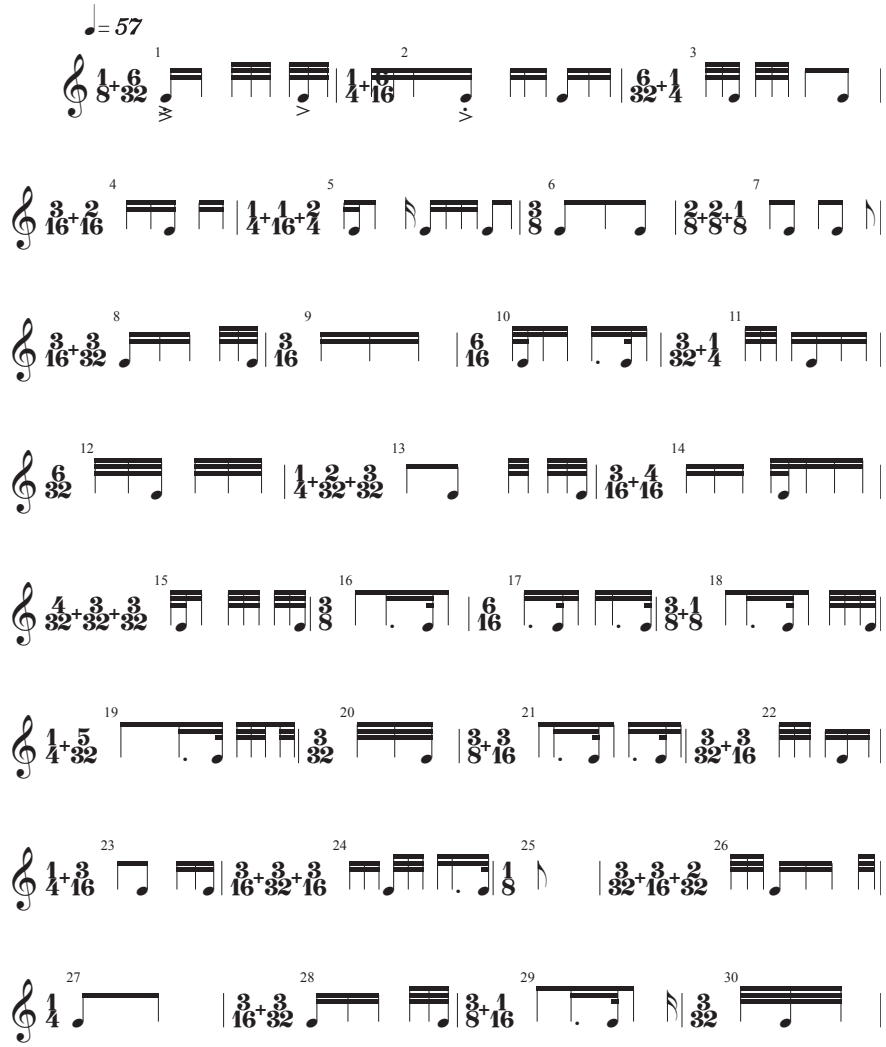
2.4

362. all note heads



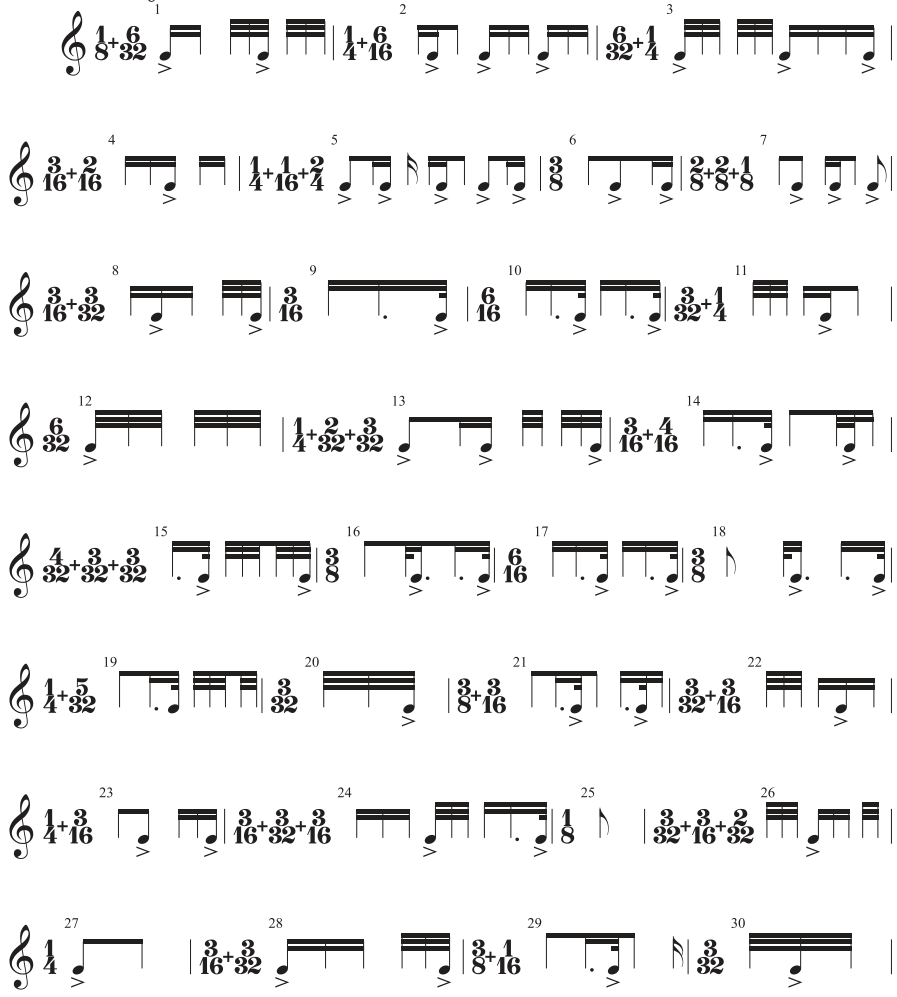
tags: ***Const x/change y***; ***Fun***; ***Lollipop***; ***Long-Hand***; ***Metronome***; ***Yeasty***; ***Beam-Beat***. Audio example number 2003.

362. evry 4



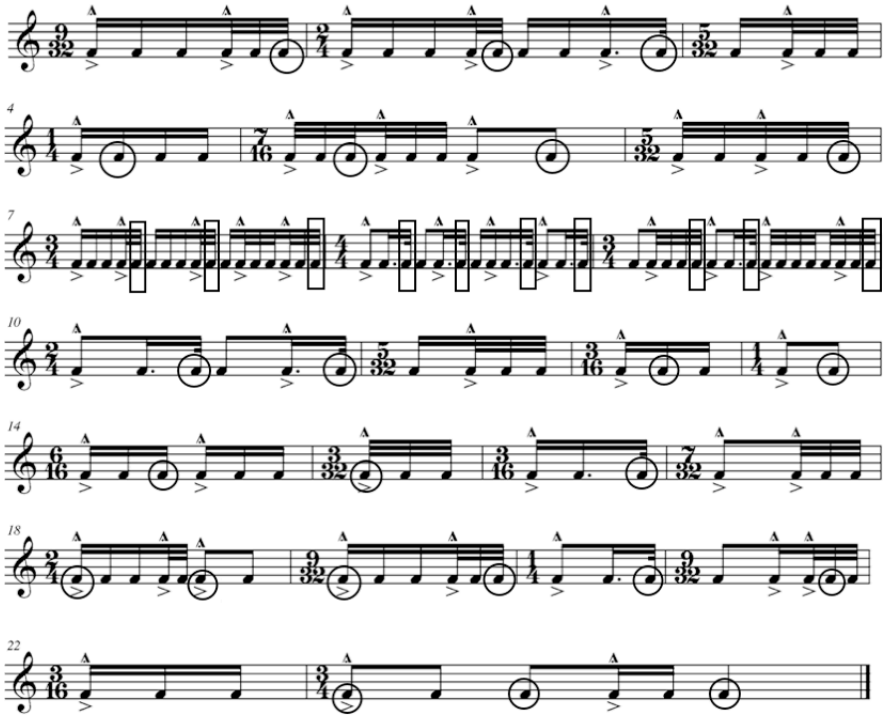
tag: ***Every x***.

394. evry 3

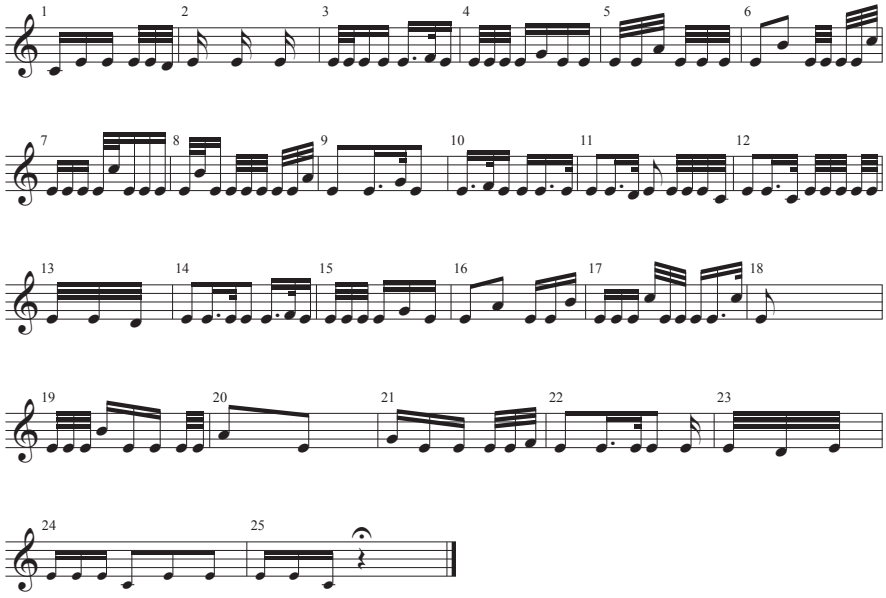


tag: ***Every x***. Audio example number 2003.

362. circles (invert)

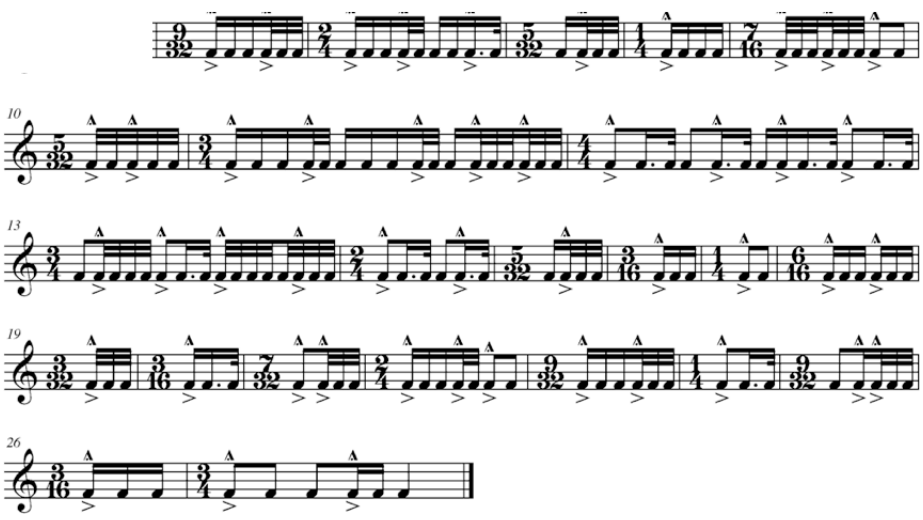


362. scale (No TS)

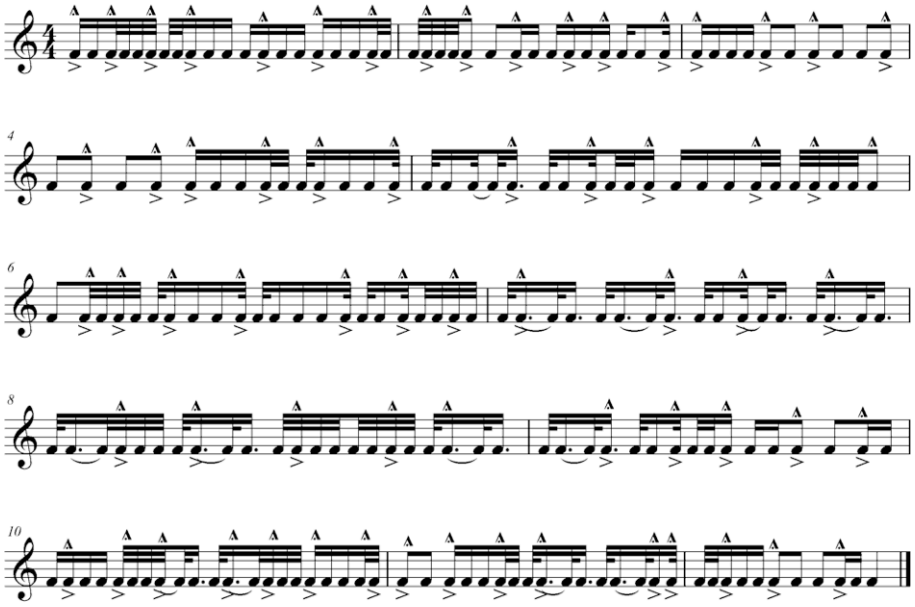


Audio example number 2011.

362. accents



362. invert



tags: ***Invert***; ***Odd Evening***. Audio example number 2009.

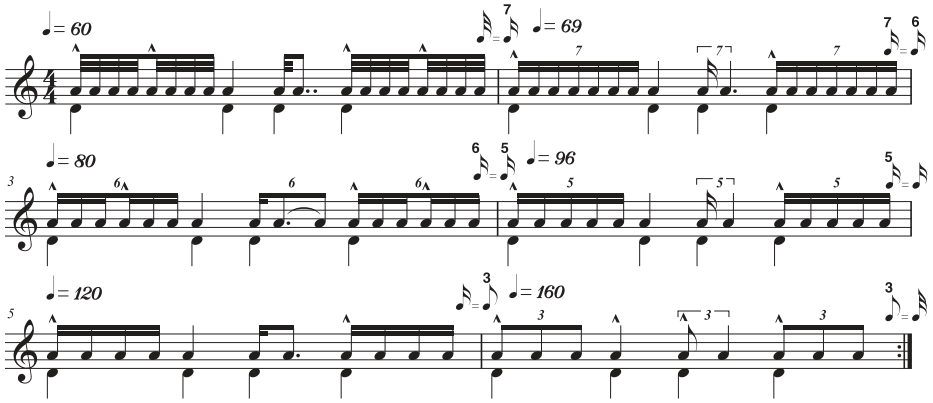
Chapter 3

3.1

147. free

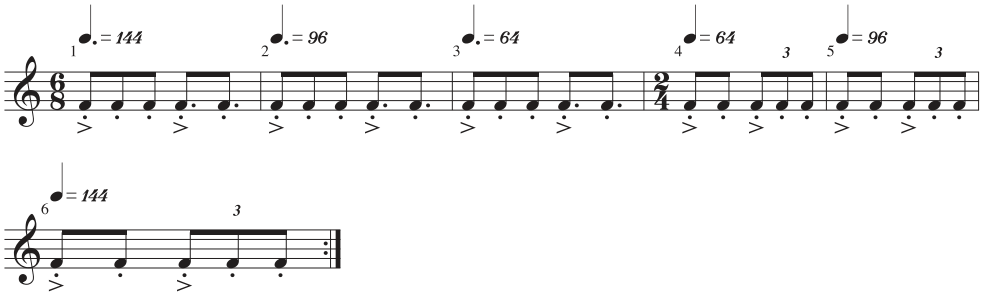
Audio example number 1006.

156. Met Mod



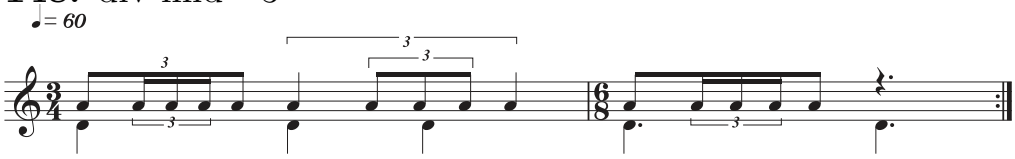
Tag: ***Met Mod***. See also: 25; 39; 40; 58; 65; 105; Audio example number 20015.

158. very fast



tag: ***Fun*** Audio example number 11008.

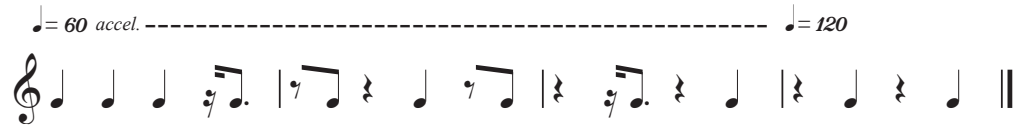
148. div mid - 3



Audio example number 3013.

3.2

185. offset / beat accel-fix-Oblique



tag: ***Look Diffic/Are Easy***

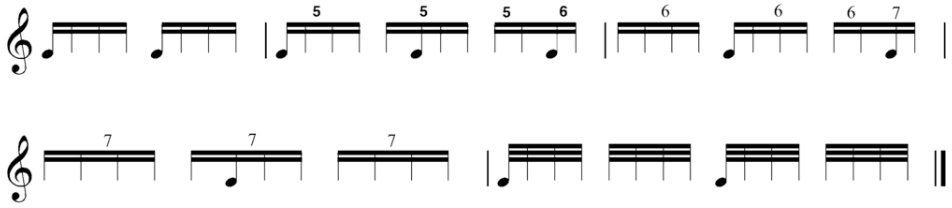
In exercise 185 the notated duration between articulations (as opposed to the implied duration of *sound*) increases (or slows). Each beat is 4 16ths in duration. Thus the durations between articulations are 4455667788.

But the included instruction—"Attacks should be equally spaced"—simultaneously with the instruction that the beat accelerates, changes the resultant rhythm.

This example is very easy to perform, even sight-read.

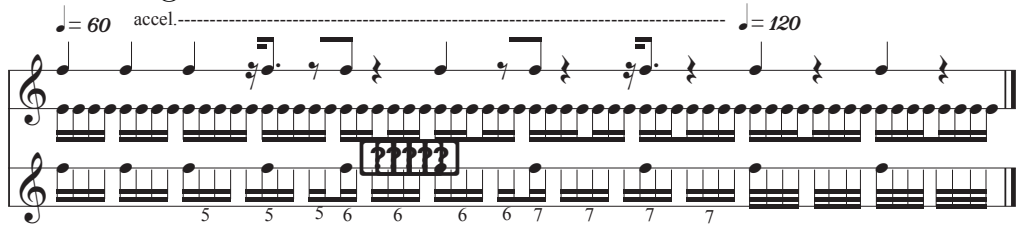
If one wanted to notate this example in conventional notation one must offset the increase in notated duration between articulations with note-speeds (ratios) that proportionally decrease the duration between articulations (increase the speed) 4:1, 4:1, 5:1, 5:1, etc. (This is not to suggest that one *permanently* renotate examples, but often times a temporary renotation can facilitate learning the correct rhythm. For many of the examples in this book one may need more than one way of conceiving or notating an example.)

186. Conventional

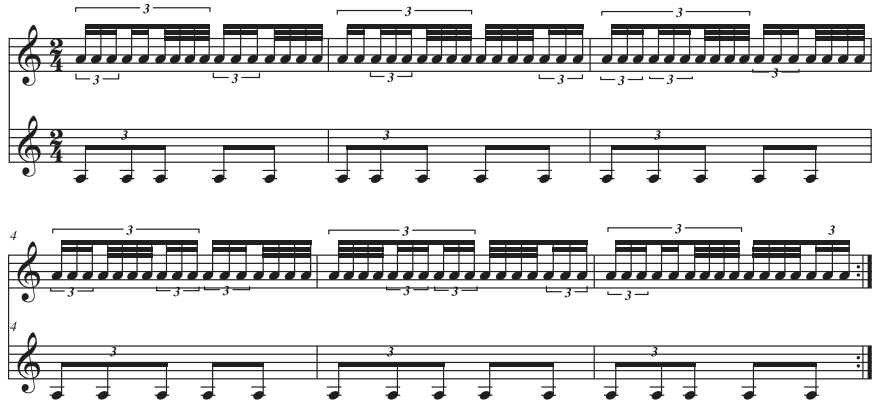


In exercise 186 a beat consists of 4 stems in duration. This means that some special ratios will be partial; e.g., we see the speed of quintuplets but there are only 4 per beat (a shorter beat). Noteheads are attacks. Headless stems are silent. The example results in doubling the beat-speed. Audio example number 17003.

186b. Figure

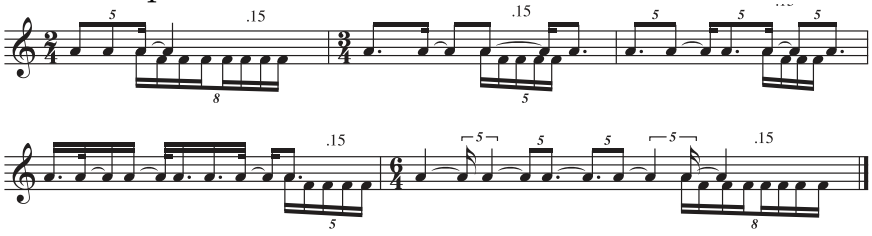


397. 3-2-4



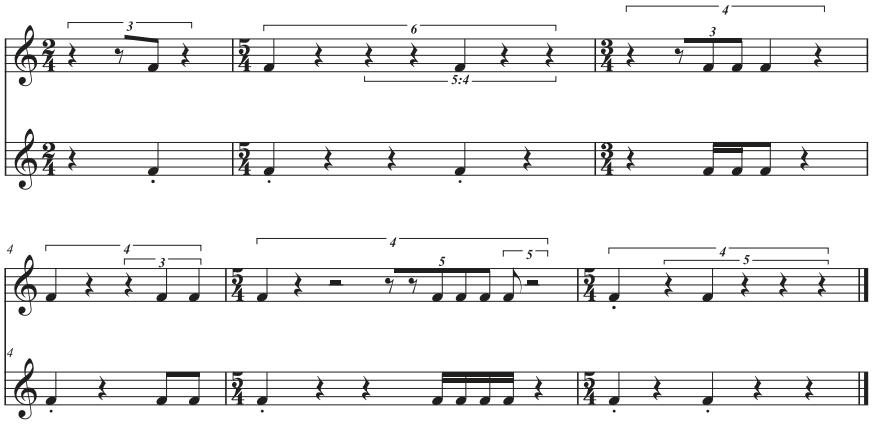
Audio example number 17014.

214. Duplex



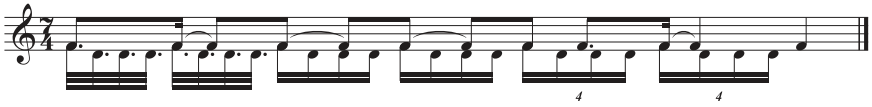
tags: ***Duplex***; ***Long-Hand***; ***Differ Nests/same speed***; ***Look Differ/Are Same*** Audio example number 6013.

280. Silly Nest



tags: ***Nests***; ***Differ Nests/same speed***; ***Levels***; ***Look Differ/Are Same***; ***Look Diffic/Are Easy*** Audio example number 6014.

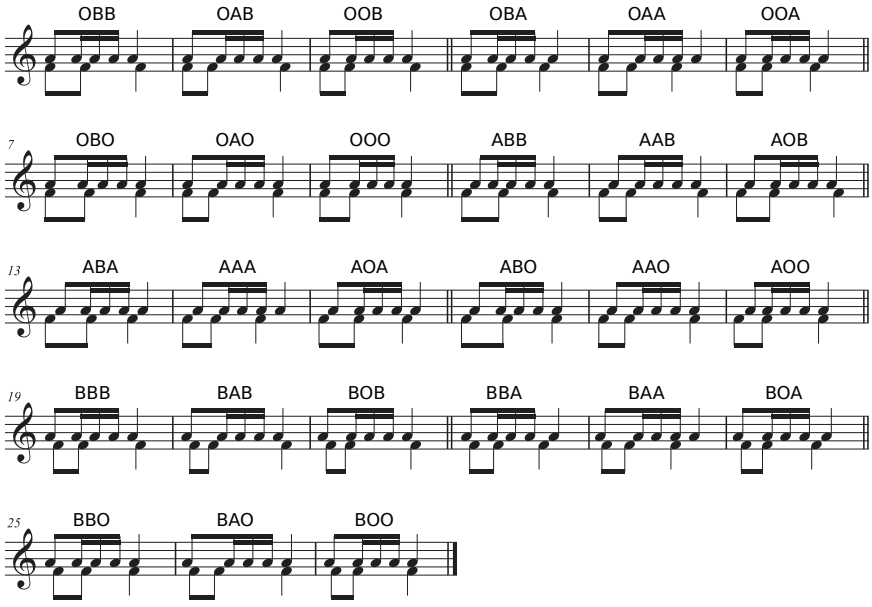
95. Duplex 4s



tag: ***Duplex*** Audio example number 1005.

3.3

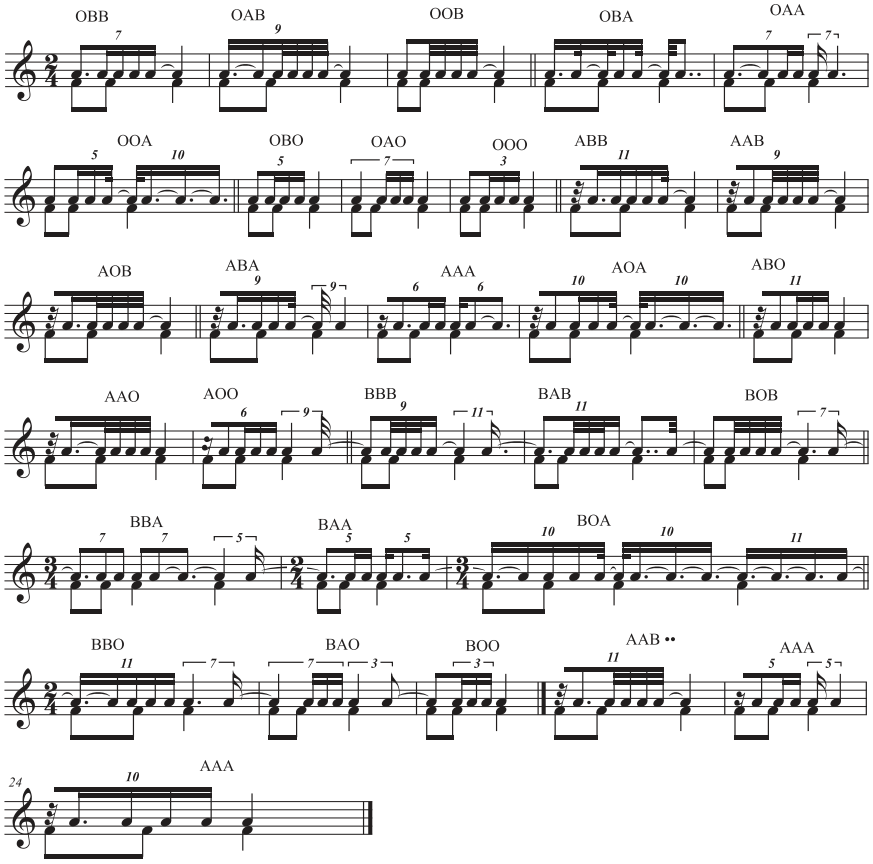
355a. w Beat-Patt Notation,each/once



Tag: ***BAMO***. Audio example number 18003.

The tag BAMO refers to exercises in which we pay attention to whether an onset occurs before ("B"), after ("A"), or directly on ("O") the beat. See also 356. other tags: ***Each/Once/(Spread)***; ***No #s***; ***Short-Hand/Patt 1st***; ***Show Beat***; ***Yeasty***.

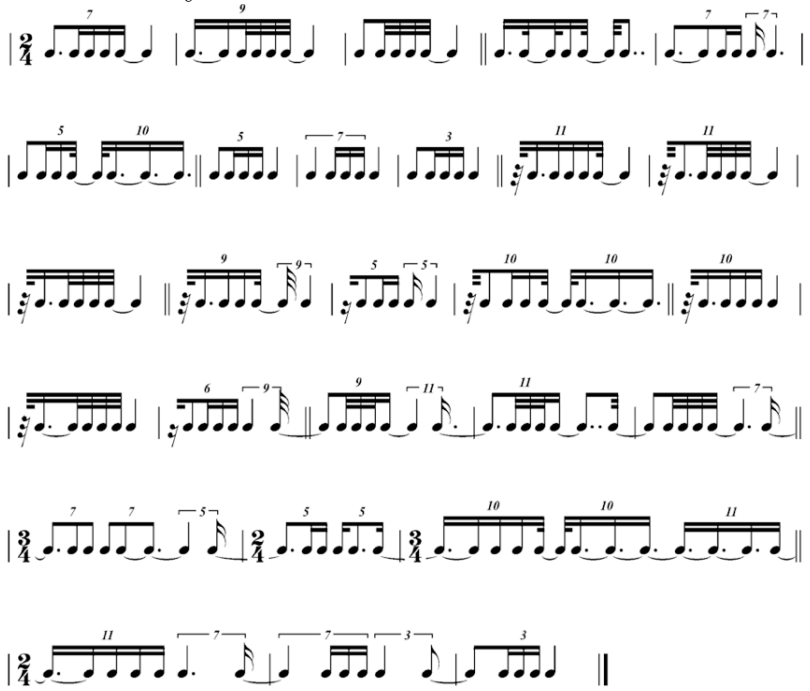
356. w Beat



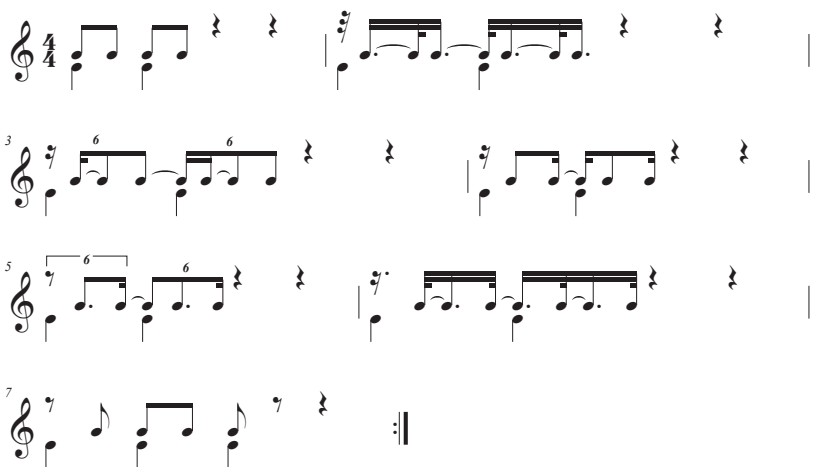
tag: ***BAMO***; ***Look Diffic/Are Easy***

As in the previous example, “B,” “A,” and “O” mean before, after, or on the beat, respectively.

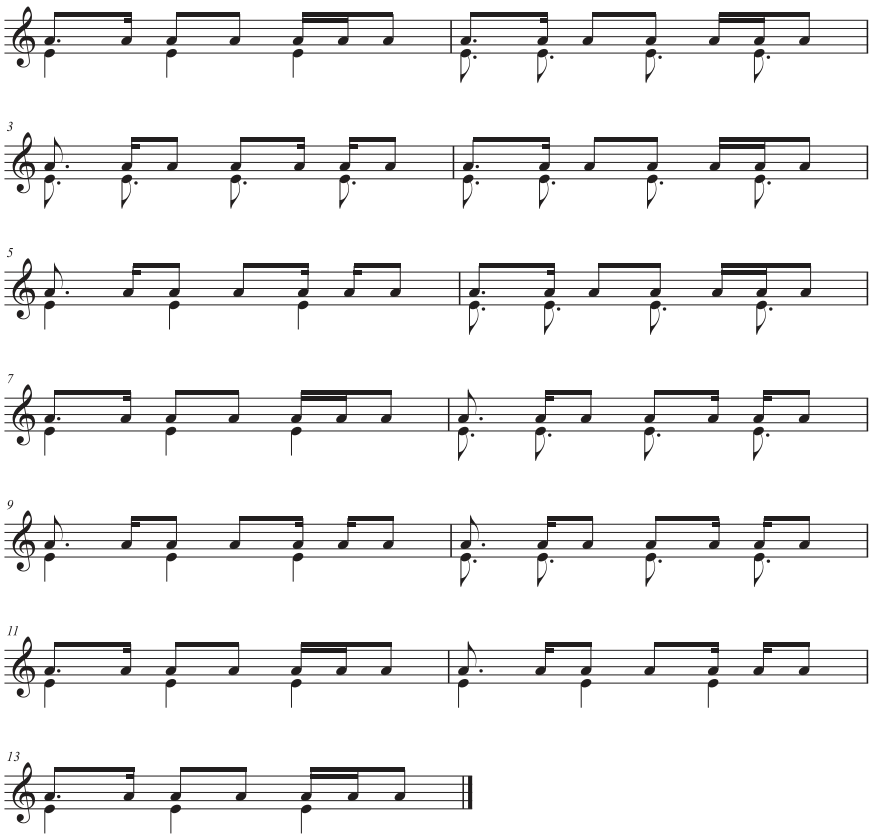
356b. Taffy-Conventch



5. rotate w beat

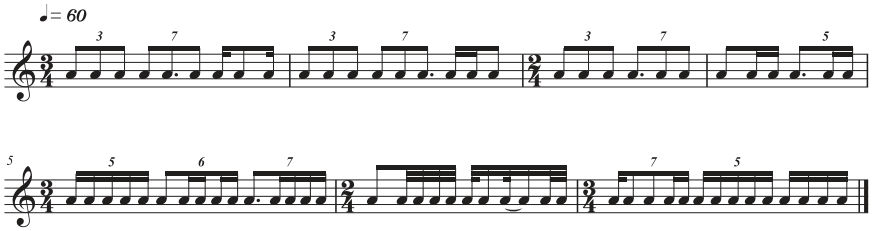


548. 3&4 feelings



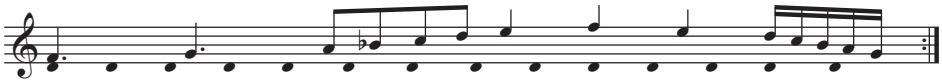
tag: ***Awkward sensations*** Audio example number 7015.

277. Transf into



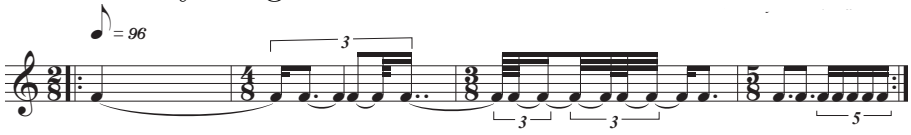
Tag: ***Transform Into***. See also: 402; 217. Audio example number 18014.

374. 9-7-15 scale



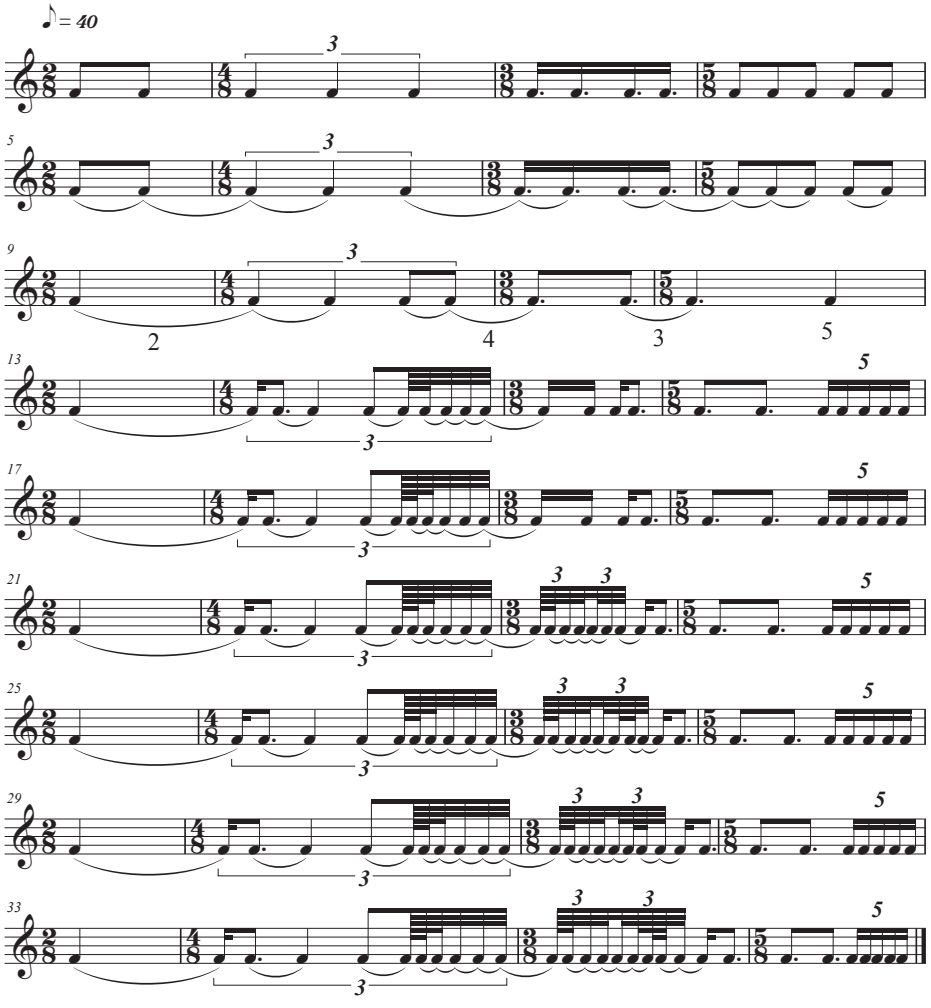
tags: ***Hard Rhy/Easy Pi***; ***Levels***; ***Proportional***; ***Show Like-Dur Beams***; ***Yeasty***. Audio example number 11006.

374b. Ferney Orig



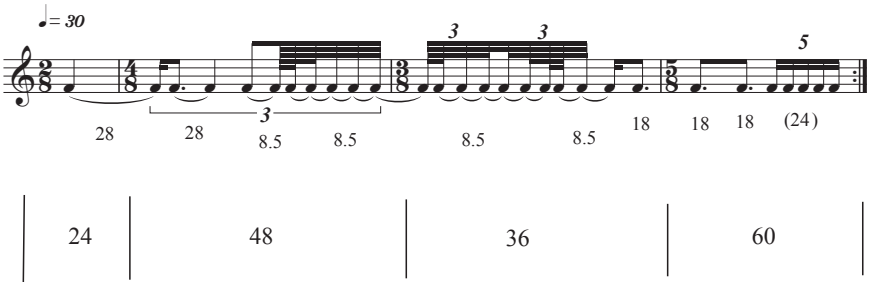
tags: ***Hard Rhy/Easy Pi***; ***Yeasty***

374h. fern levels



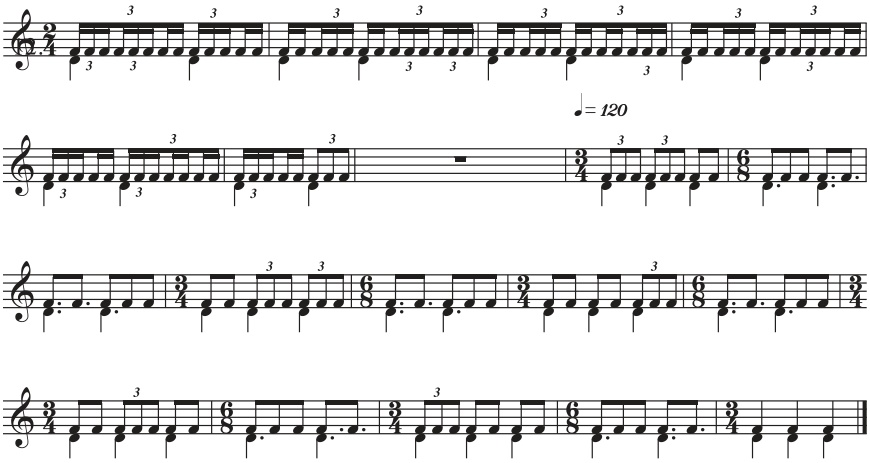
tags: ***Levels***

374j2. w Dur in 64th Triplets



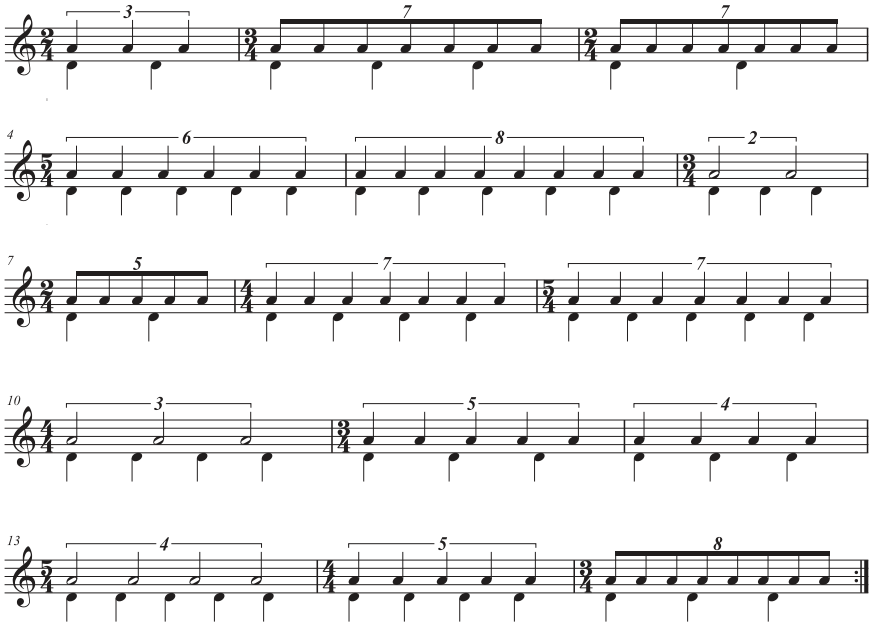
tags: ***Show Like-Dur Beams***

458. 12-beat-bar



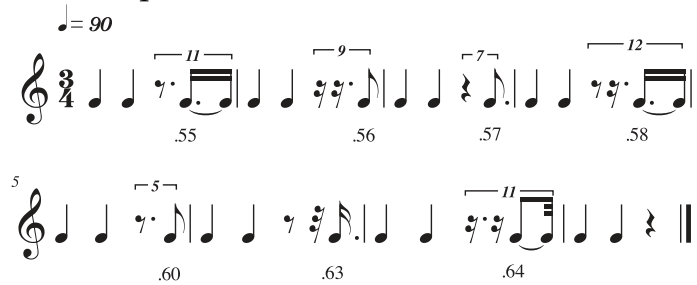
Audio example number 25017.

392. tuf rats



tags: ***2-ways***; ***Met Mod***; ***Tough Order*** Audio example number 5004.

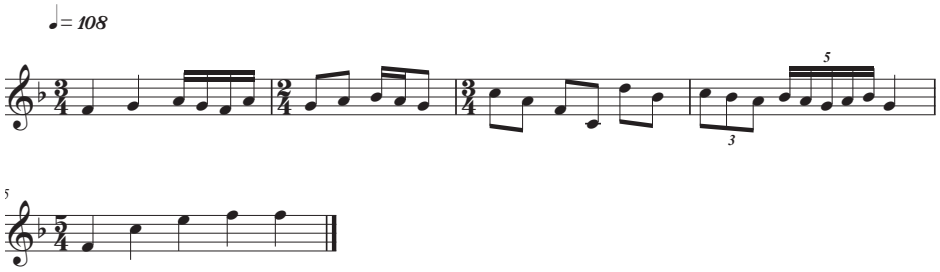
402. imposs



tags: ***Impossibles***; ***Transform Into*** Audio example number 11014.

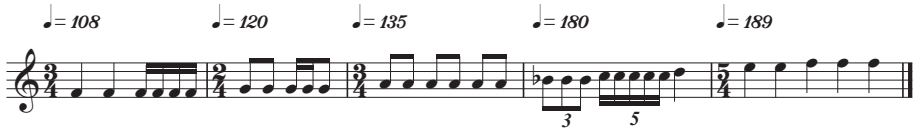
3.4

197e. Simple pitches



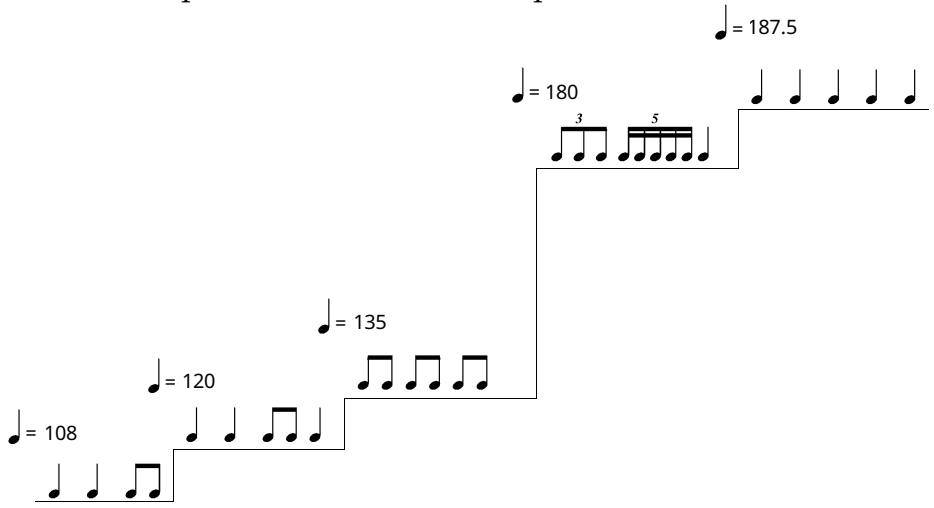
Audio example number 16003.

197g. his rhy/my pi



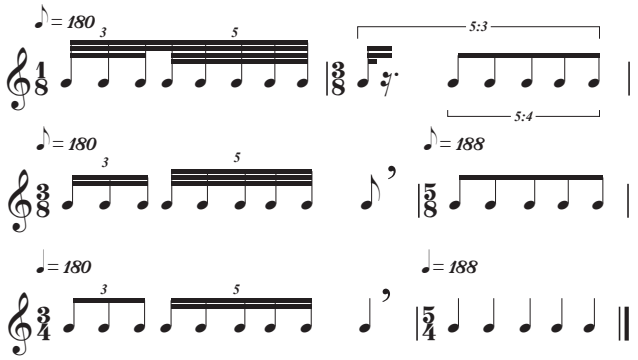
Audio example number 16007.

196c. Simple on Plateau w tempi

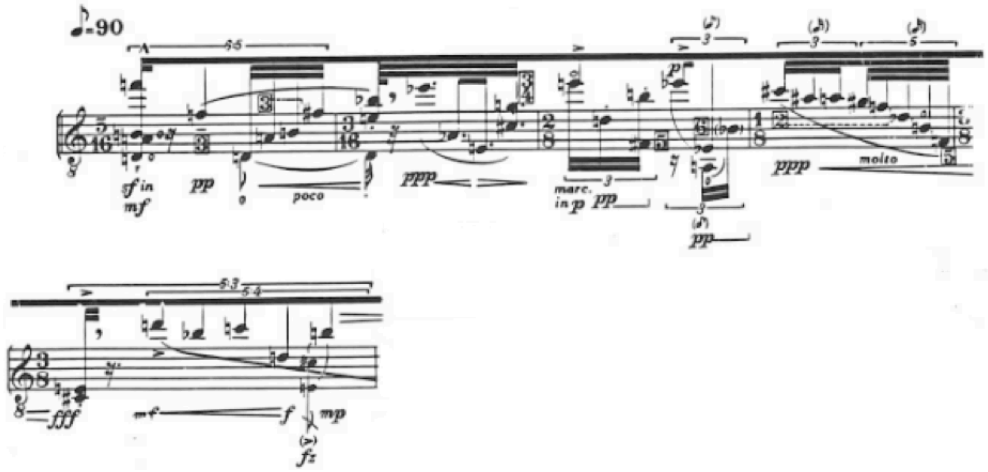


Audio example number 16007.

196c. Simple on Plateau w tempi, continued

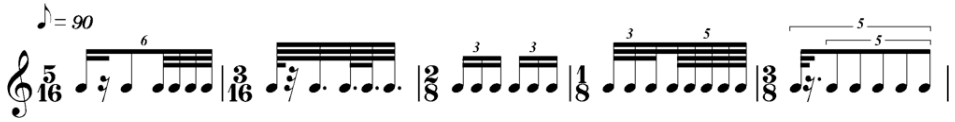


197. Ferneyhough orig

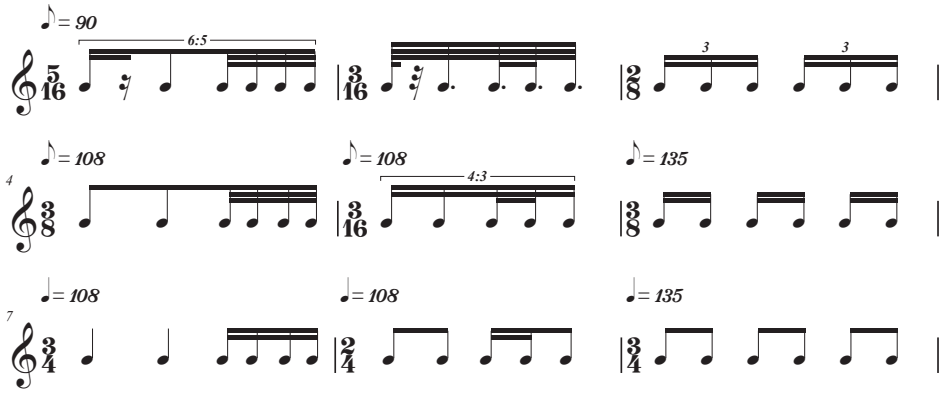


Audio example number 16008.

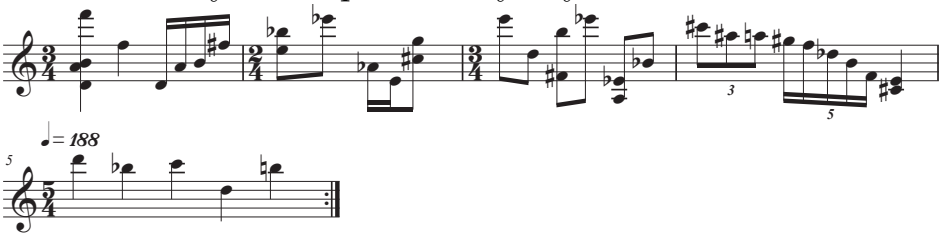
197a. Ferney wo most things



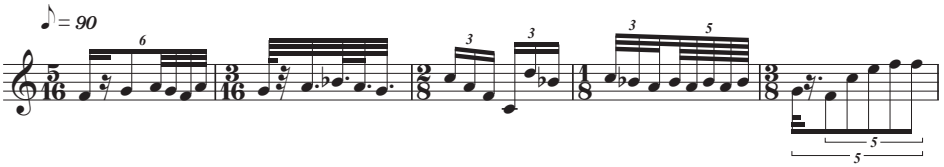
197b. compare w mult & sound-BN



197d. Ferney w his pitches-my rhy



197a2. Ferney w his Rhy & my pi

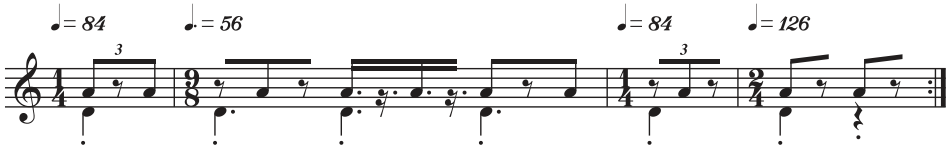


Audio example number 16014.

Chapter 4

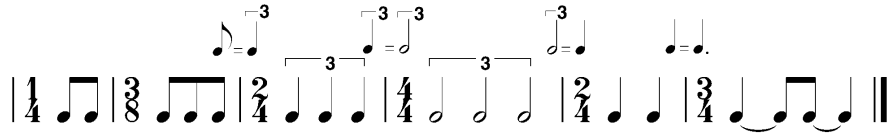
4.1

180. 4/12 bar



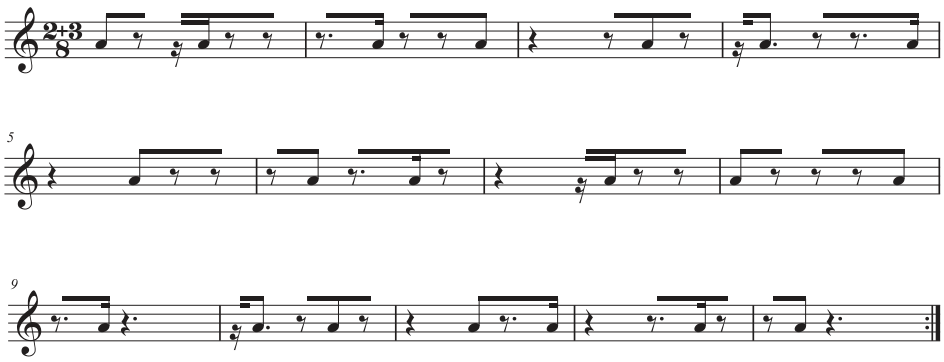
tag: ***Fun***. Audio example number 28010.

182. Different Rat/same speed



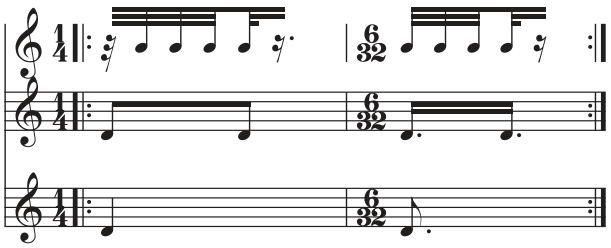
The tempo changes from measure to measure but the sounded rhythm is ESPIT (equally spaced in time). Tags: ***Different Rat/same speed***; ***Met Mod***.

216c. Start on Beat



tag: ***Rotation***. Audio example number 10018.

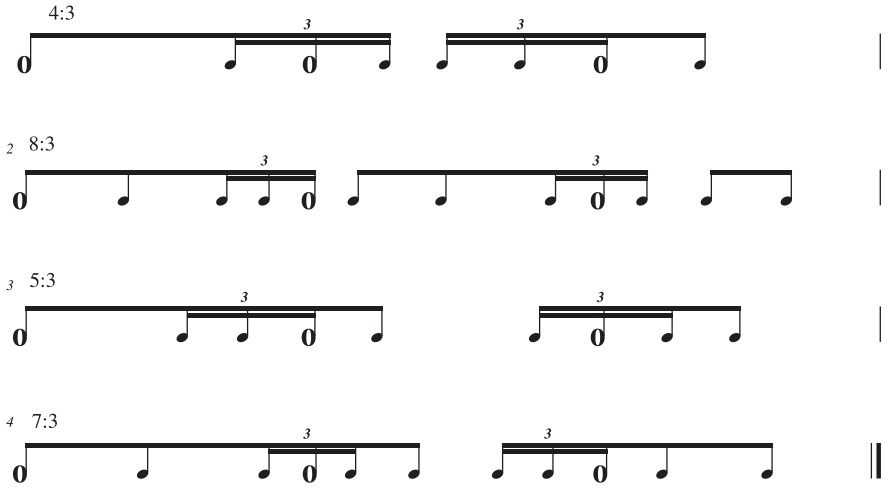
385a. 1/4 - 6/32



Audio example number 17017.

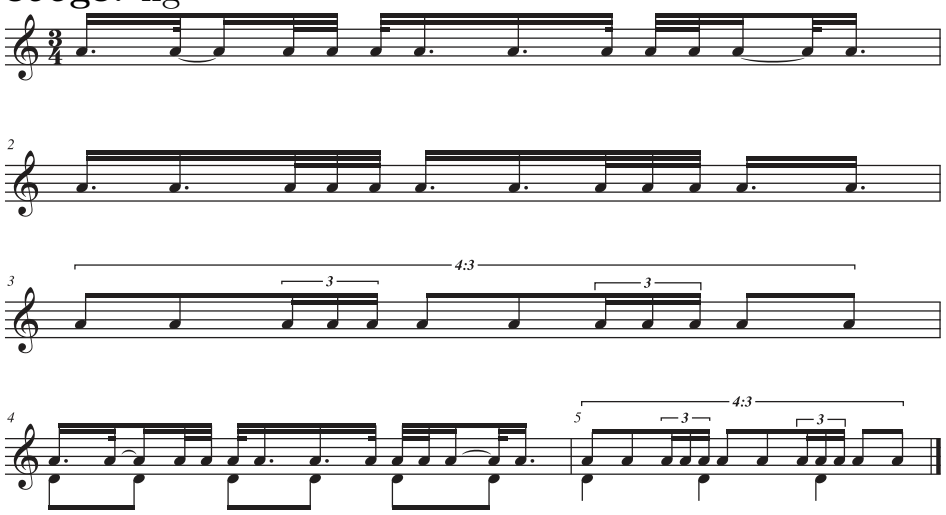
4.2

395. prob

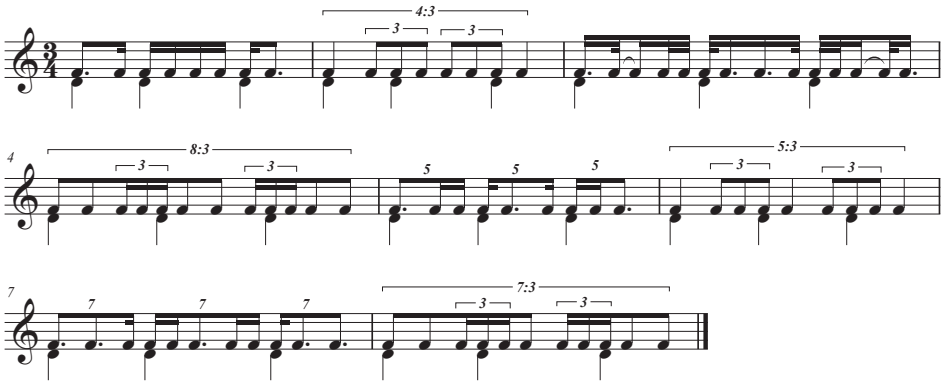


tags: ***3/4***; ***Look Differ/Are Same***; ***Look Diffic/Are Easy***; ***No #s***; ***Show Beat***; ***VB***; ***Yeasty***.

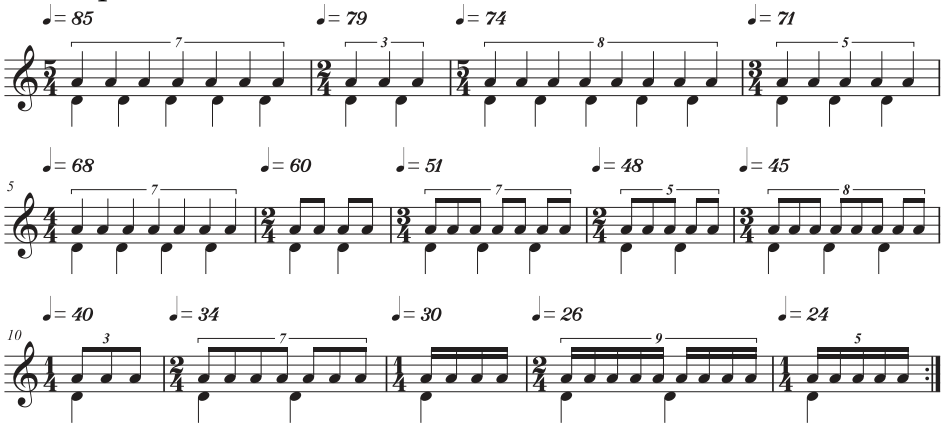
395g3. fig



395L. other rats

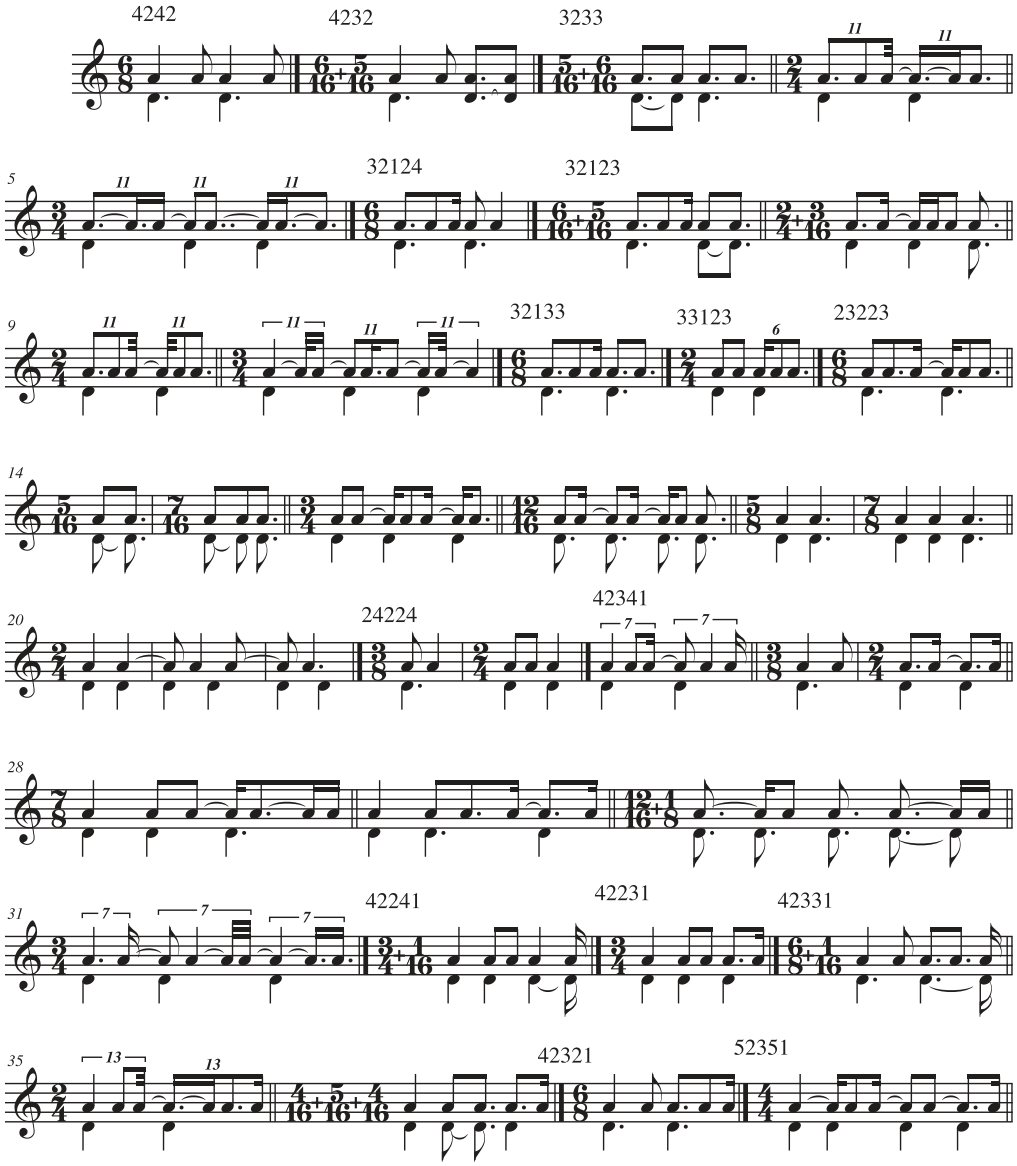


419. partial rats



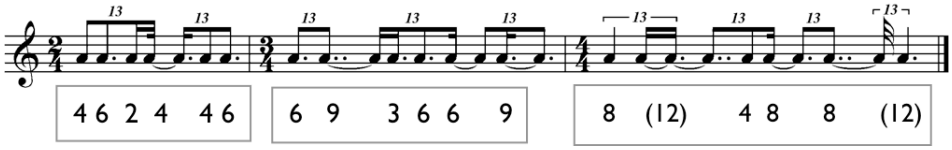
tag: ***Partial Rats***. Audio example number 29002.

422. big copy



tags: ***2-ways***; ***Const x/change y***; ***Find Patts***; ***Generate Examples***; ***Reducing Fractions***; ***Same durs seq / diff beat***; ***Short-Hand/Patt 1st***; ***Yeasty***.

422.1. reveal

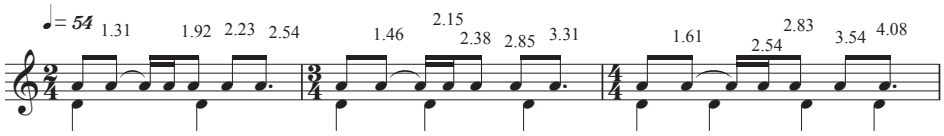


Audio example number 2018.

422j. Figure-orig order

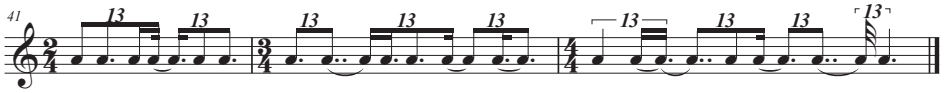
422 j		
13:2	13:3	13:4
ea =.15385	ea = .23077	ea = .3077
Dur = 462446	**Dur = 693669**	**Dur = 8(12)488(12)**
	or (reduced) = **231223 for each**	
1.00 •	1.00 •	1.00 •
1.15	1.23	1.31
1.31 •	1.46 •	1.62 •
1.46	1.69	1.92
1.62	1.92	2.23
1.77 •	2.15 •	2.54 •
1.92 •	2.38 •	2.85 •
2.08	2.62	3.15
2.23 •	2.85 •	3.46 •
2.38	3.08	3.77
2.54 •	3.31 •	4.08 •
2.69	3.54	4.38
2.85	3.77	4.69

422. Figures



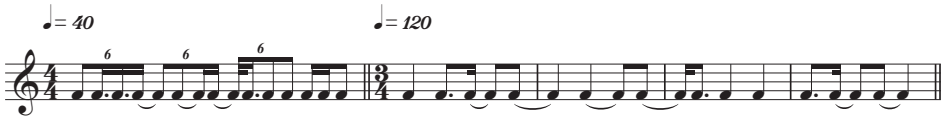
The figures (i.e., numbers) are those in the table above (422j).

422. 13s



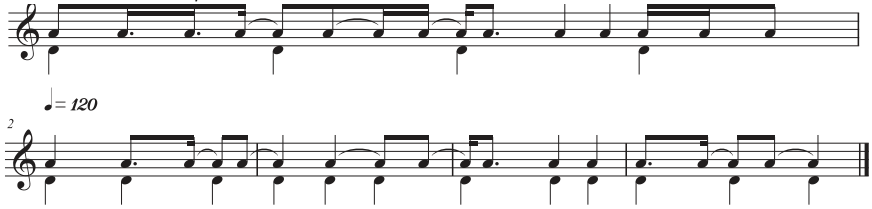
4.3

440. 6-3/4 alone beat-bar, 381

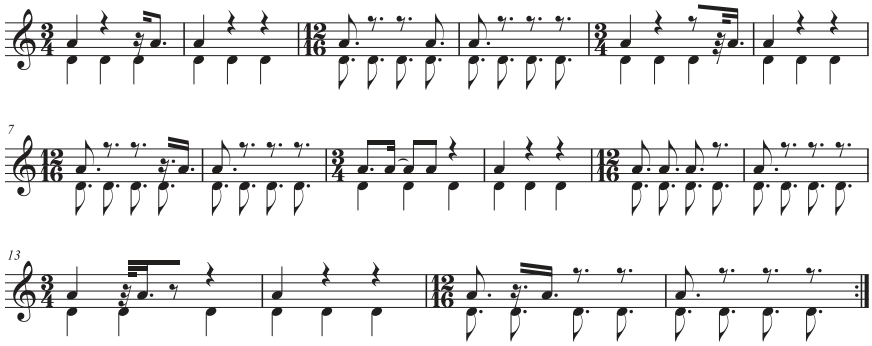


tags: ***3/4***; ***Different Rat/same speed***; ***Equivalent Note-Values***; ***Look Differ/Are Same***; ***Look Diffic/Are Easy***; ***Yeasty***. Audio example number 1002.

440b2. 6-3/4

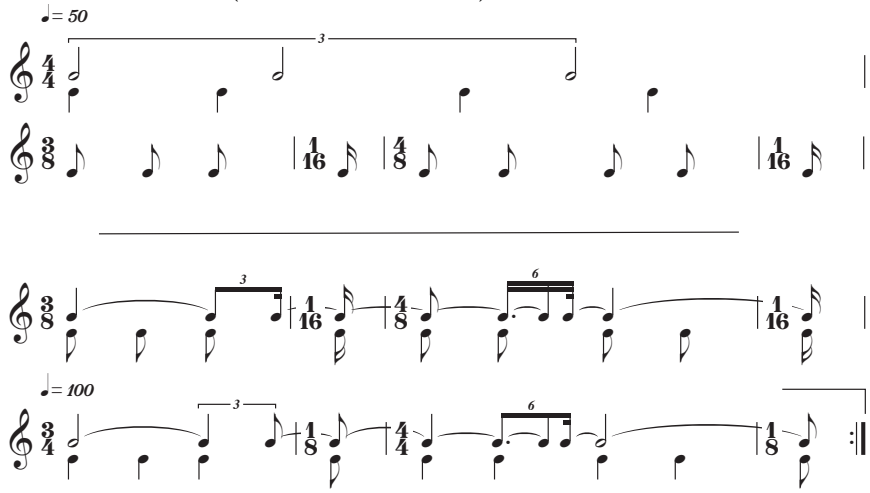


440k1. 6-3/4



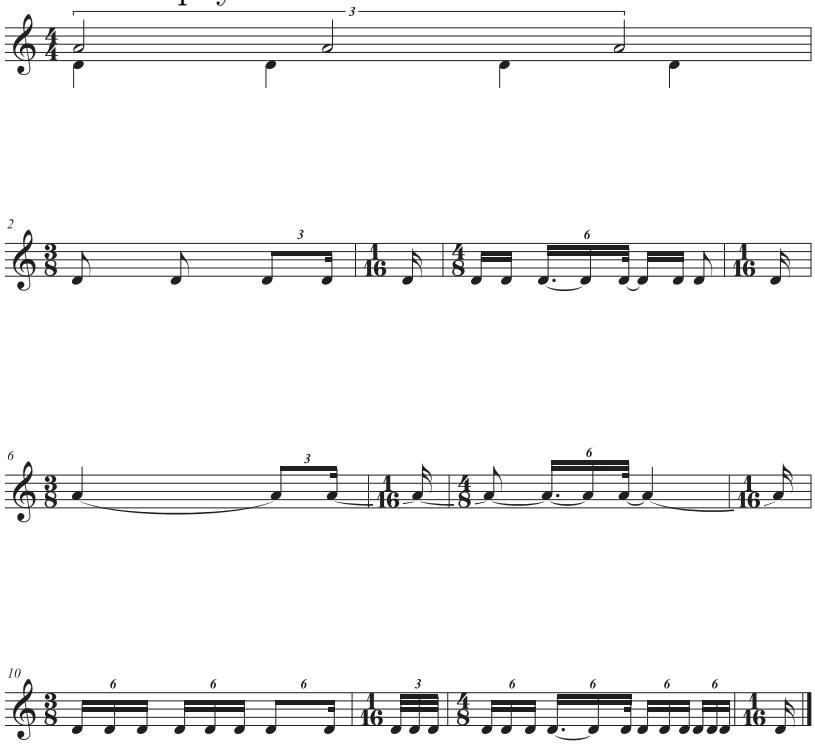
Audio example number 1004.

461. Shapey (from Weisberg)

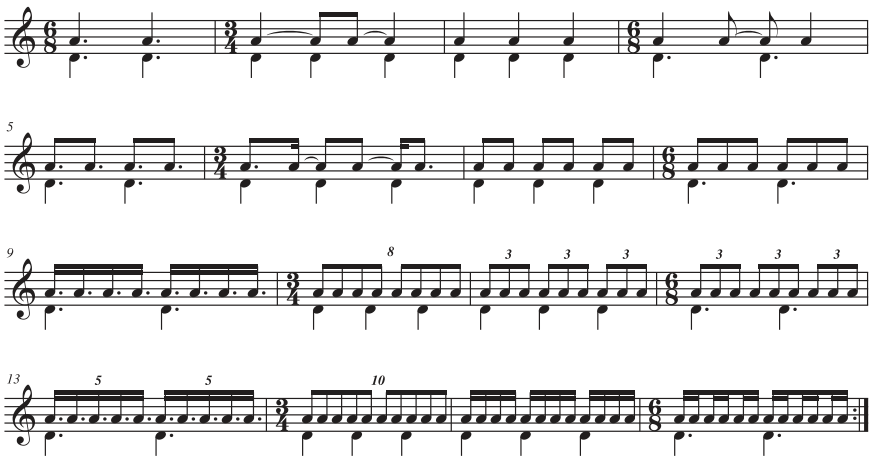


Audio example number 21002.

461z. Shapey w lines

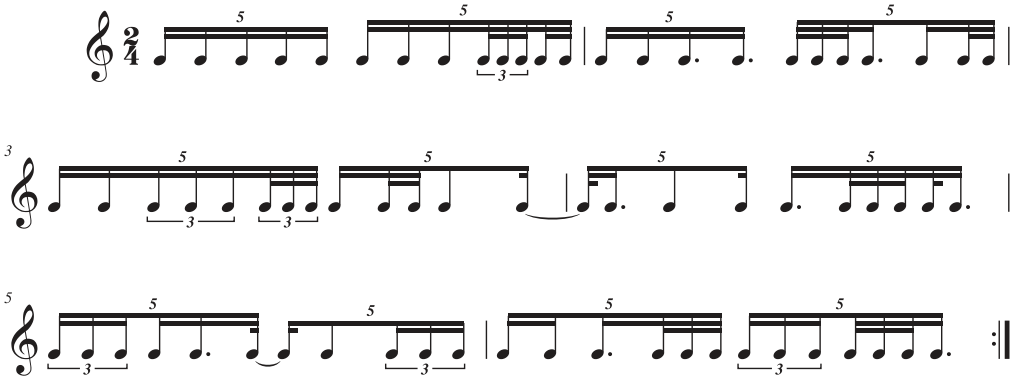


130. Simp/Compound



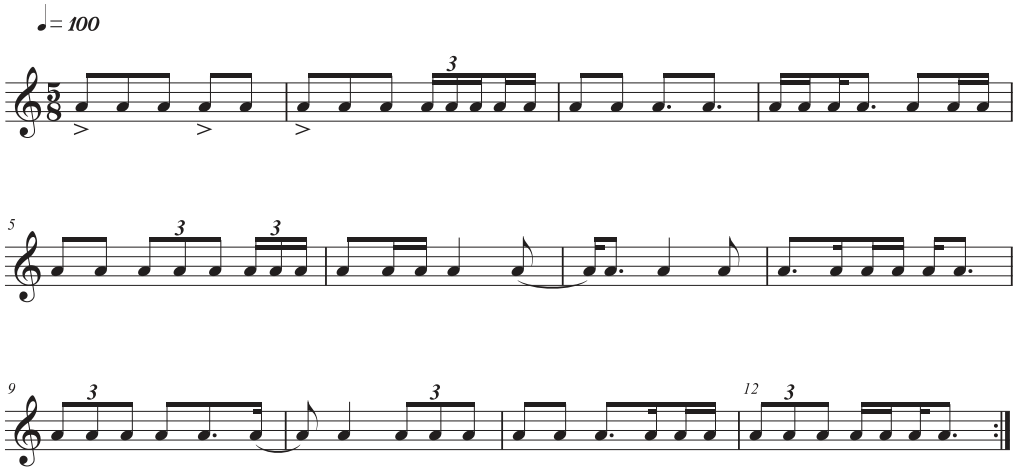
Audio example number 5005.

410b1. quin-5/8



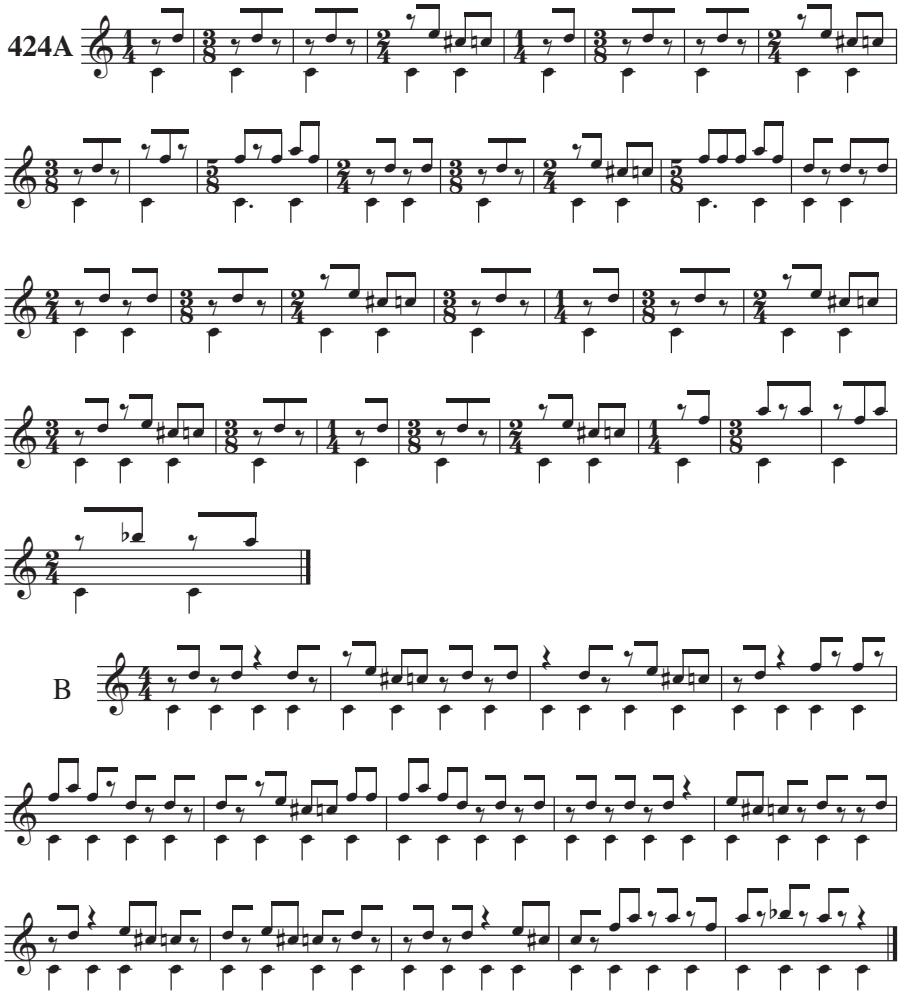
tag: ***Beat Note/Beat-Bar***. Audio example number 26012.

410d1. quin-5/8



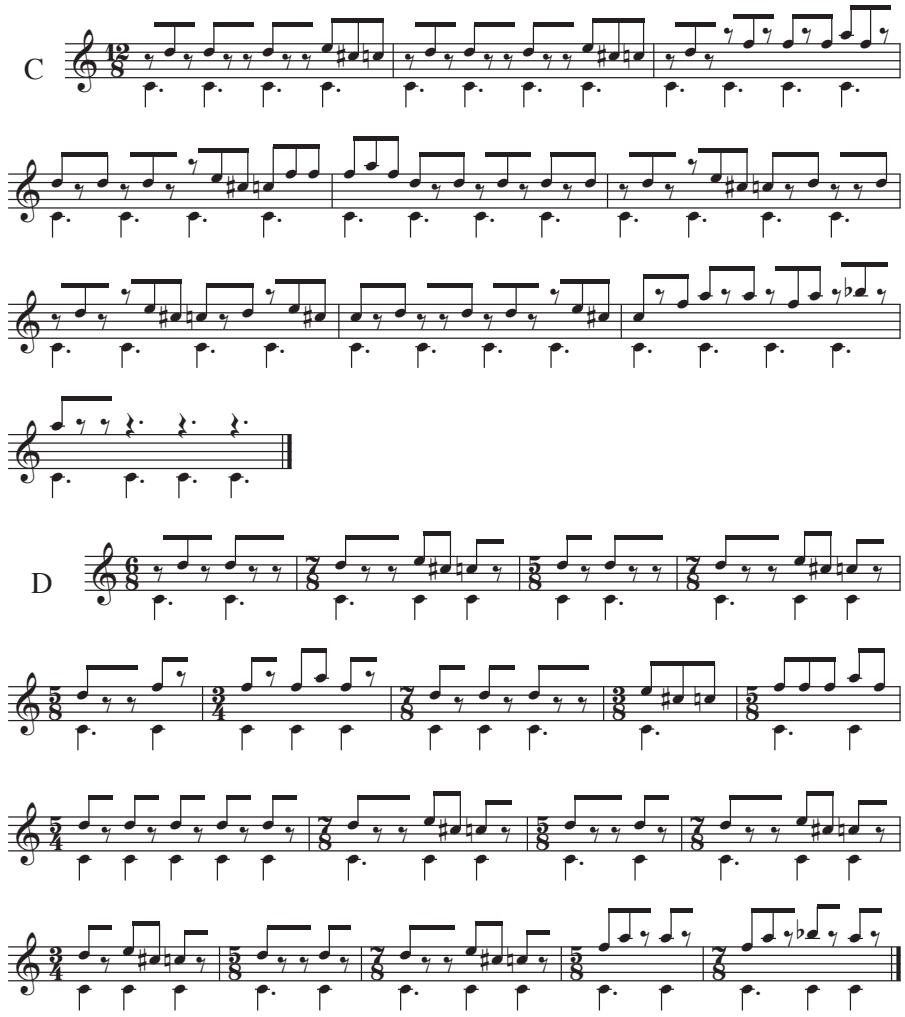
Audio example number 26013.

424ab. Rite

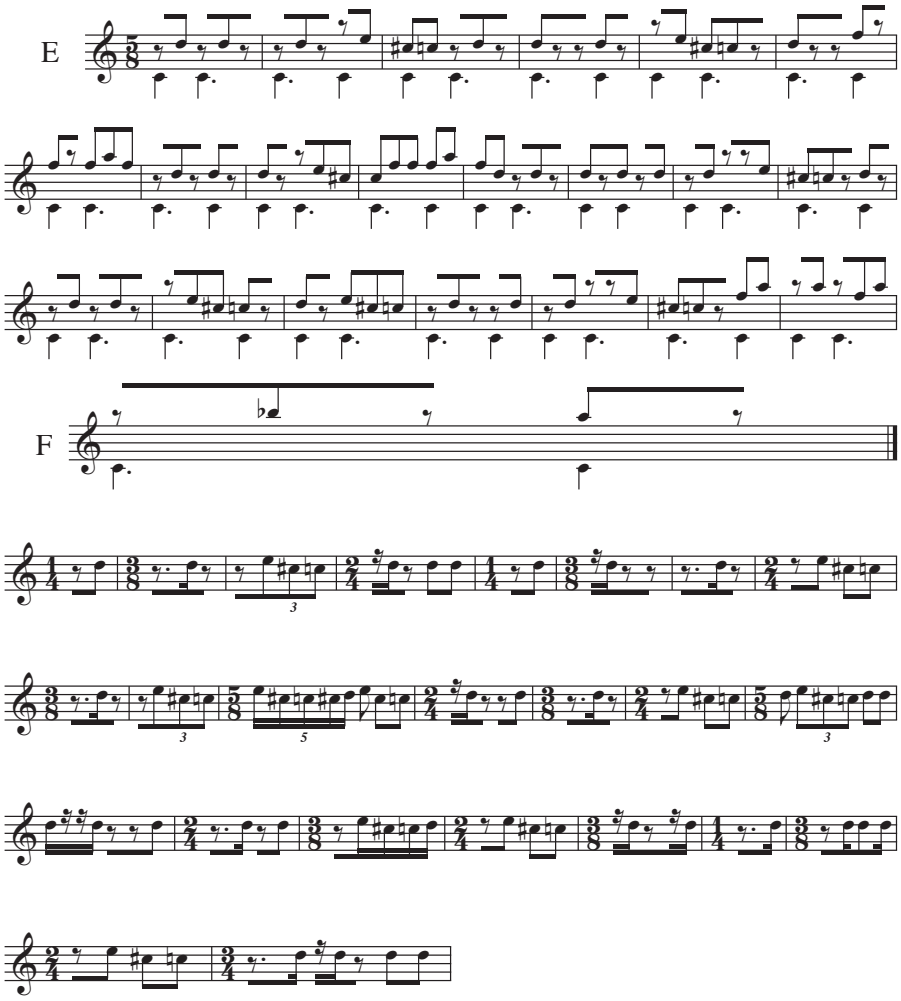


tags: ***Fun***; ***Known Tune/Wrong Rhy***. Audio example number 19002.

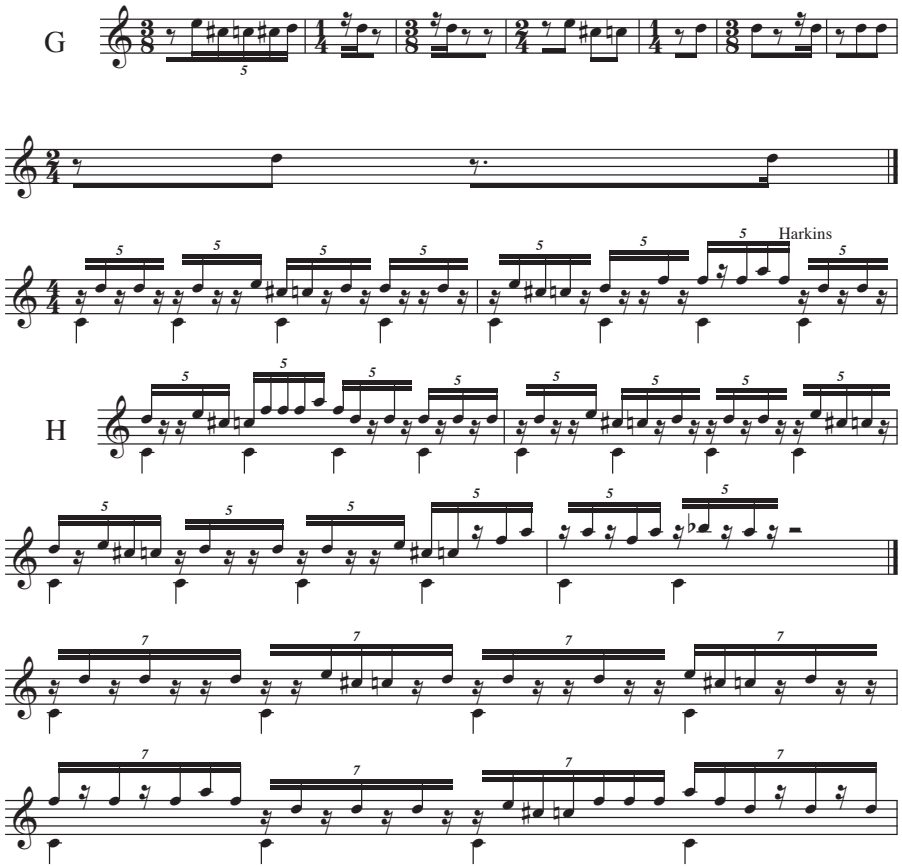
424cd. Rite



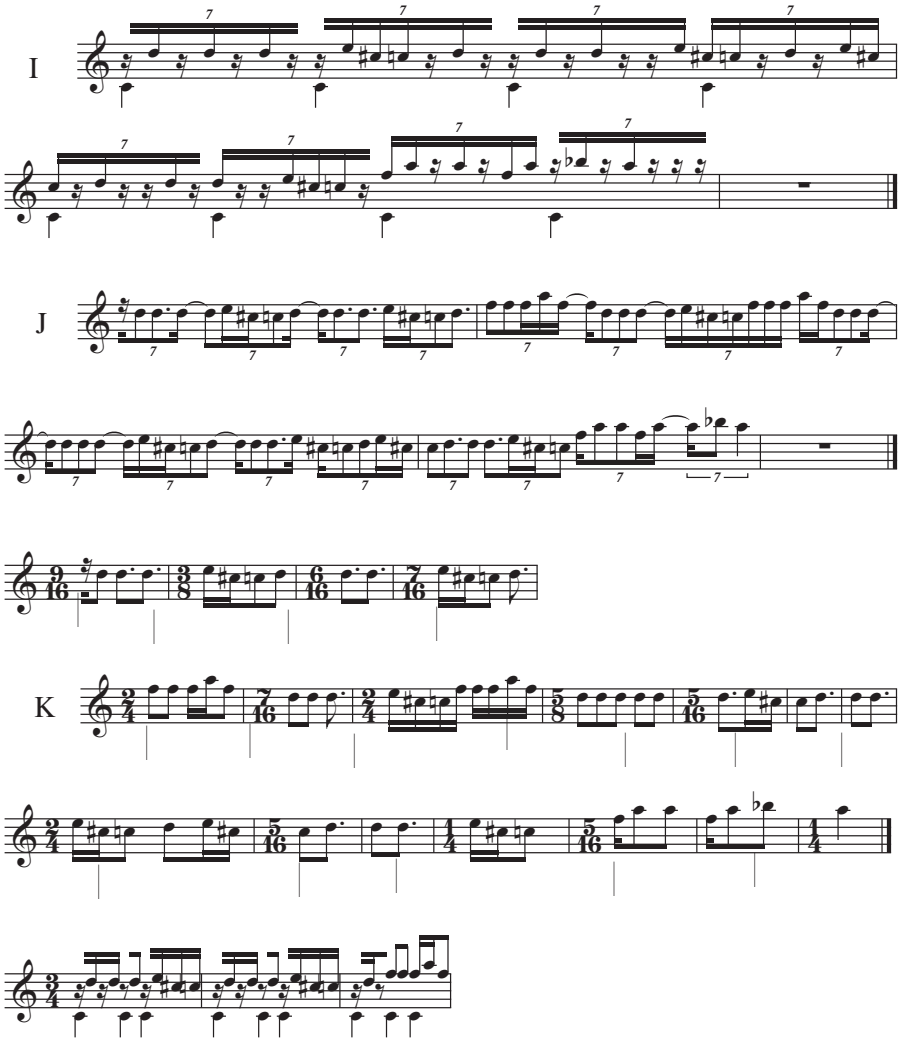
424ef. Rite



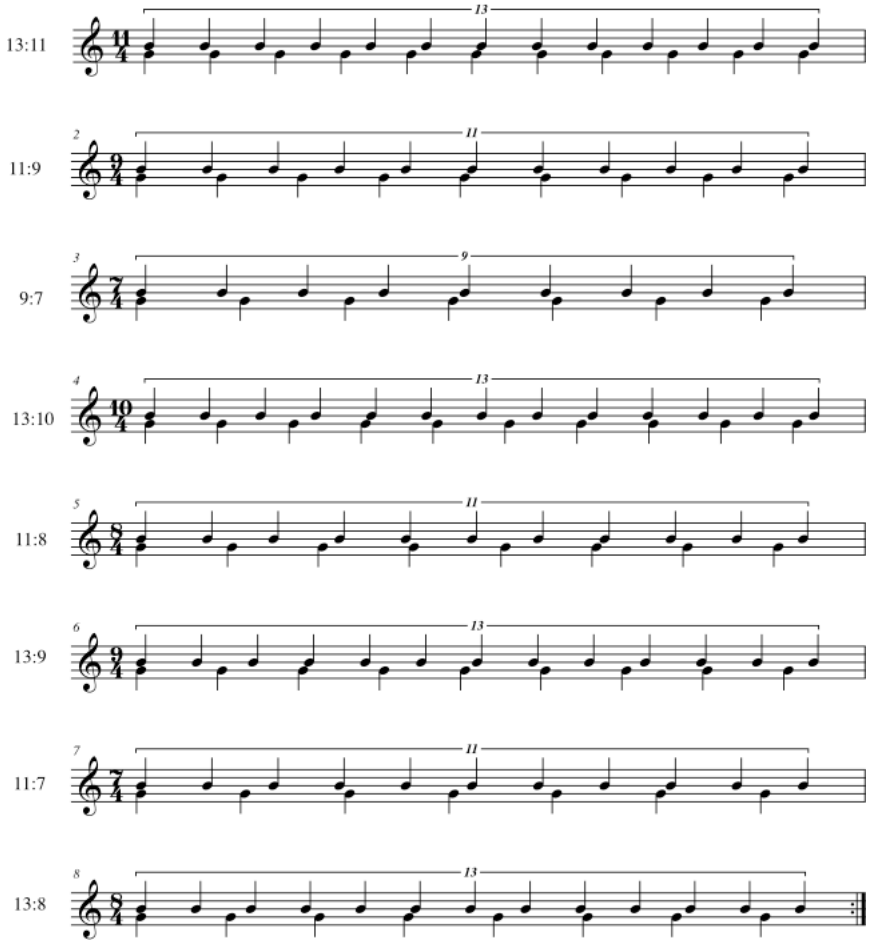
424gh. Rite



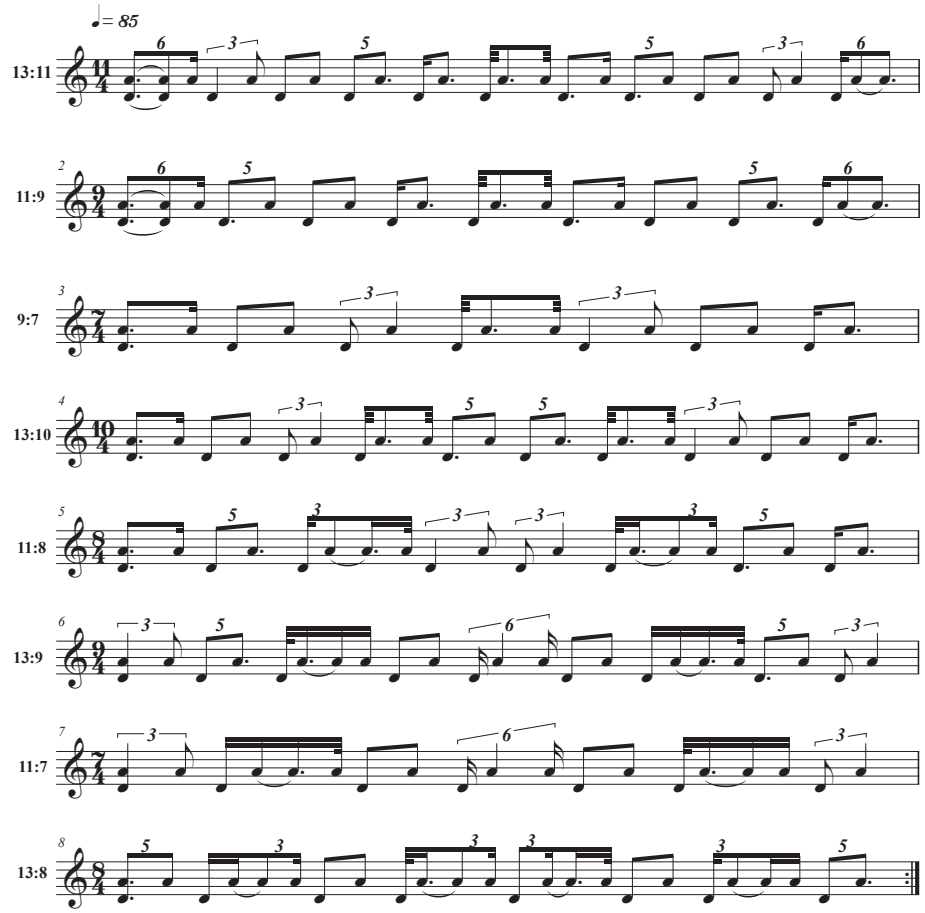
424ijk. Rite



425. true



425b2. AproPo CR

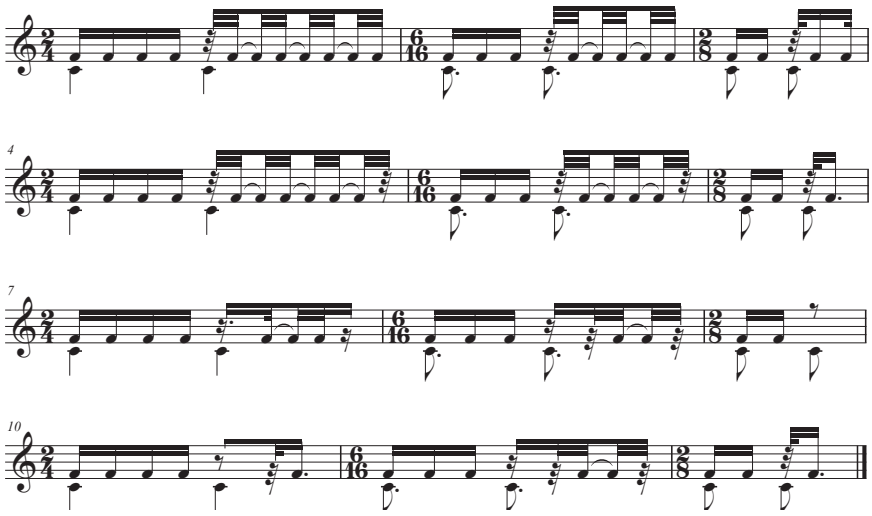


Audio example number 30006.

425. figure

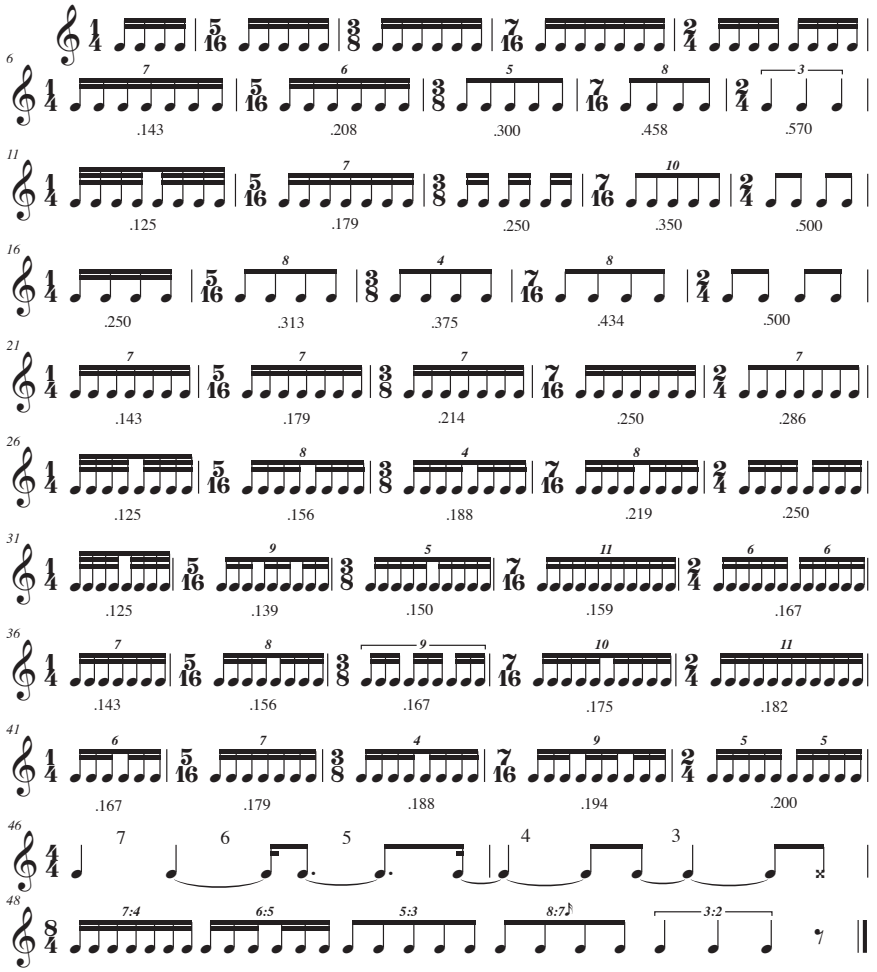
Ratio	HAM	Decimal Duration
4:3	211	.750
11:8	21,211, 211	.727
18:13	21,211,21,211,211	.722
7:5	21,211	.714
17:12	21,21,211,21,211,211	.706
10:7	21,21,211	.700
13:9	21,21,21,211	.692
3:2	21	.667
11:7	211,21,21	.636

296. my 32nds

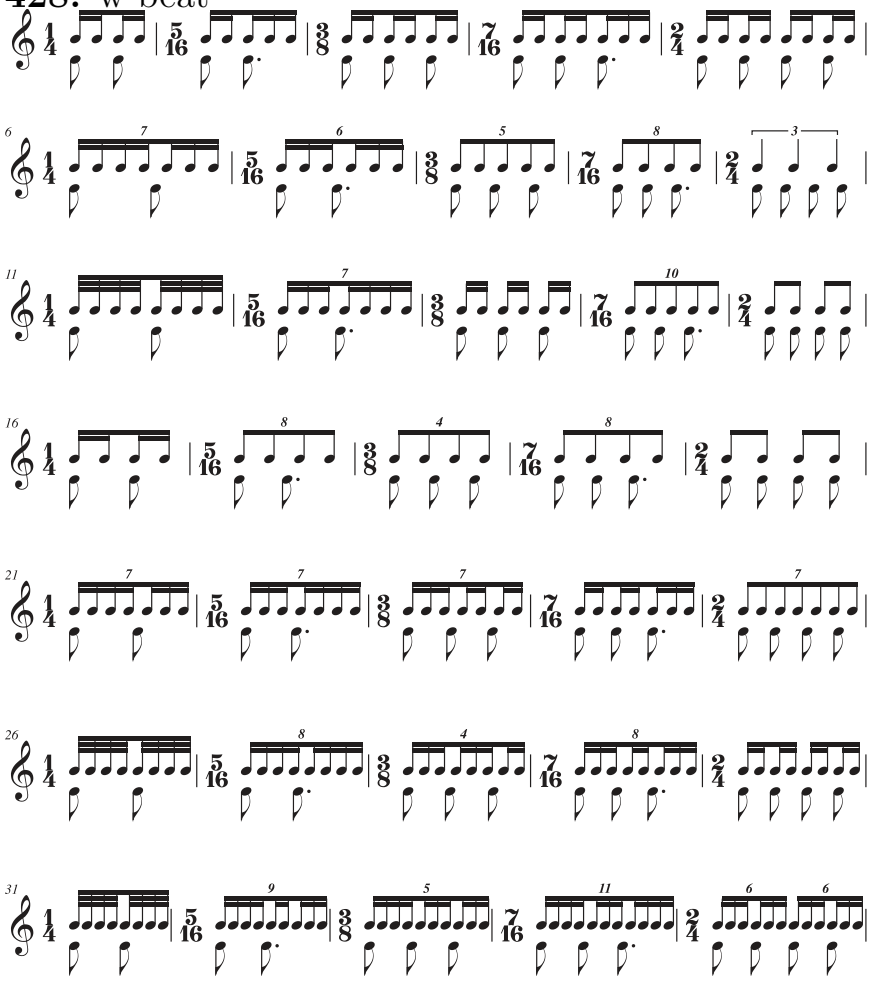


tag: ***Fun***. Audio example number 24008.

428.2. Grad met. Rit. Q Q. w decimals



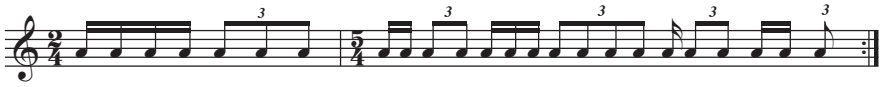
428. w beat



Audio example number 12004.

4.4

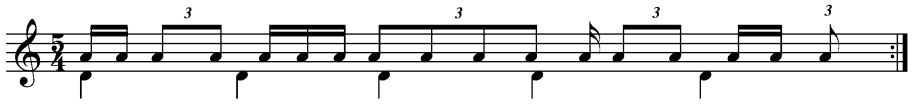
112j. no beats-Interrupted Ratio



112. Artic points / decimal durations

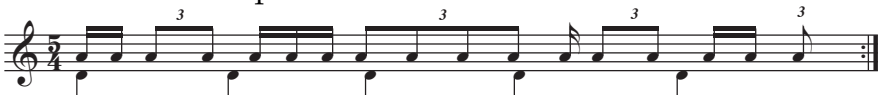
#112	
1.00	4
1.25	4
1.50	4
1.75	4
2.00	3
2.33	3
2.67	3
3.00	4
3.25	4
3.50	3
3.83	3
4.17	4
4.42	4
4.67	4
4.92	3
5.25	3
5.58	3
5.92	3
6.25	4
6.50	3
6.83	3
7.17	4
7.42	4
7.67	3

112h. Partial Rat w beat

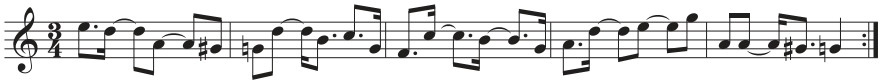


Audio example number 12011.

112h1. interrupted - w beat



112r3. tune

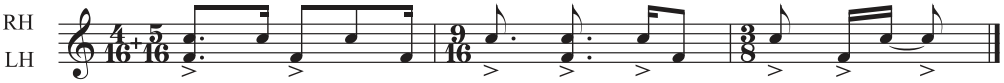


Audio example number 12018.

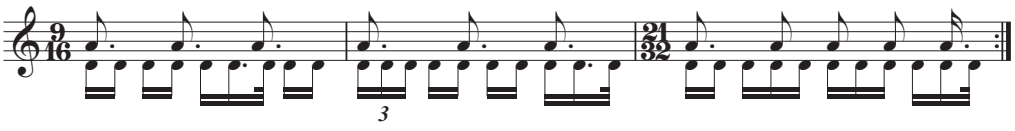
Chapter 5

5.1

254. rad 4:3

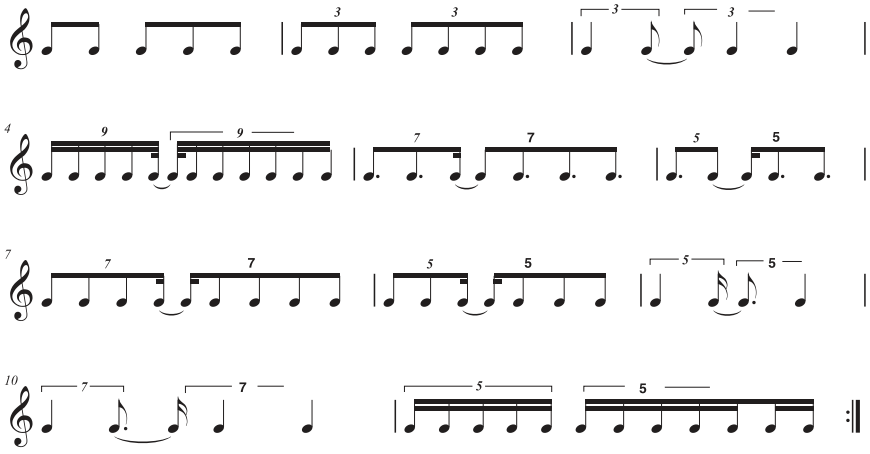


109. pat 1st sho beat on top



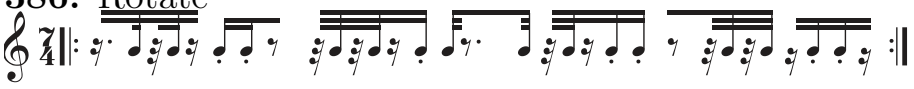
Audio example number 30003.

279. Partial Rats



tags: ***Beam-Beat***; ***Partial Rats***. Audio example number 3002.

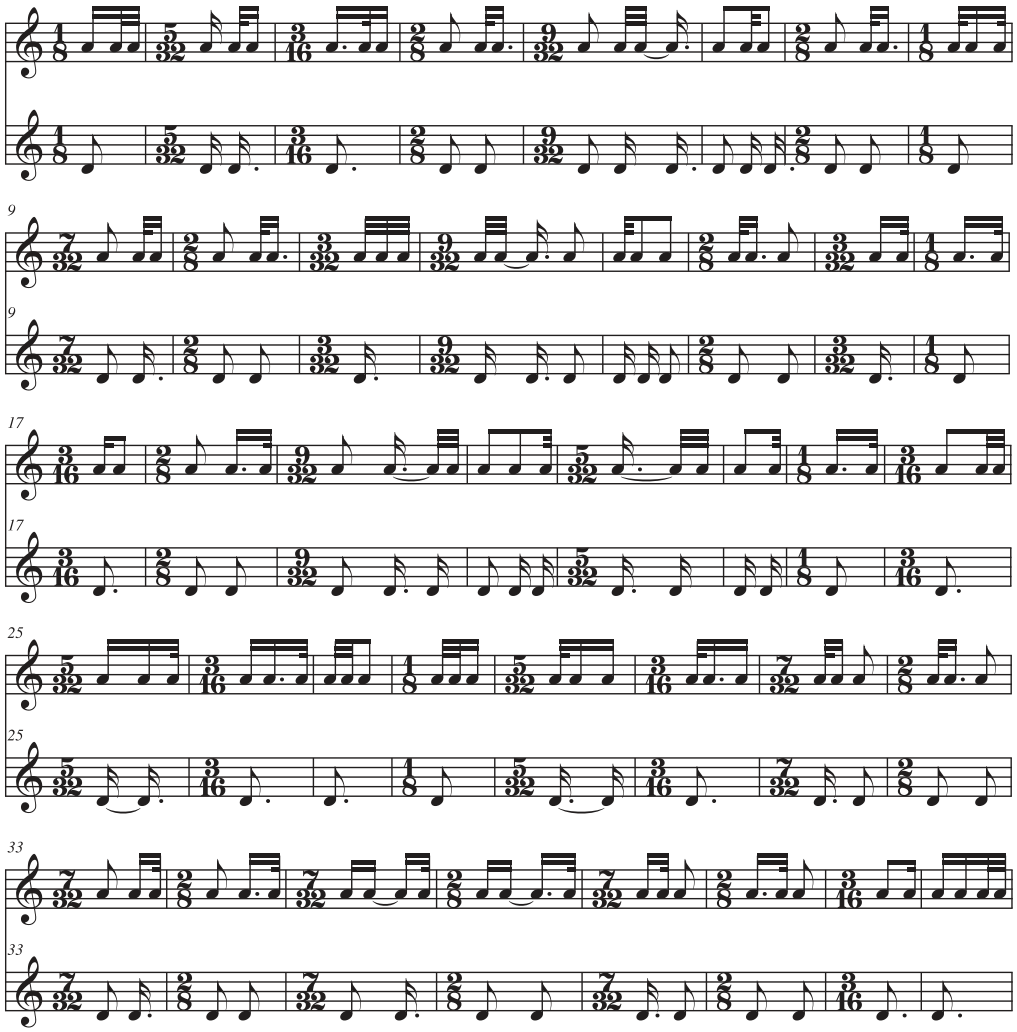
386. Rotate



tag: ***Rotation***. Audio example number 11013.

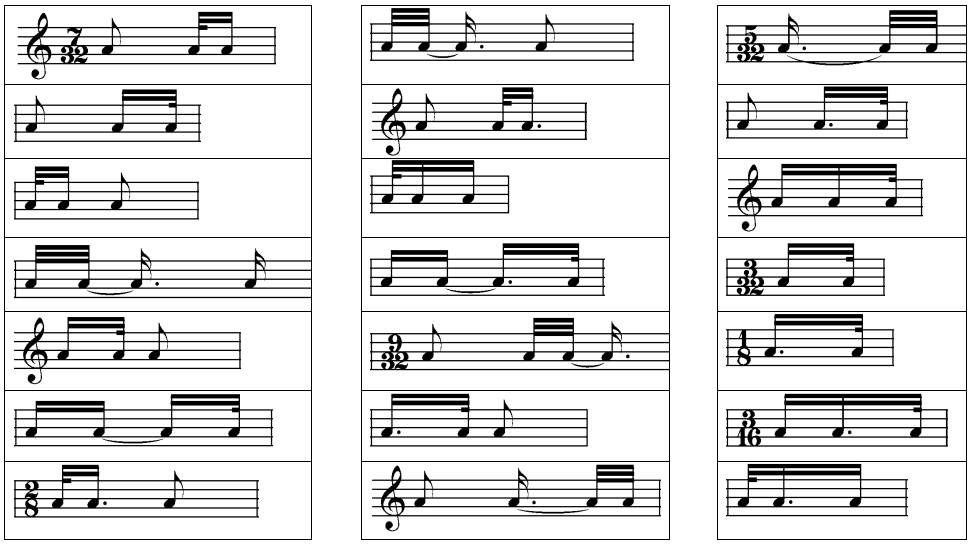
5.2

505. Near Pats



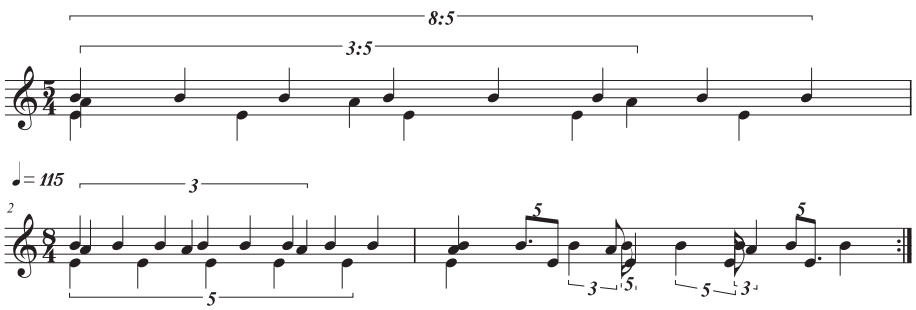
tags: ***Flitting***; ***Typical Myst***. Audio example number 3011.

513. List Glance



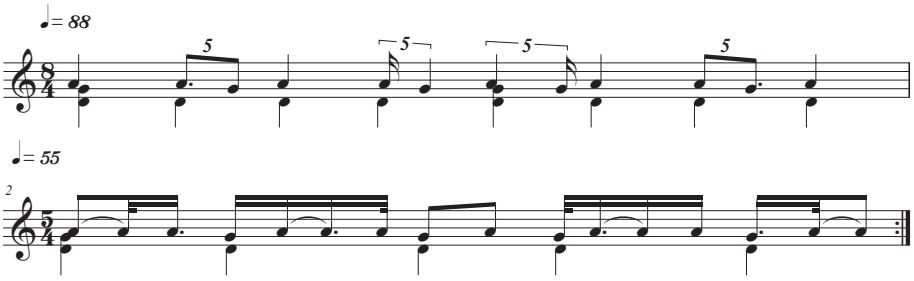
tag: ***Typical Myst***.

571. 8:5:3



tags: ***AproPo***; ***Composite Ratios***. Audio example number 3005.

571b. Invert 8/5-5/8



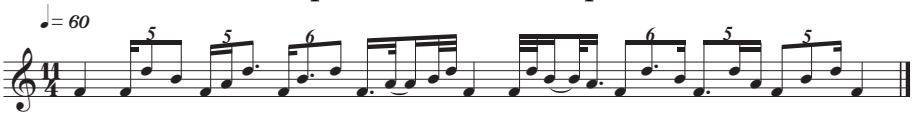
Audio example number 3006.

572. Proximities for 5,7 & 9:11

		5, 7 & 9:11			
11	9	7	5	AproPo Proximities	Ratio used
Dur = 1.00	Dur. = 1.22	Dur. = 1.57	Dur. = 2.2		
Pitch = F	Pitch = D	Pitch = B	Pitch = A		
1.0	1.0	1.0	1.0		
2.0					
	2.22			.02	5:1
		2.57		.03	5
3.0					
			3.2	.00	5
	3.44			.04	5
4.0					
		4.14		.01	8
	4.67			.00	6
5.0					
			5.4	.02	8
		5.71		.04	8
	5.89			.01	8
6.0					
7.0					
	7.11			.02	8
		7.29		.04	8
			7.6	.03	8
8.0					
	8.33			.00	6
		8.86		.02	6
9.0					
	9.56			.04	5
			9.8	.00	5
10.0					
		10.43		.05	8
	10.78			.03	8
11.0					
				total = .40 fr 18 AP's	
(1.0)				avg. = .022	

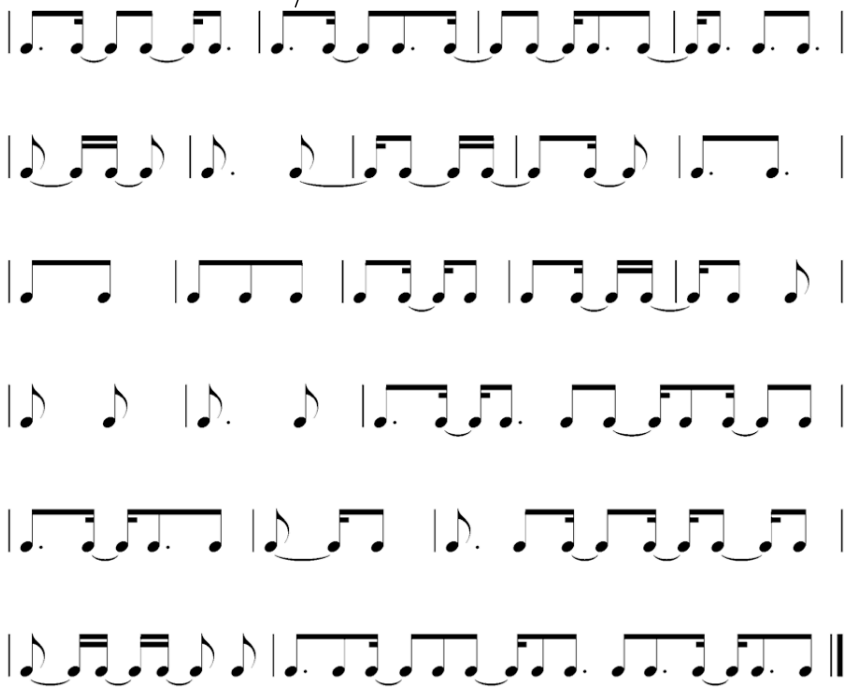
tags: ***Decimals***; ***Short-Hand/Patt 1st***; ***Simul/Sequent***.

572a. 1 Part-Composite-no nests apro



Audio example number 10016.

132. each once - 2/3

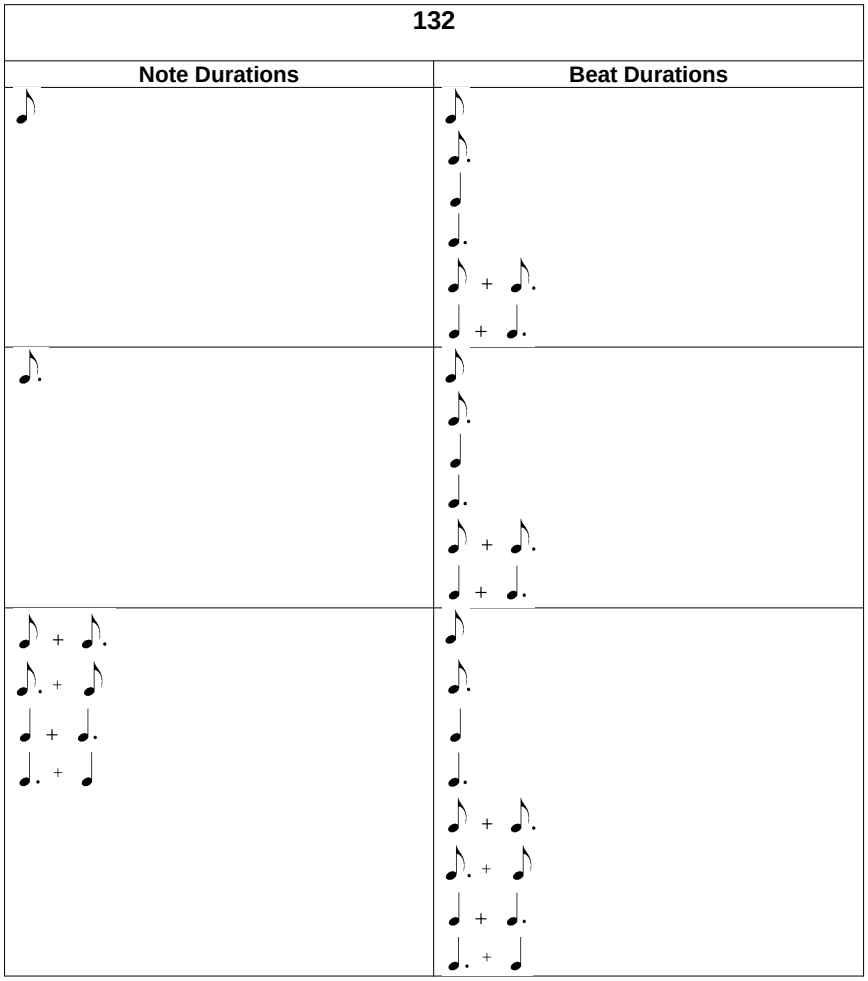


tags: ***2-Hands***; ***Class Representatives***; ***Each/Once/(Spread)***; ***Fun***. Audio example number 25003.

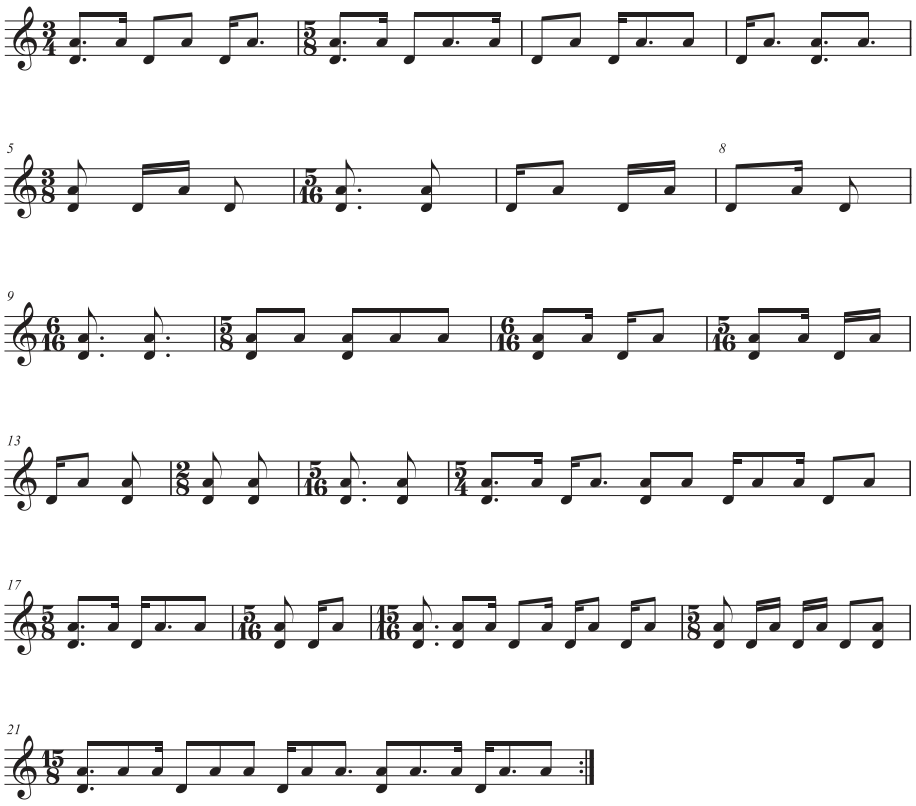
Here one will hear the same rhythms over and over regardless of notation. The notes are all the same length but the beats change a little. The duration of each note is the same but won't necessarily look the same.

The last measure in line one: there are 2 attacks of the note (which are the same duration as all the notes that precede them) but 3 beats.

132. Class Reps-each/once

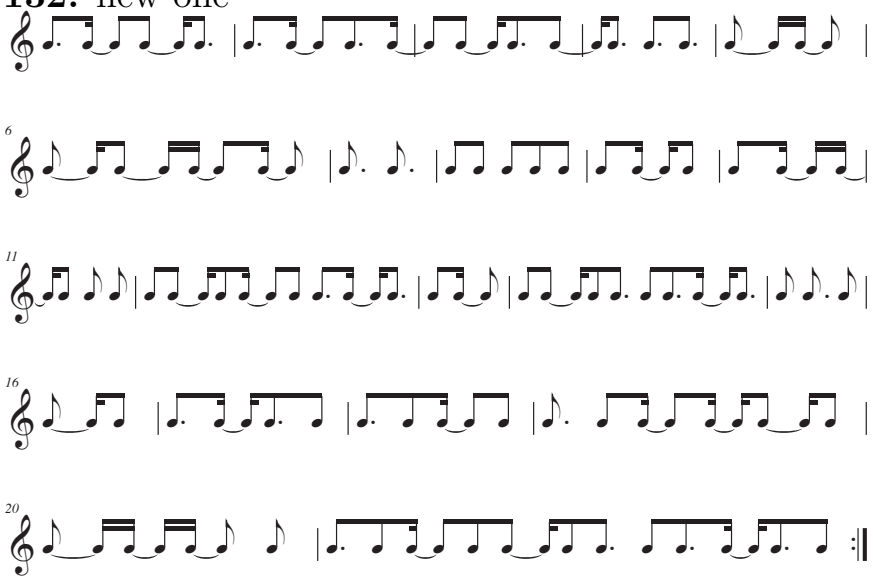


132. 2-hands



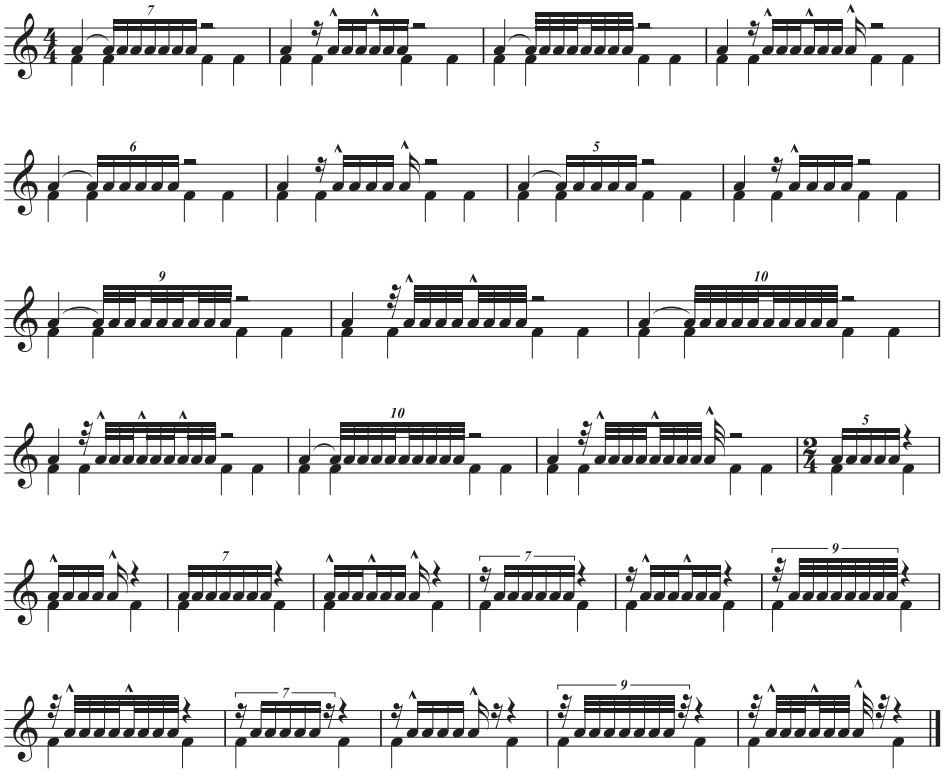
Audio example number 25005.

132. new one



Audio example number 25007.

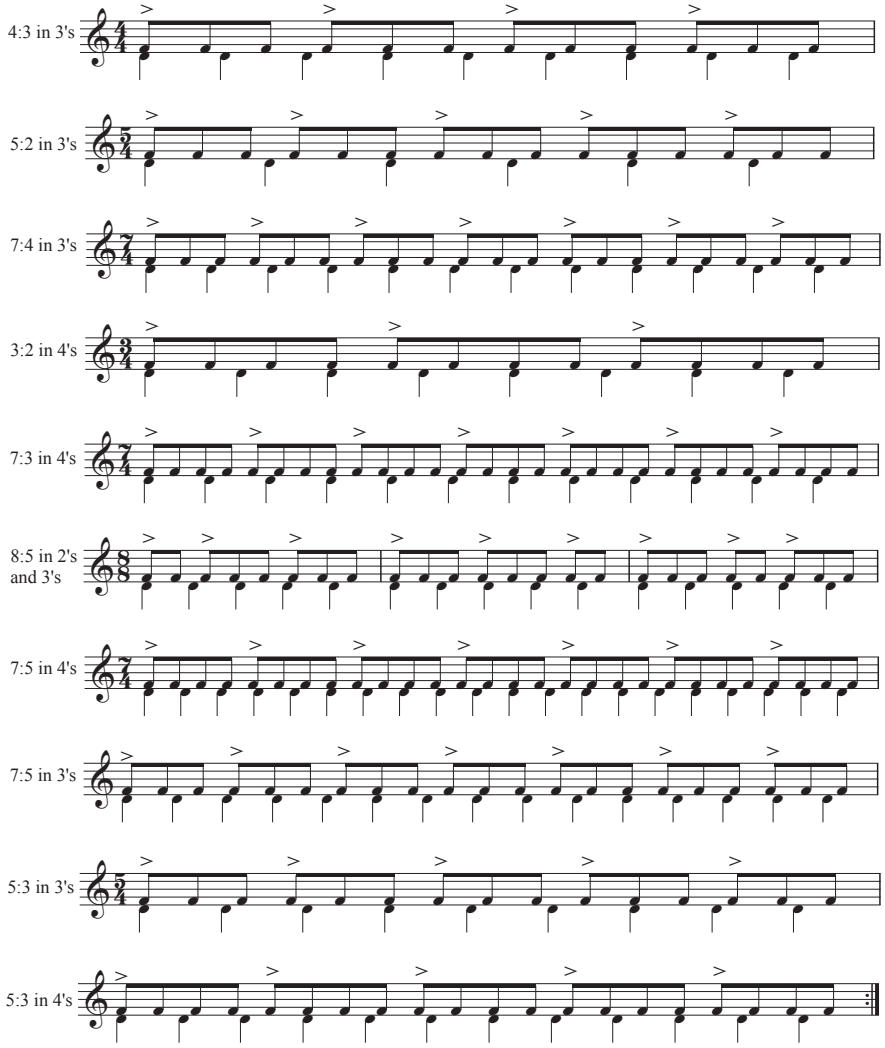
455. Special ReGroups



tag: ***ReGroup***. Audio example number 28006.

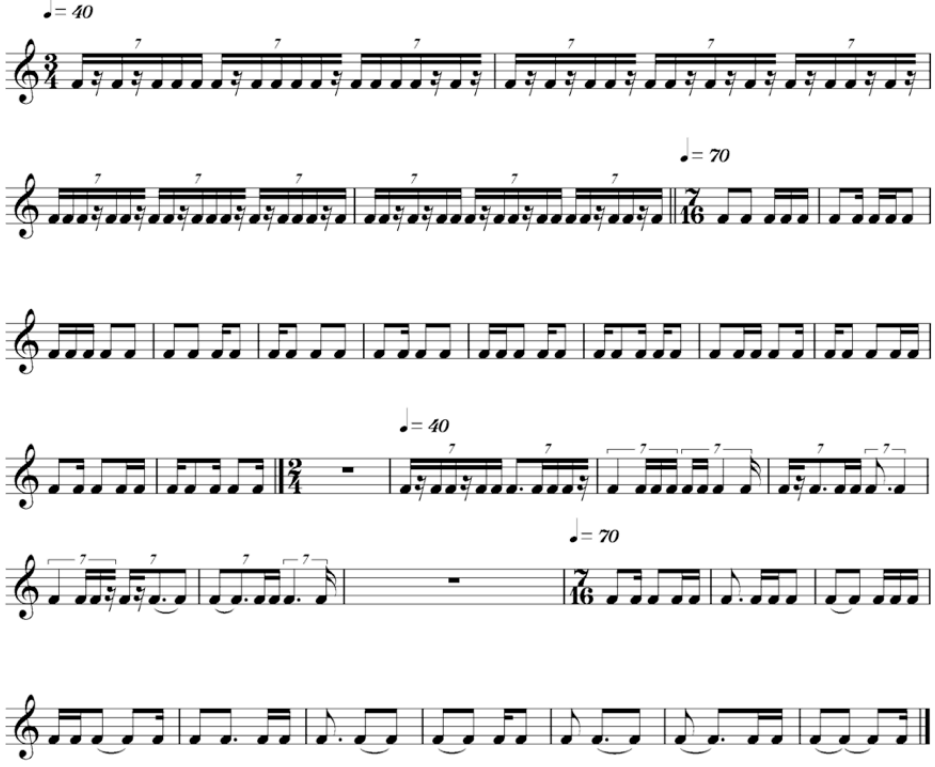
5.3

442. CR regroup



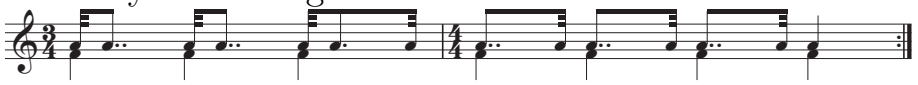
tag: ***ReGroup***. In this exercise the performer is doing something that sounds fancy but in a sense is 4 against 3. There are two parts moving independently which converge in only two places in each line (other than the starting point). The notation might be confusing. This might be difficult at first. Audio example number 14008.

447. ratio to Odd



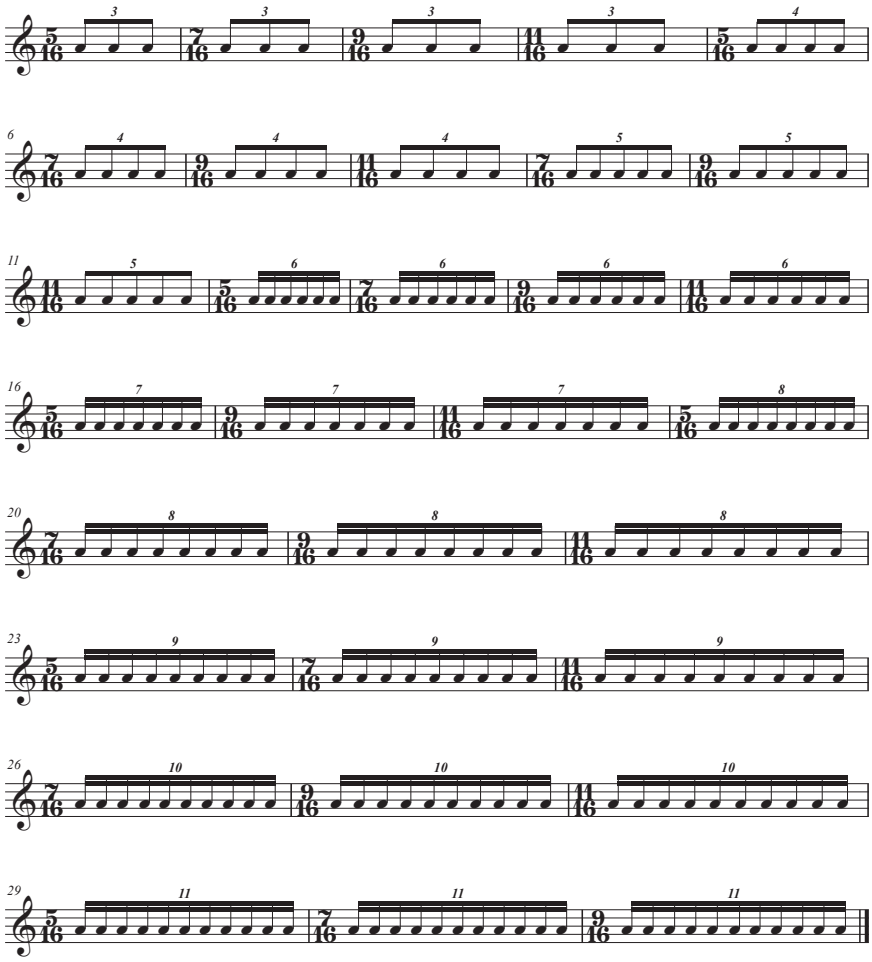
tag: ***ratio to Odd***. Audio example number 28005.

449. my short-long



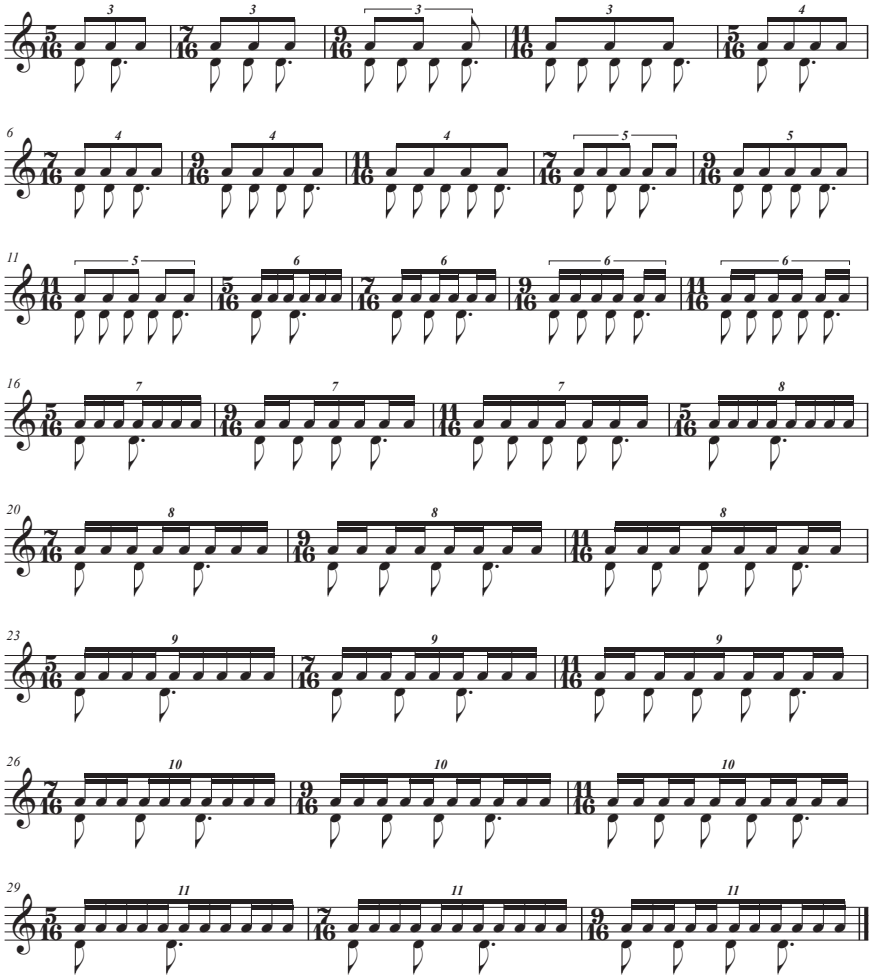
Audio example number 17015.

603f. Orig Metric



tags: ***Q Q.***; ***Yeasty***.

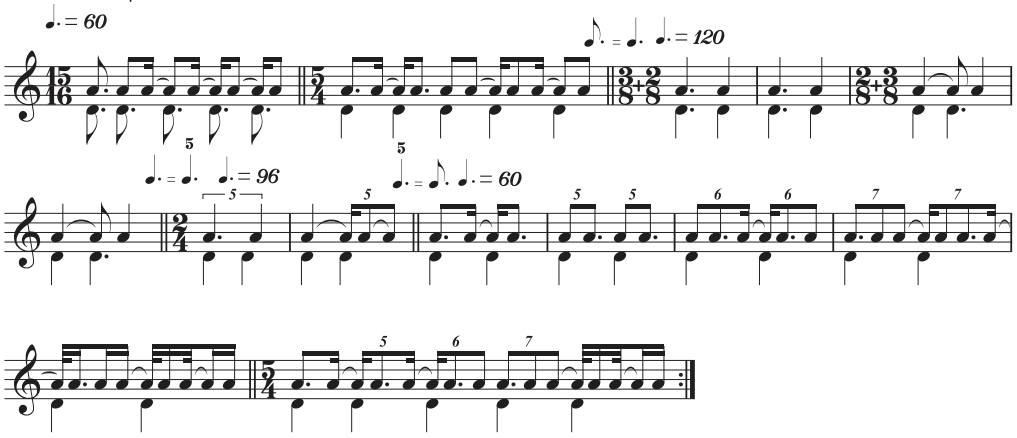
603d. w Beats & Subbeams & 3 Rat



603. rit. lists

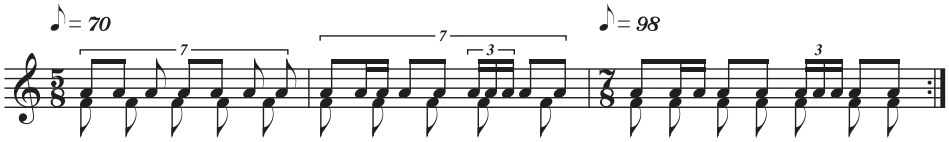
603 Rats	603g Rit	Note Durations	603h Hear
3:2.5	11:2.5	.227	3:2.5
3:3.5	9:2.5	.277	4:5.5
3:4.5	8:2.5	.313	3:4.5
3:5.5	11:3.5	.318	4:4.5
4:2.5	10:3.5	.350	other
4:3.5	7:2.5	.357	
4:4.5	9:3.5	.389	
4:5.5	11:4.5	.409	
5:3.5	6:2.5	.417	
5:4.5	8:3.5	.438	
5:5.5	10:4.5	.450	
6:2.5	10:5.5	.550	
6:3.5	8:4.5	.563	
6:4.5	6:3.5	.583	
6:5.5	9:5.5	.611	
7:2.5	4:2.5	.625	
7:4.5	7:4.5	.643	
7:5.5	8:5.5	.688	
8:2.5	5:3.5	.700	
8:3.5	6:4.5	.750	
8:4.5	7:5.5	.786	
8:5.5	3:2.5	.833	
9:2.5	4:3.5	.875	
9:3.5	5:4.5	.900	
9:5.5	6:5.5	.917	
10:3.5	5:5.5	1.10	
10:4.5	4:4.5	1.13	
10:5.5	3:3.5	1.17	
11:2.5	4:5.5	1.38	
11:3.5	3:4.5	1.50	
11:4.5	3:5.5	1.83	

446. 3+2 diff contx



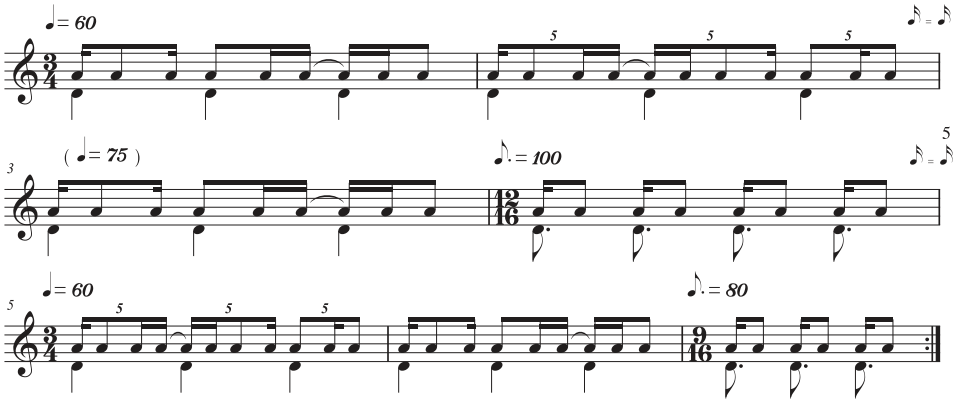
Audio example number 23008.

510. 7:5 modifys



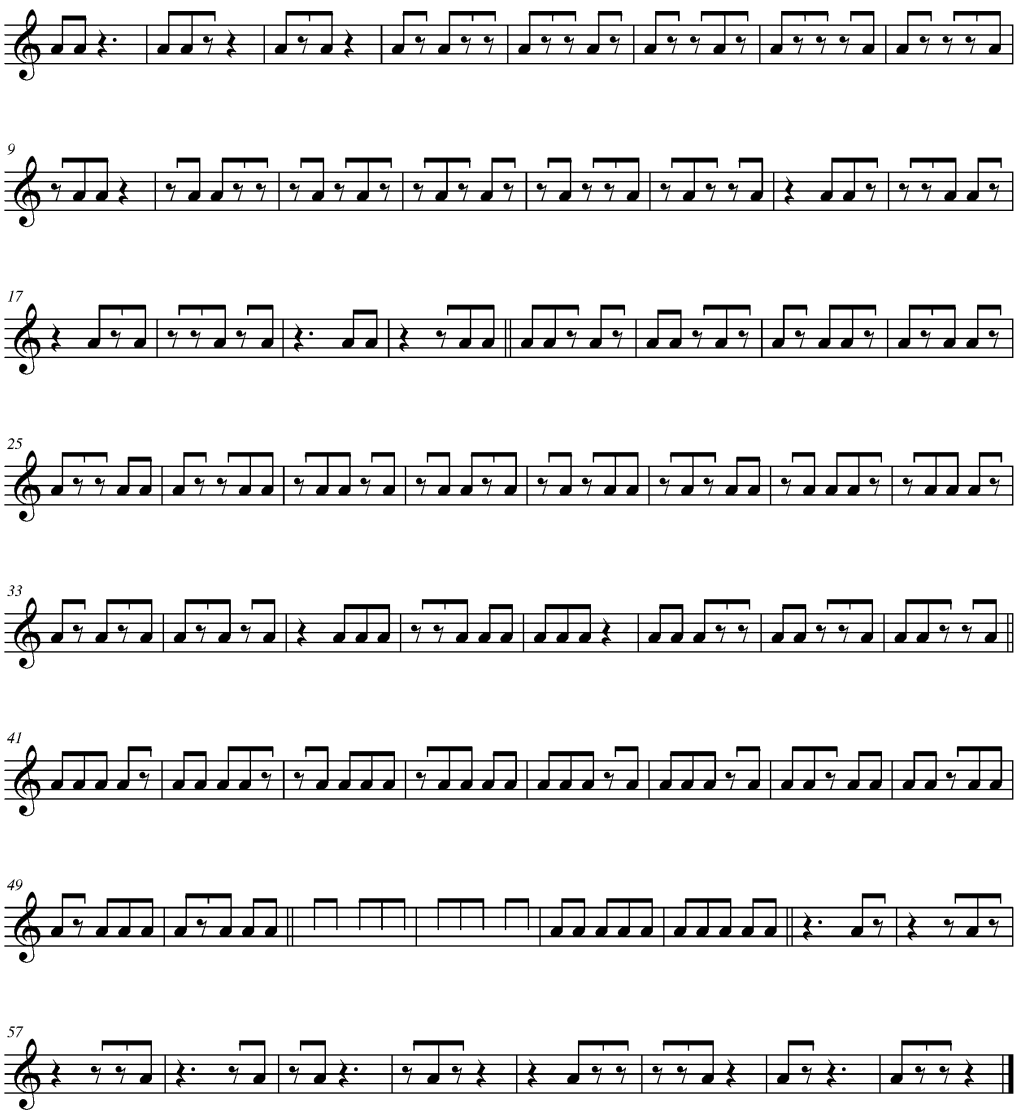
Audio example number 30004.

471. same patt/dif rat

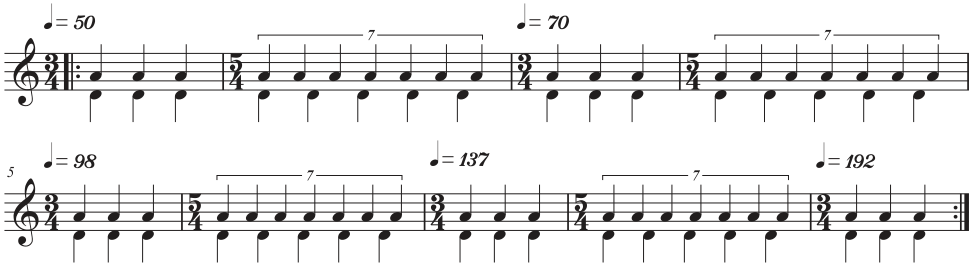


tags: ***Levels***; ***Same Patt/Differ Rat***. Audio example number 5014.

525. all 5/8s

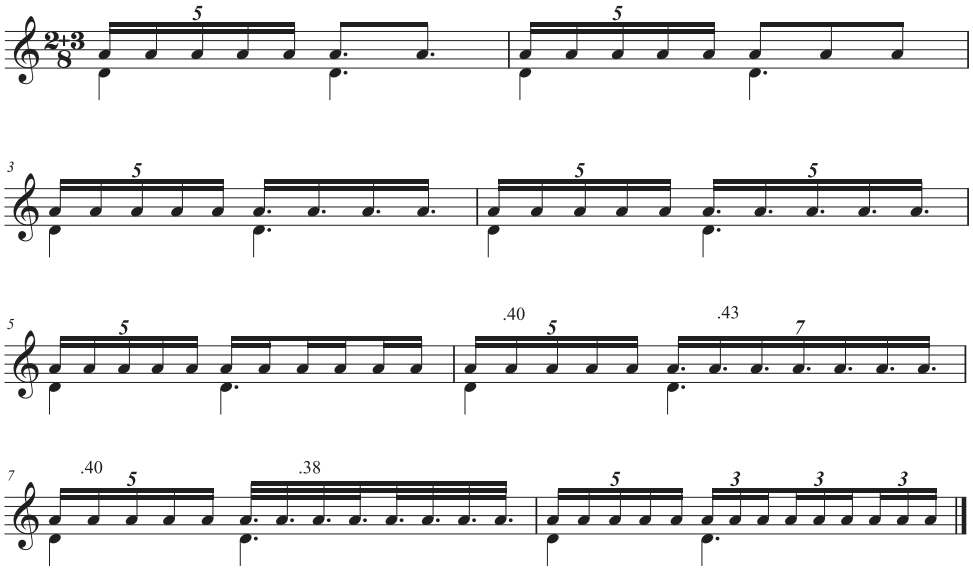


481. Met Mod Accel



tag: ***Met Mod***. Audio example number 5016.

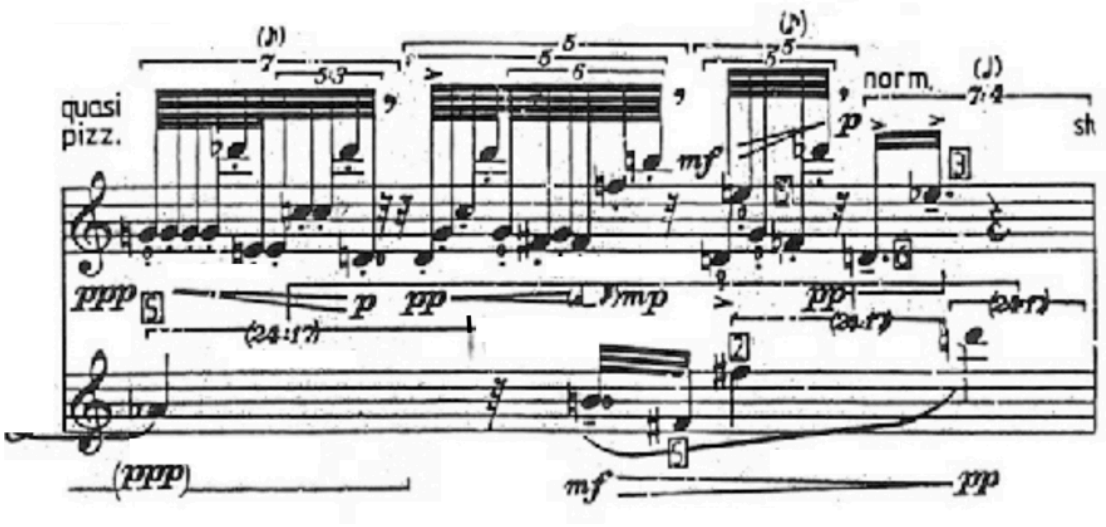
224. rats 5/8



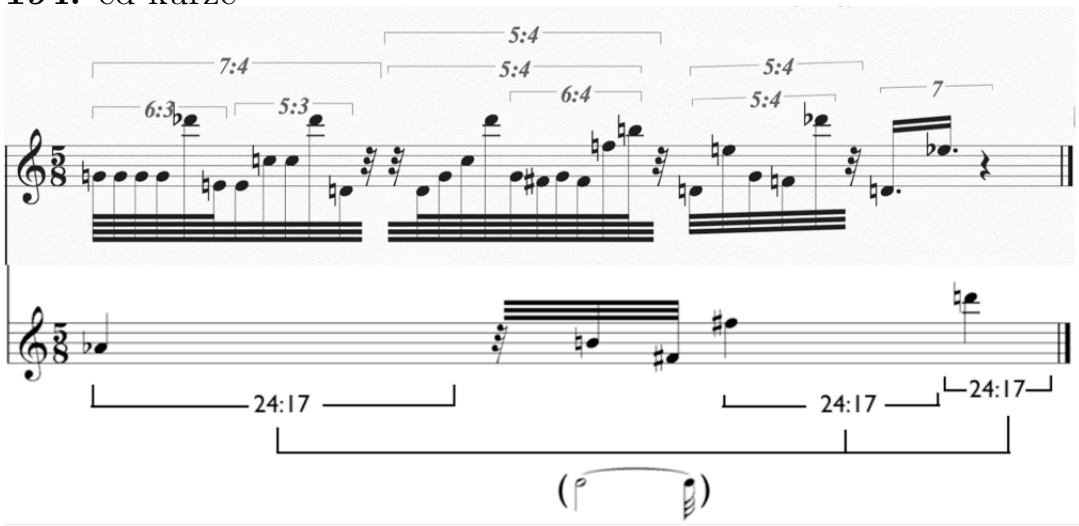
Audio example number 27010.

5.4

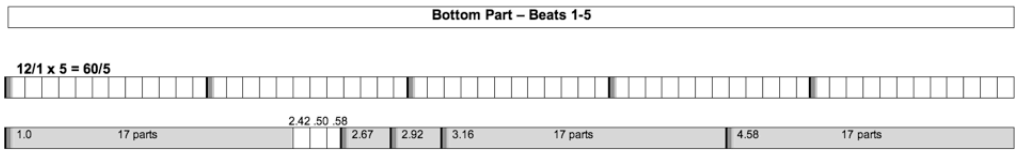
194. ferney orig - from Brian Ferneyhough, *Kurze Schotten II*



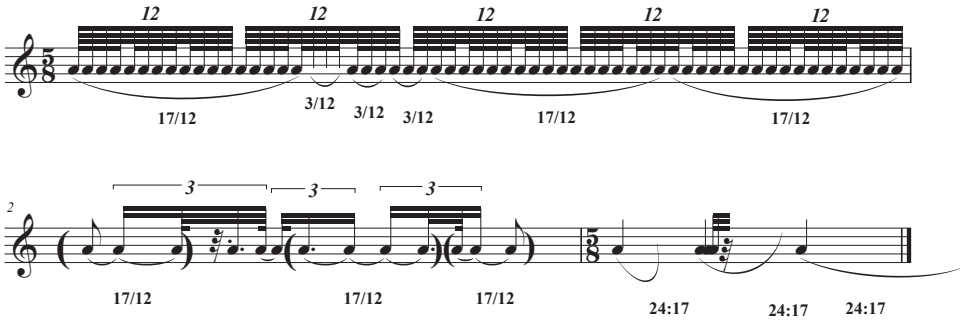
194. ed kurze



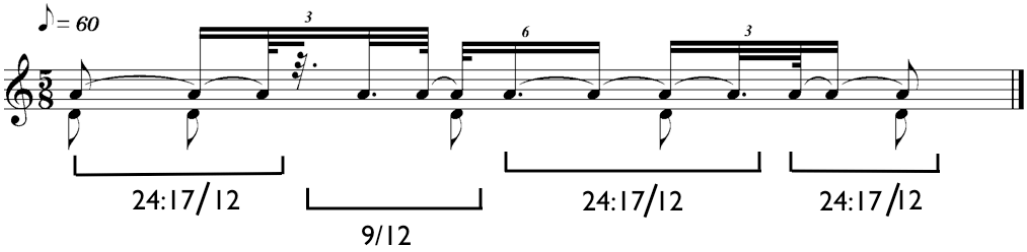
194. Bottom w word-bars 1-5+reveal



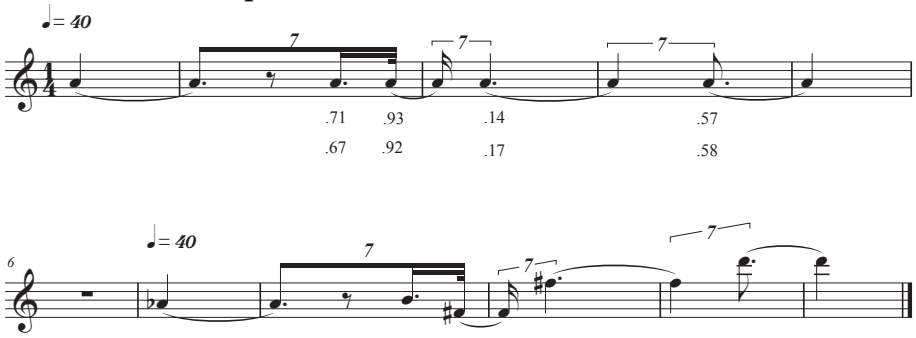
194. bot w conven-Levels-triplets



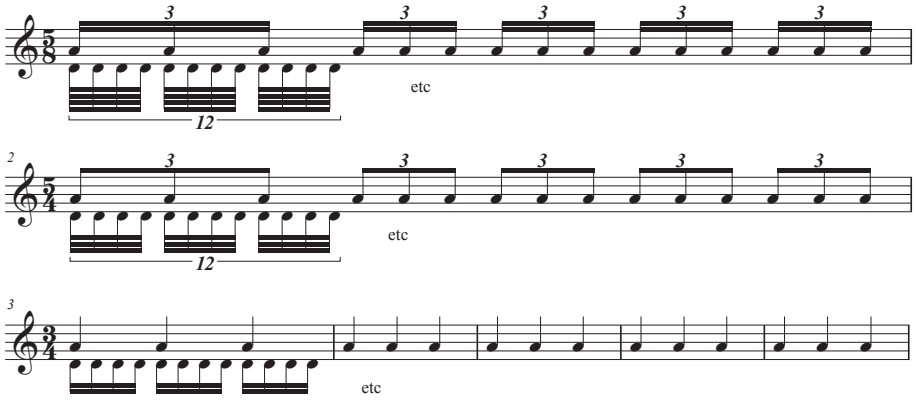
194. Simpler 2-Triplet (fr 55)



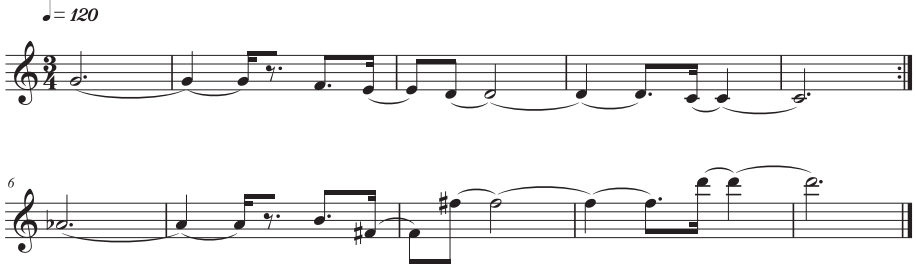
194n. aside AproPo Bot



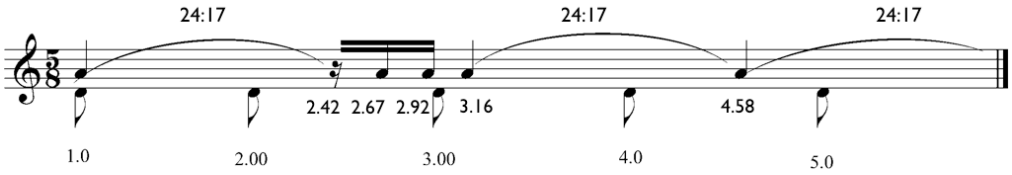
194m. Simpler 1 -a 5/8 to a 3/4



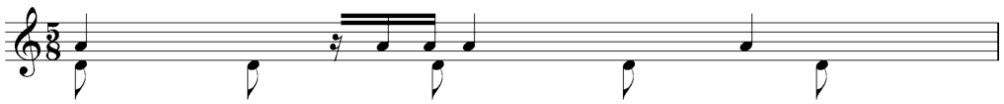
194k. Simpler 3 (pitch too)



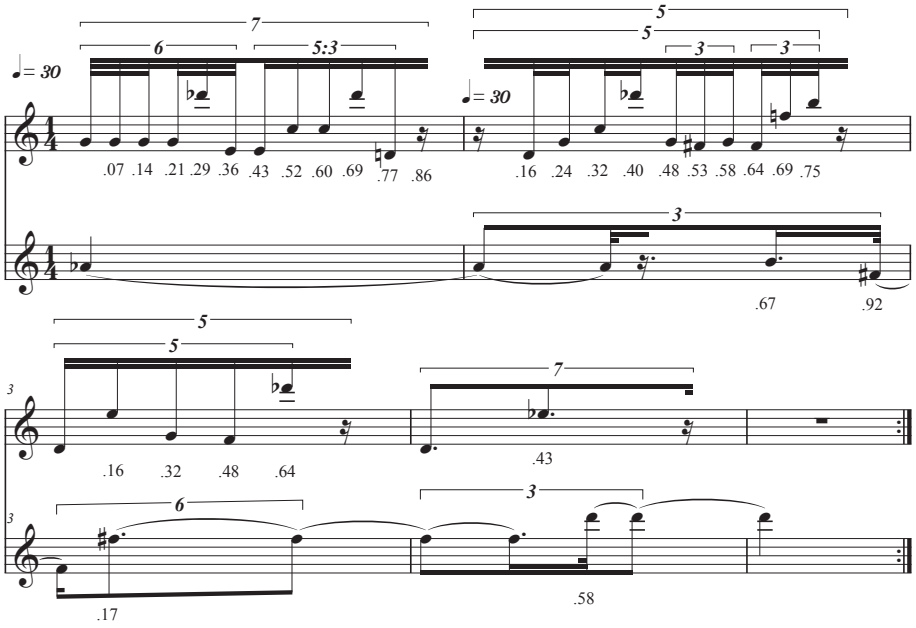
194. Propor Bottom part B-3



194. Propor Bot B-6 no rats, decs or ties



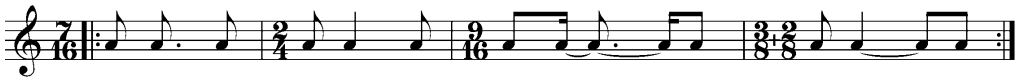
194. all correct (-7s) w dec



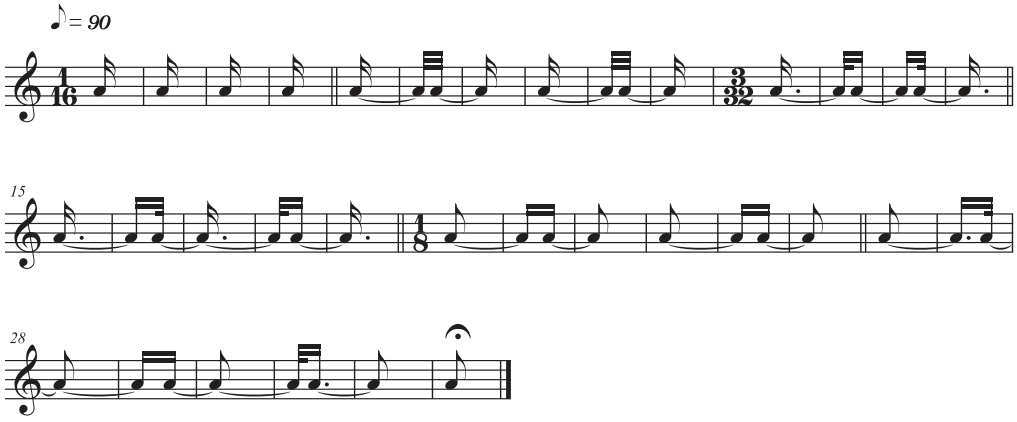
Chapter 6

6.1

311. Expand patt

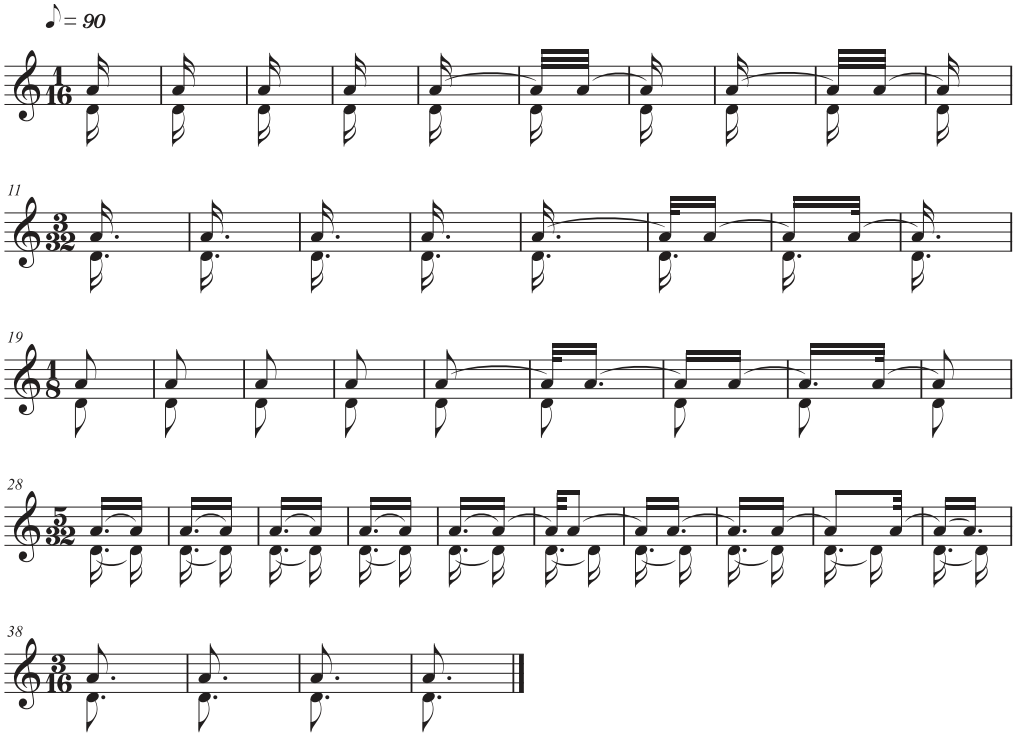


320. rit



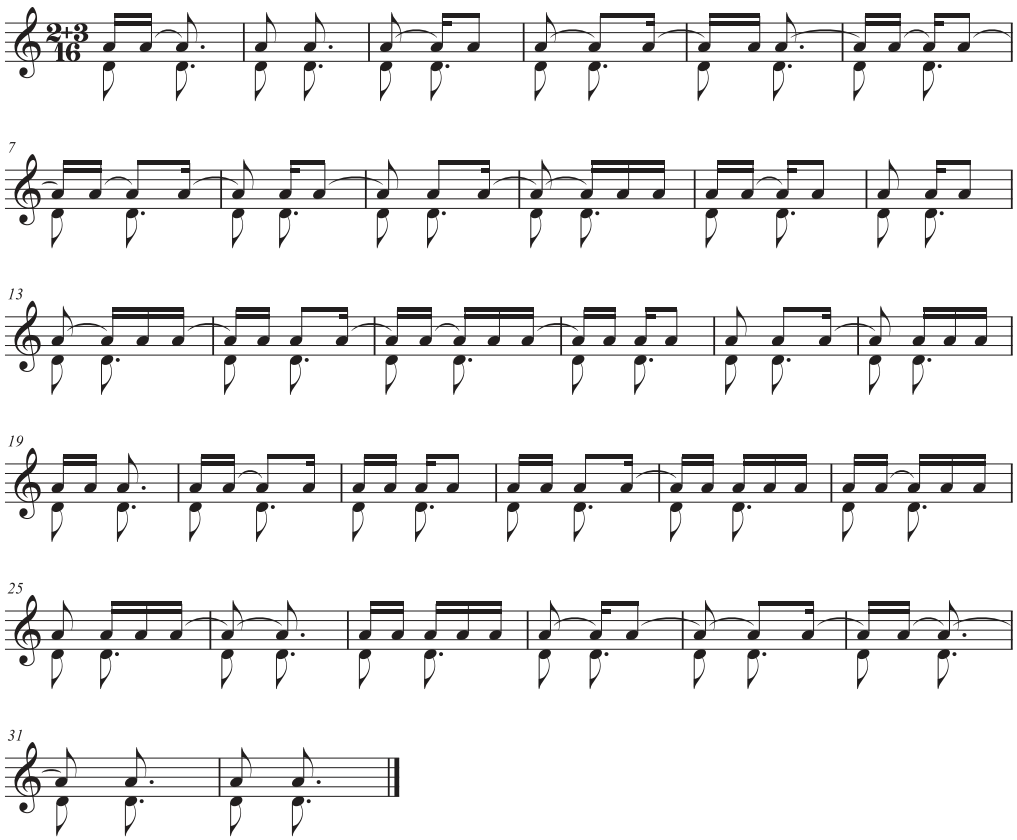
Audio example number 32001.

321. rit



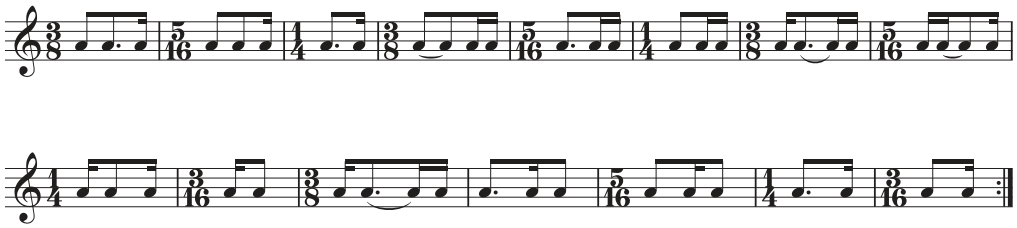
Audio example number 32002.

376. 2+3



Audio example number 5012.

443. no layer-beat

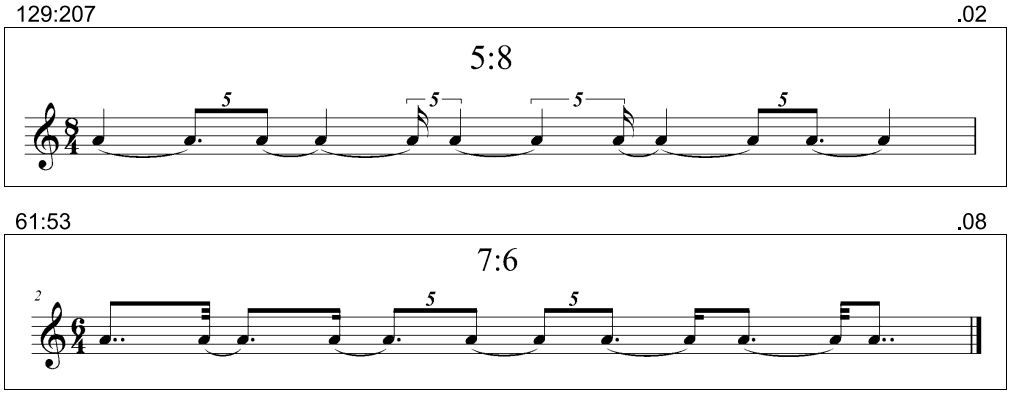


tag: ***Class Representatives***. Audio example number 23005.

6.2

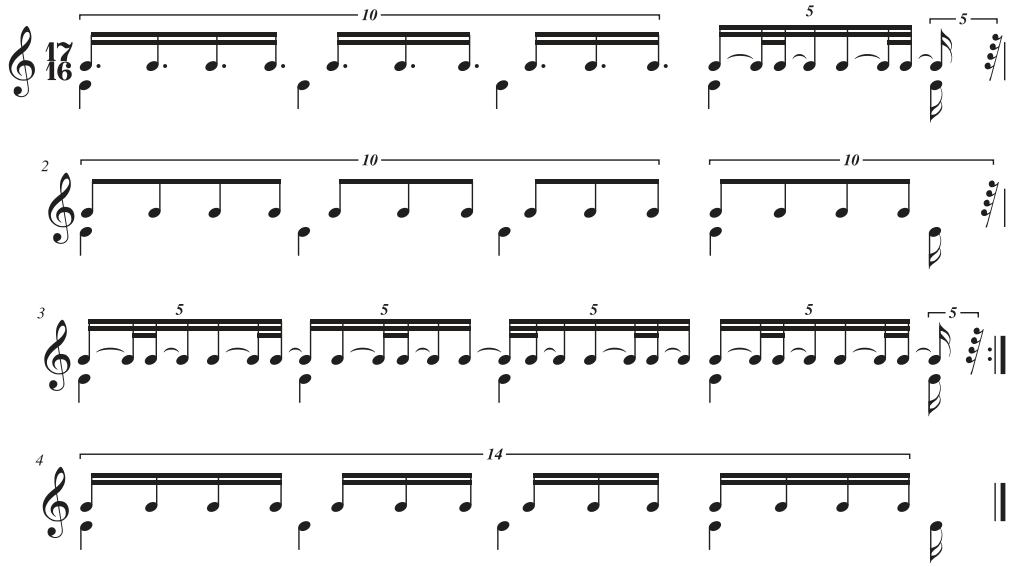
595. Hi-Number Ratios

Ratio Call	Dur of ea		Near Dec	Near Rat	slight dif	Totl Dif	HAM	Next APoint
213 : 61	.28638		.28571	7 : 2	faster	.00067	43	3.004
913 : 684	.74917		.75000	4 : 3	slower	.00083	211	4.997
94 : 28	.29787		.30000	10 : 3	slower	.00213	433	3.979
129 : 207	1.60465		1.60000	5 : 8	faster	.00465	110,110,10	9.023
61 : 53	.86885		.85714	7 : 6	faster	.01171	211111	7.082
53 : 17	.32075		.33333	3 : 1	slower	.01258	3	1.962
23 : 31	1.34783		1.33333	3 : 4	faster	.01450	1110	5.043
17 : 13	.76471		.75000	4 : 3	faster	.01471	211	4.059



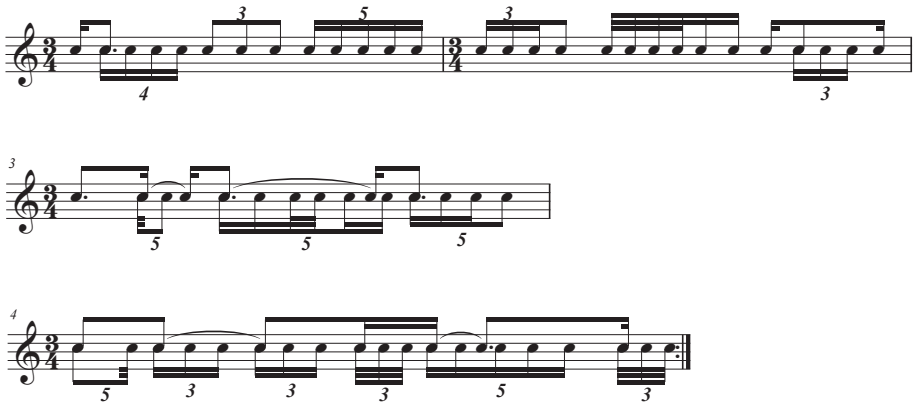
tags: ***Near Rats***; ***Reducing Fractions***.

557. Dobrian Rhy



tags: ***One NV***; ***Show Beat***. Audio example number 16017.

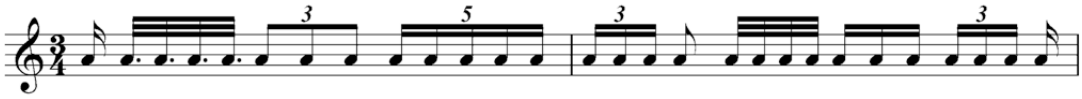
590. My Babbitt



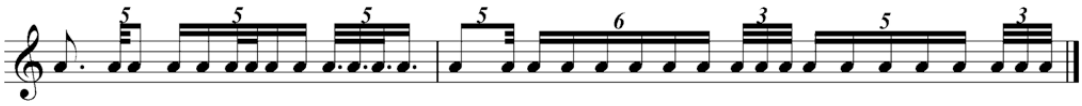
Audio example number 21018.

590. tuf Babbitt

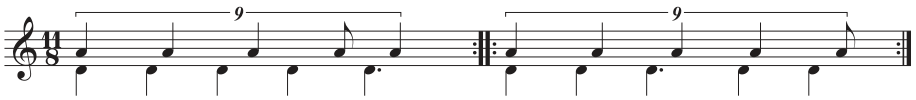
from Babbitt's "Playing for time"



from Babbitt's "My Complements to Roger" (Sessions)



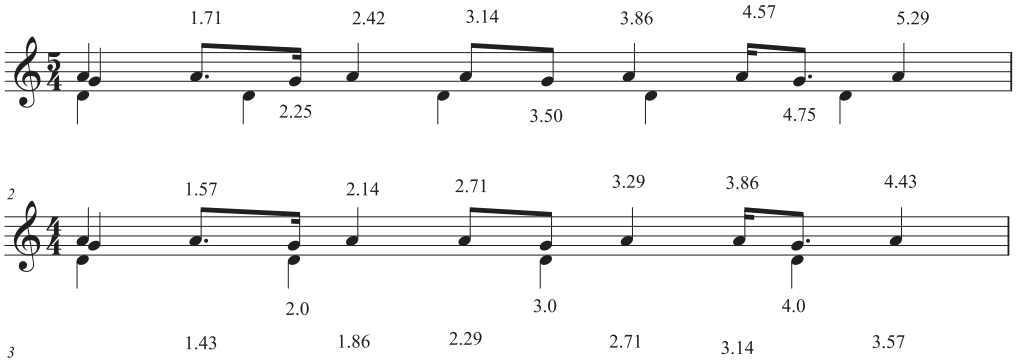
606. 4.5:5.5



Audio example number 7017.

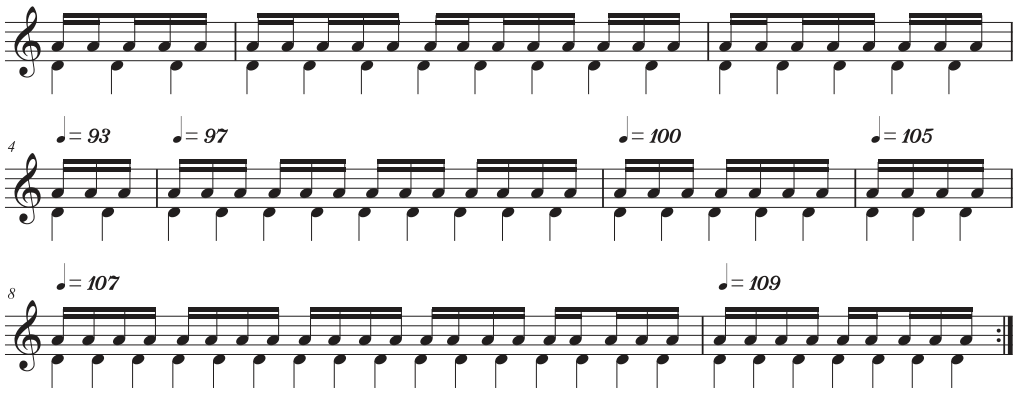
6.3

612. 7:5 in 3,4,5



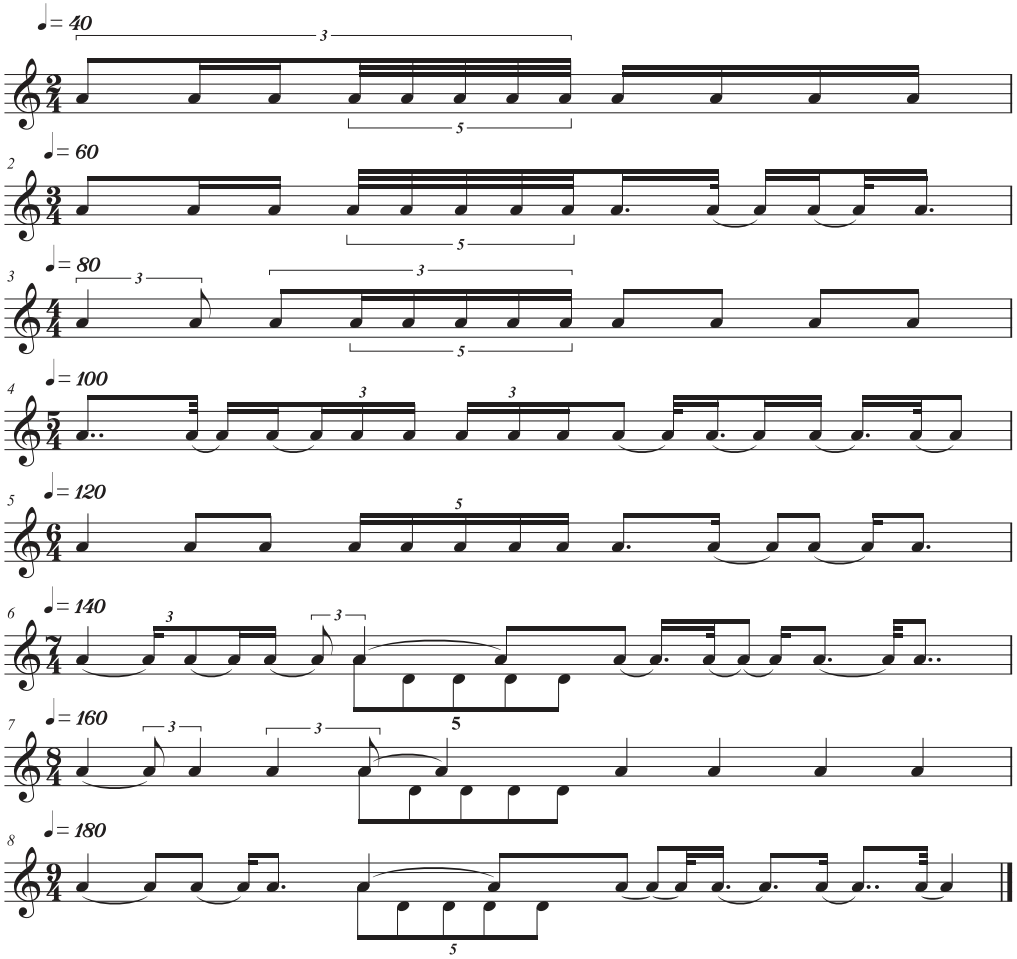
Audio example number 27005.

495c3. No Ratios, TS, static Tempi accel



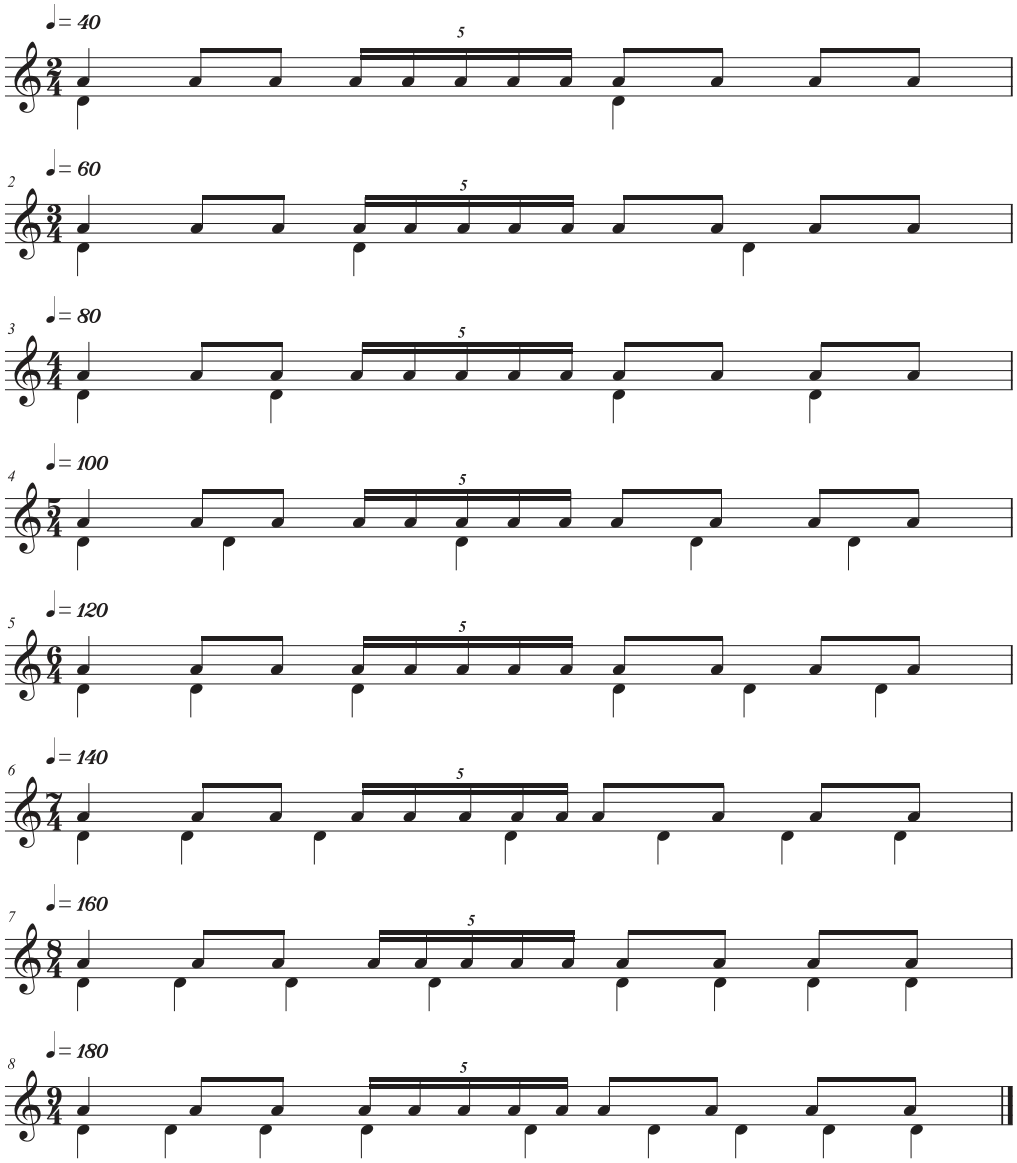
Audio example number 25005.

538a. Same Patt/diff speeds



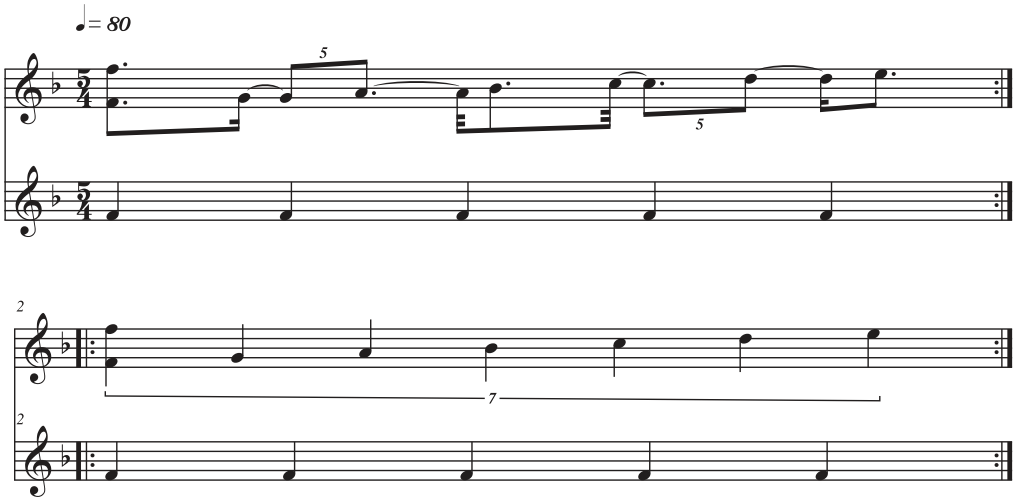
tags: ***2-ways***; ***Levels***; ***Same Patt/Differ Rat***; ***Short-Hand/Patt 1st***. Audio example number 28013.

538f. Patt Notation



Audio example number 28014.

540. 7:5 AproPo Scale - hear 3 times ea



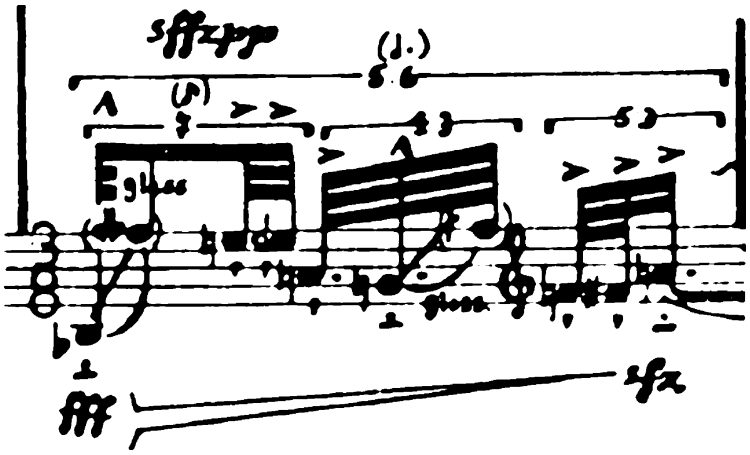
Avg. .0283 off

tag: ***Near Rats***. Audio example number 18007.

540b. Figure

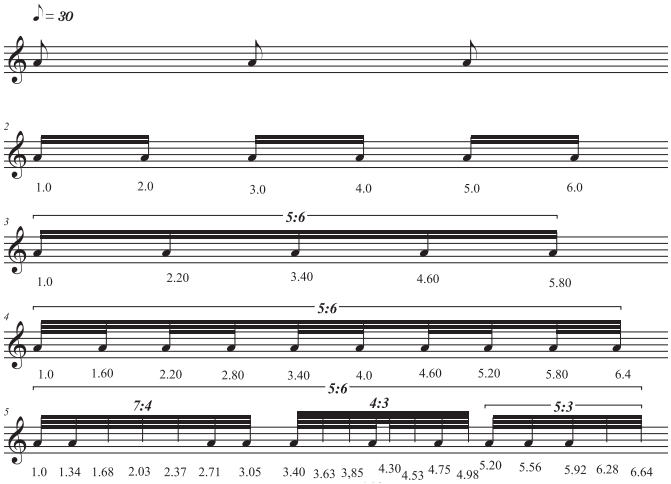
540					
apropo	**7:5**		**apropo**	**7:5**	
AP's	**AP's**	**Off**	**Dur**	**Dur**	**Off**
1.0	1.0				
1.75	1.71	.04	.75	.71	.04
2.40	2.43	.03	.65	.71	.06
3.13	3.14	.01	.73	.71	.02
3.88	3.86	.02	.75	.71	.04
4.60	4.57	.03	.72	.71	.01
5.25	5.29	.04	.65	.71	.06
		.17			.23
		Avg = .028 off			Avg = .038

542. Ferney carceri-p.5



tags: ***Decimals***; ***Levels***; ***Look Diffic/Are Easy***; ***Near Rats***; ***Nests***; ***Proportional***; ***Yeasty***.

542a1. Levels w decimals

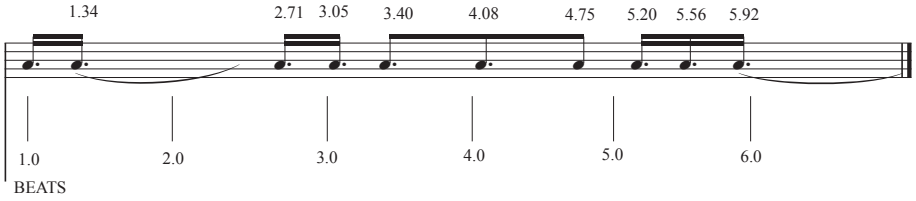


542b. word Apro decimals

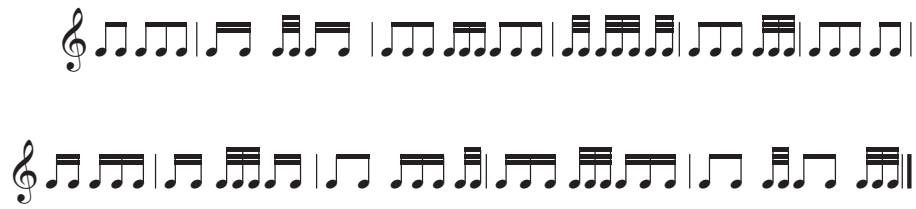
2.4 div 7=.34	1.8 div 8=.23	1.8 div 5=.36
1.0	**3.40**	**5.20**
1.34	3.63	**5.56**
1.68	3.85	**5.92**
2.03	**4.08**	6.28
2.37	4.30	6.64-7.0
2.71	4.53	
3.05-3.40	**4.75**	
	4.98-5.20	

The numbers are beat values of all the onsets in the last staff of the preceeding example. The ones that are sounded are shown in boldface.

542c. propor w decimals

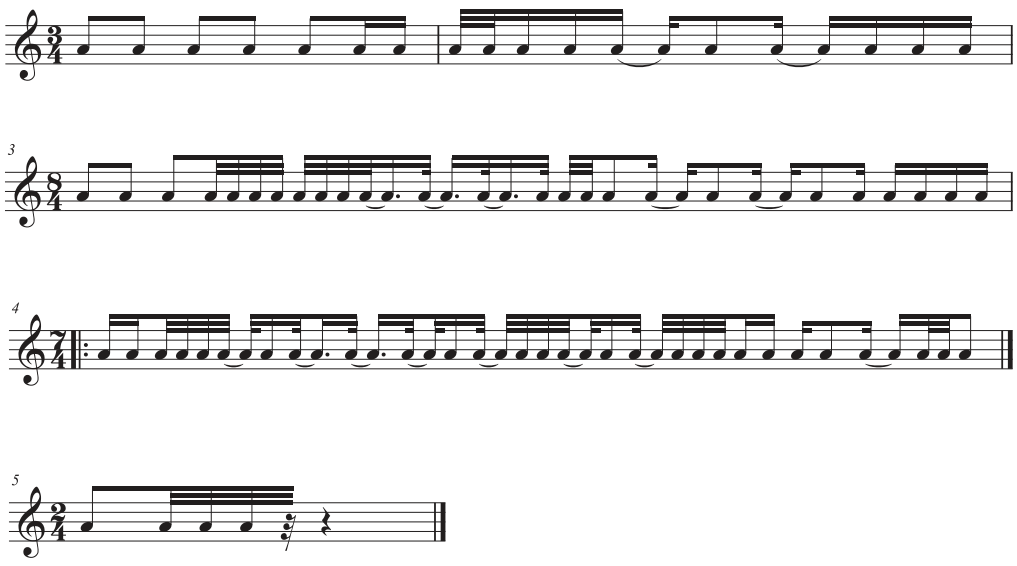


169. beam-beat-501



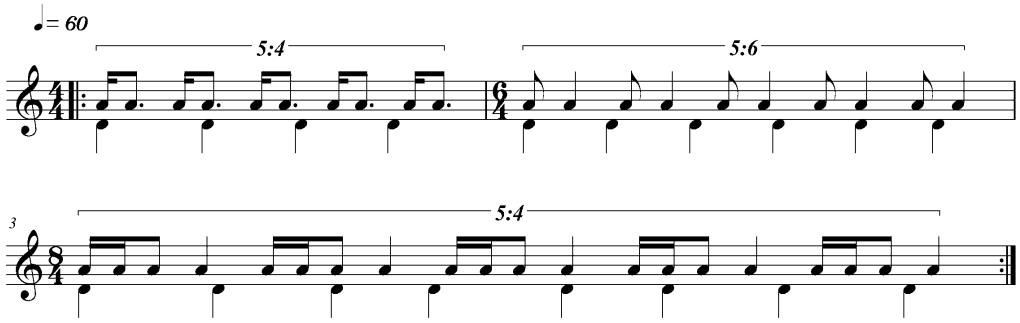
tags: ***Beam-Beat***; ***Invert***; ***Look Diffic/Are Easy***; ***Odd Evening***. Audio example number 17007.

169zz. renotated 169

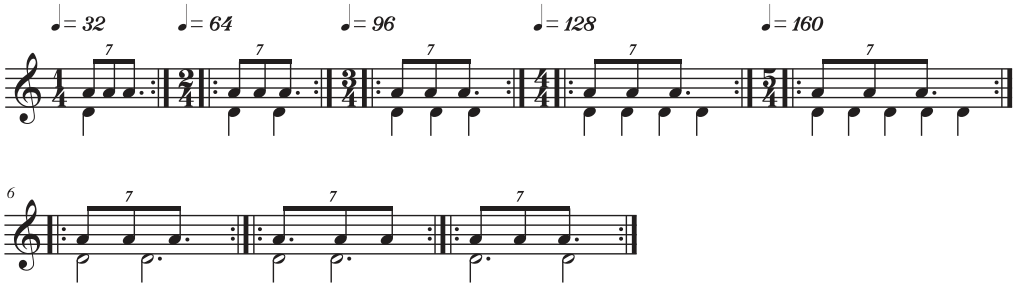


Look Differ/Are Same.

42c. Pattern Notation-Bars 1-5

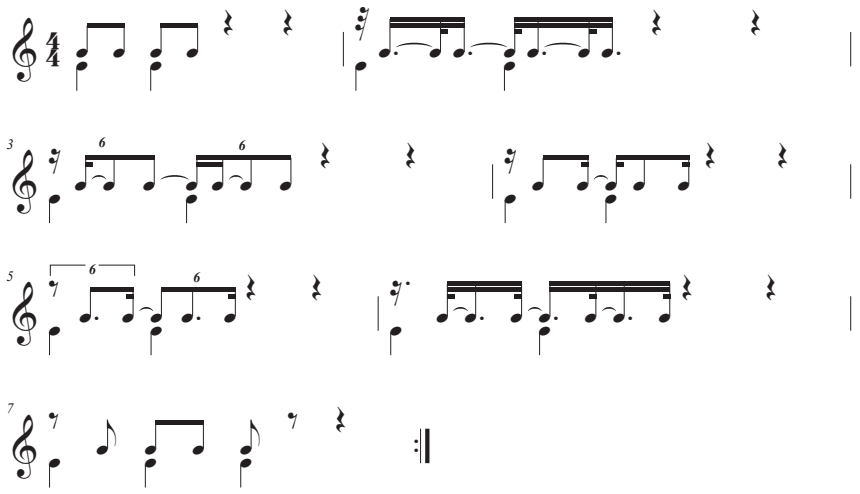


504. all Beatings

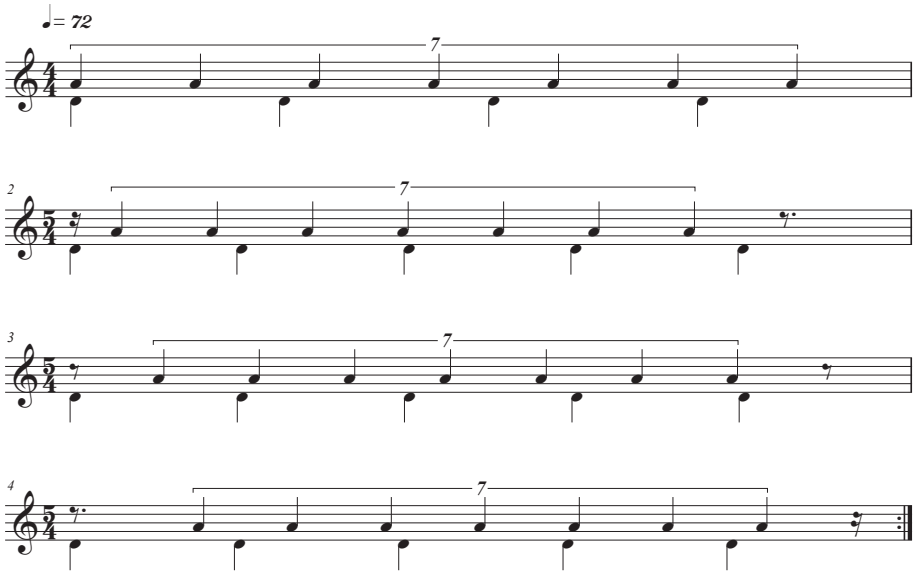


tags: ***Beatings***; ***Long-Hand***. Audio example number 22005.

5. Rotation - 4 equal



11. Displaced Rats wo Beats

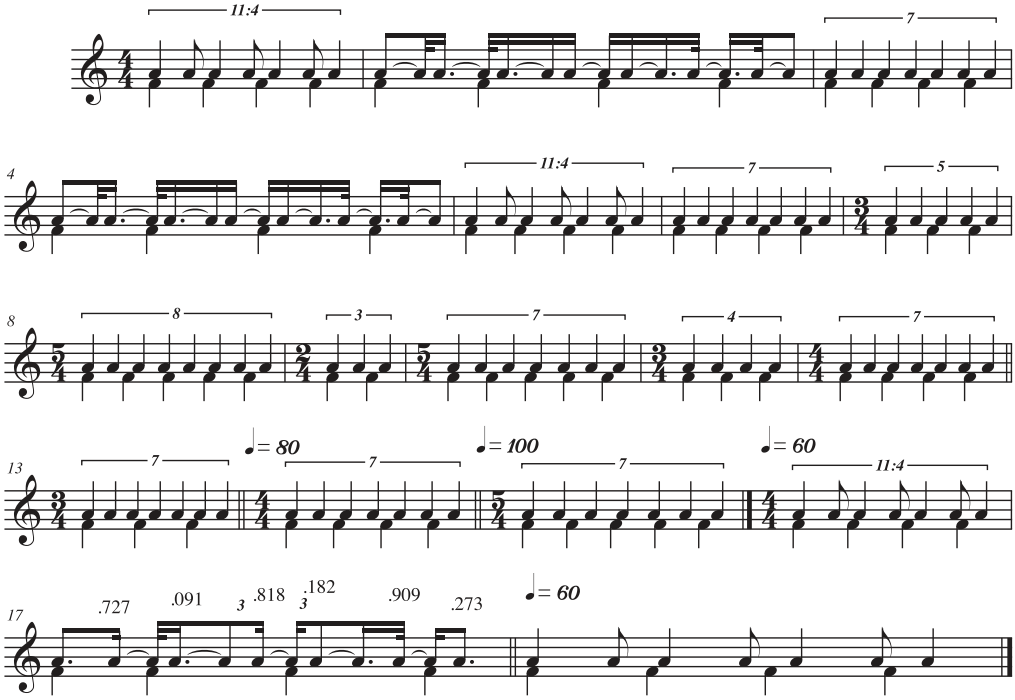


upper notes- attack points

Line 1	1.00	1.57	2.14	2.71	3.29	3.86	4.43
Line 2	1.25	1.82	2.39	2.96	3.53	4.10	4.67
Line 3	1.50	2.07	2.64	3.21	3.78	4.35	4.92
Line 4	1.75	2.32	2.89	3.46	4.03	4.60	5.17

tag: ***Displaced Rats***. Audio example number 20006.

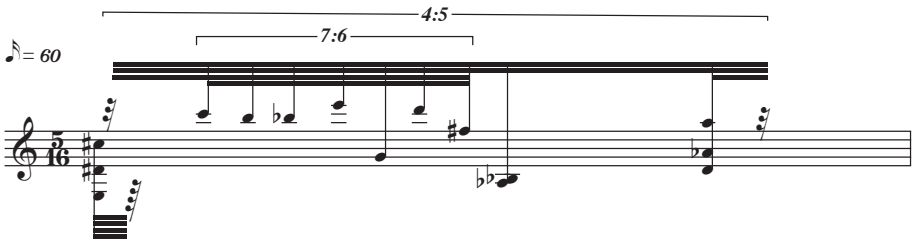
530a. 11:4 Near



tag: ***Near Rats***. Audio example number 28011.

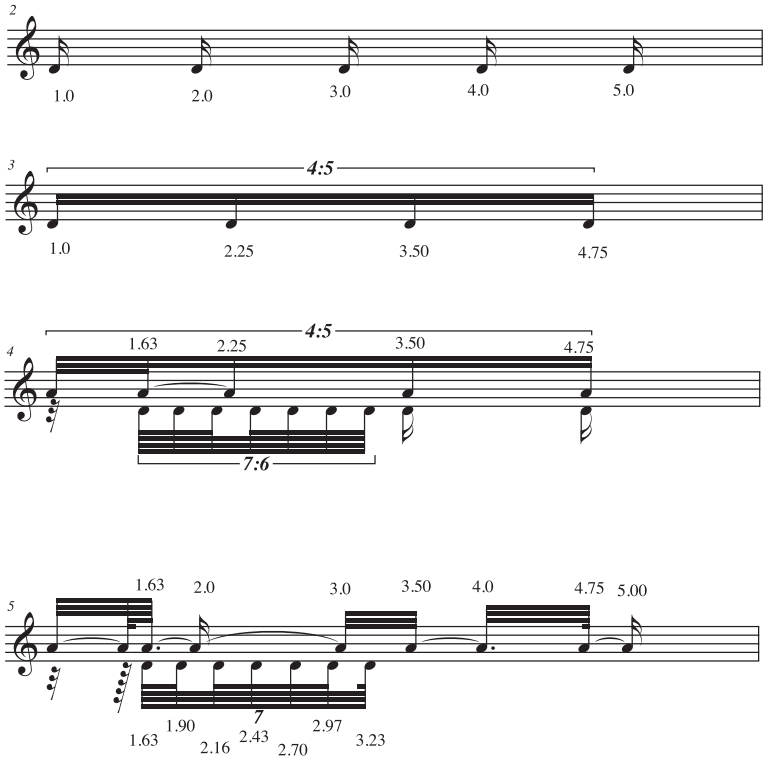
6.4

618.10. ferney

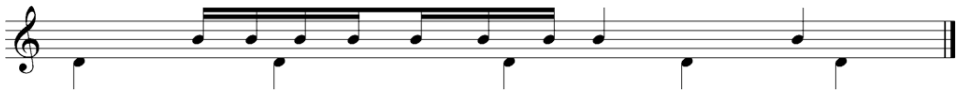


tag: ***Near Rats***; ***No #s***; ***Yeasty***.

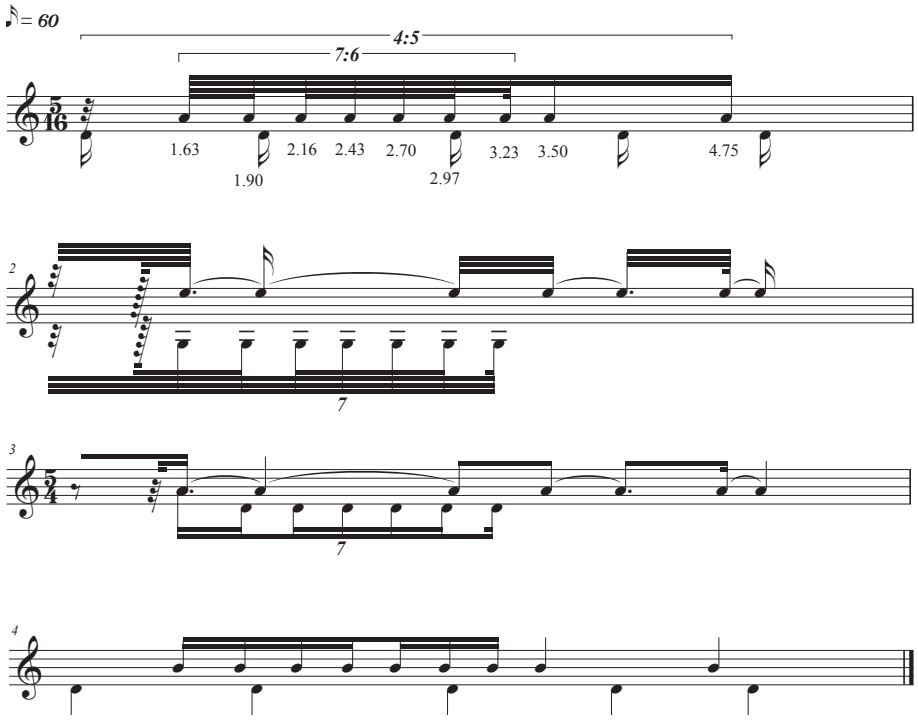
618.11. Levels



618.12. Ferney wo dec/rat #s & Propor



618e3. Too Fast w dec ea=near. 2143. (Fix ending)

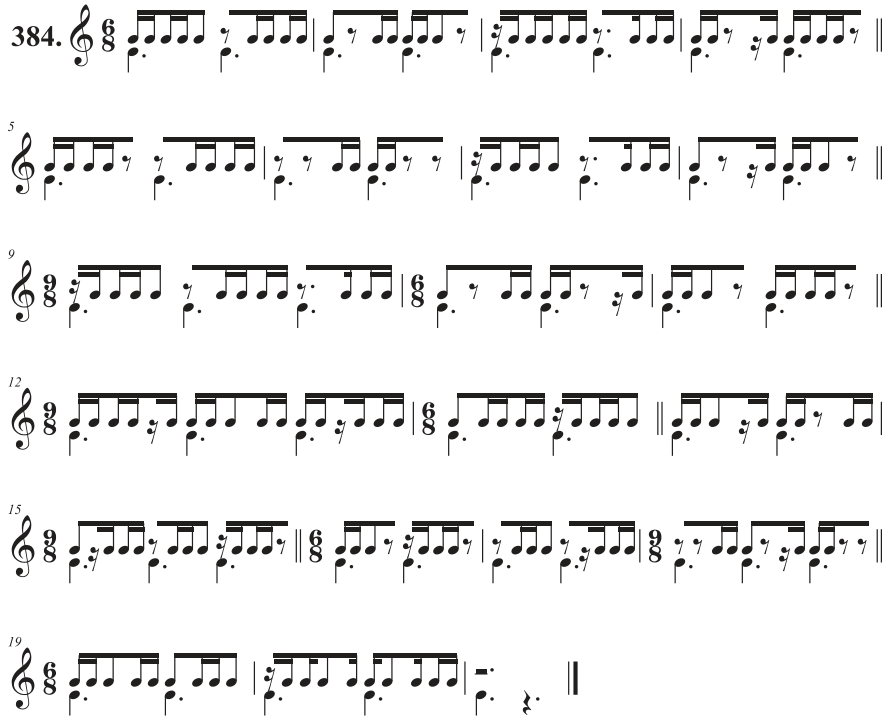


Audio example number 7012.

Chapter 7

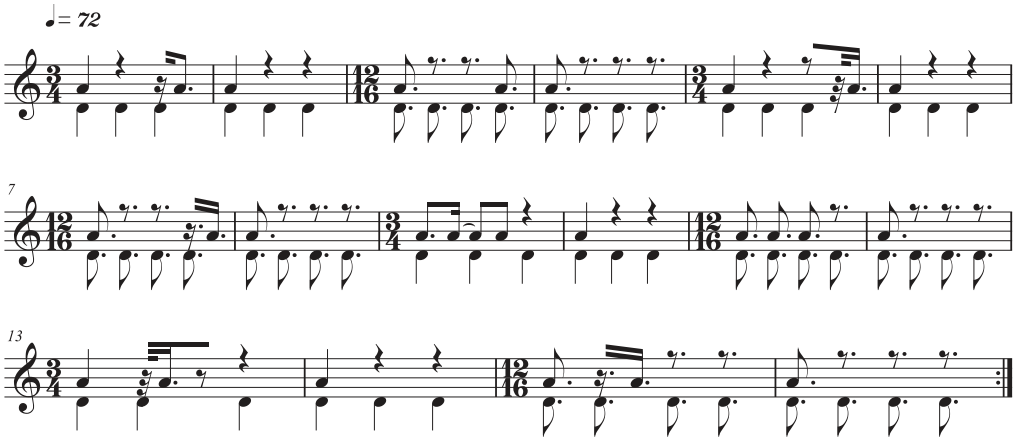
7.1

384a. rotate



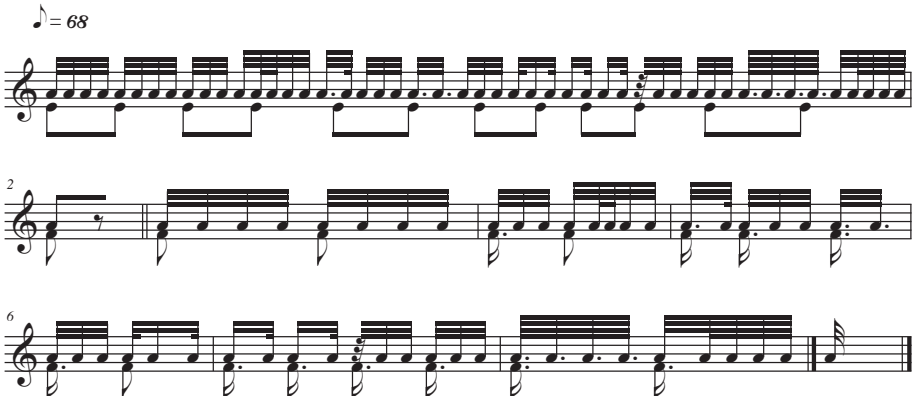
tag: ***Fun***. Audio example number 11012.

440k1. 6-3/4



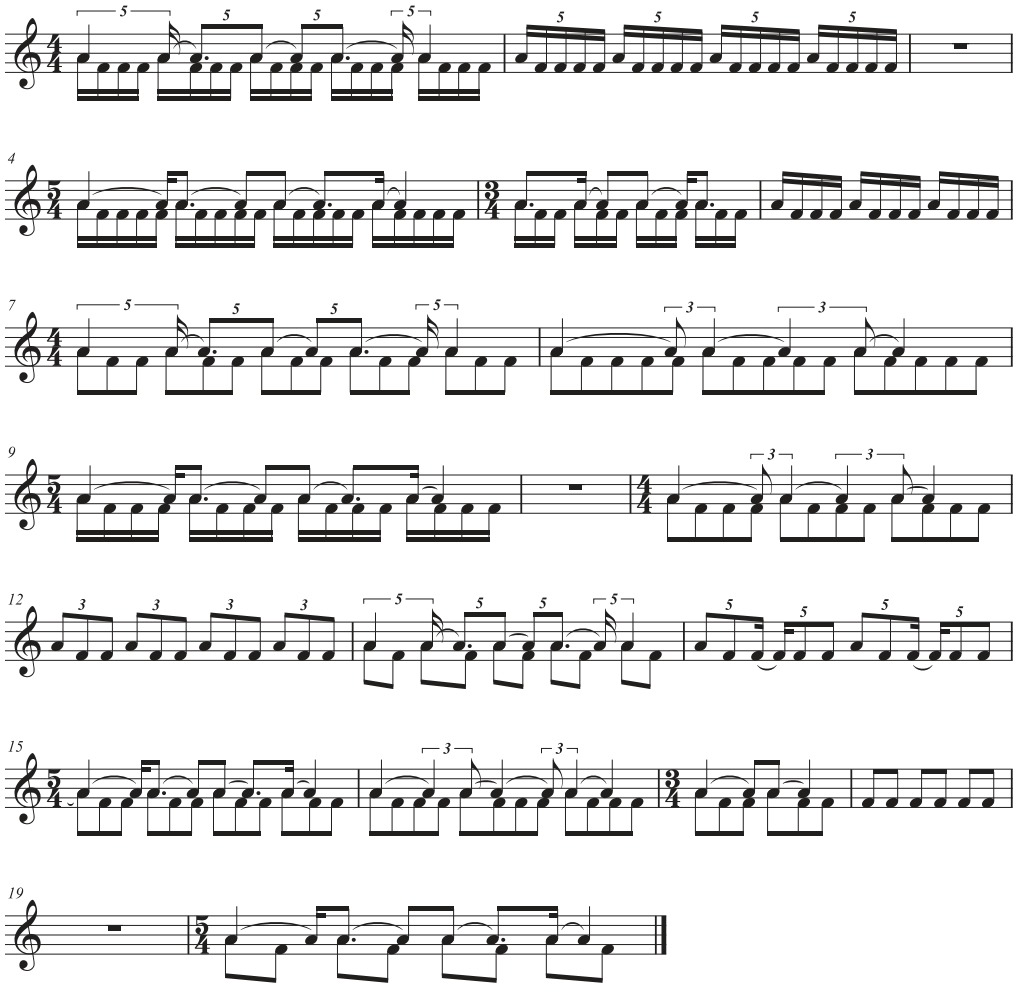
Audio example number 1004.

531b. Perc



Audio example number 15015.

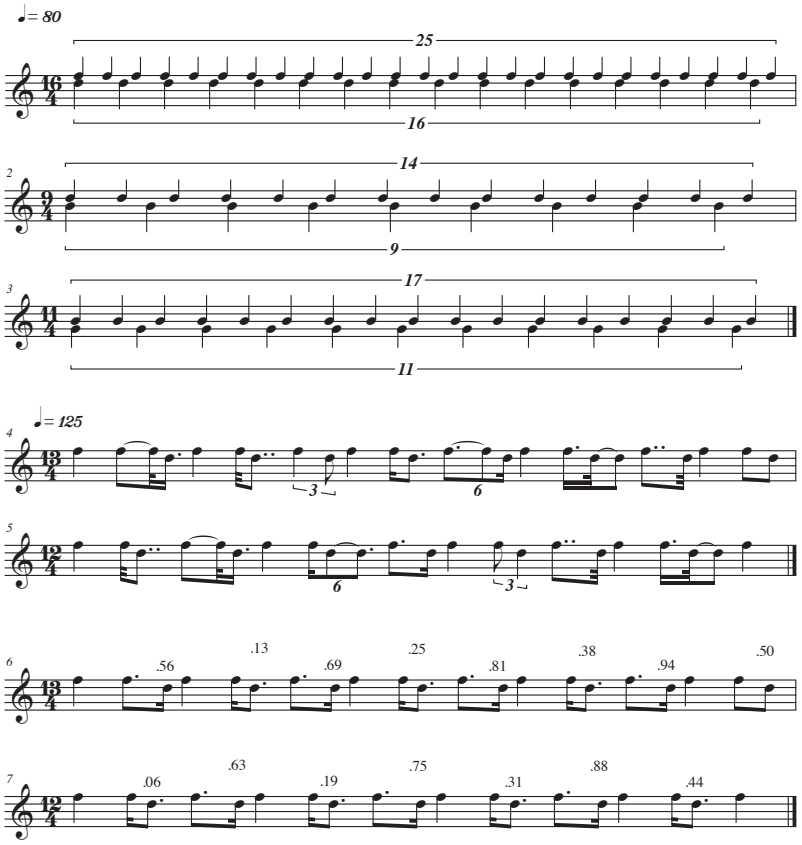
524. Natural ReGroup



tag: ***ReGroup***

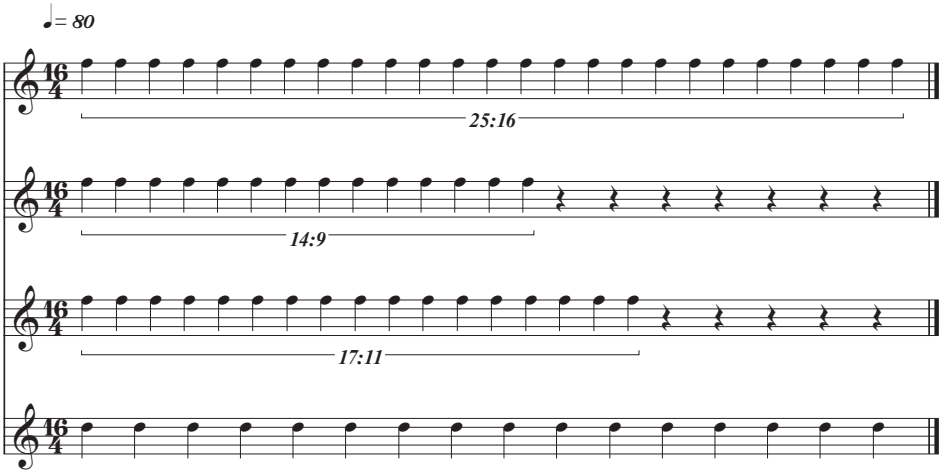
7.2

573b. 25:16,14:9,17:11-Patt,Similar-composit



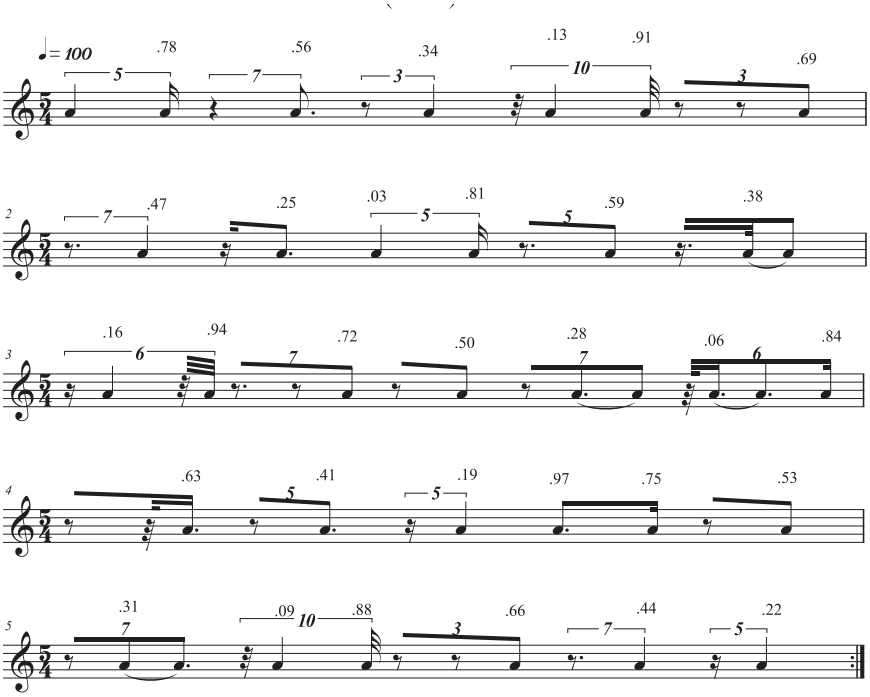
The top three staves show similarities in the three patterns. The first pattern, 25:16, is then approximated in two ways: first, as well as possible using up to 32nd-note divisions and triplets, and second, taking the nearest 16th note. The numbers above the Ds in the lower version show the number of beats after the most recent F each D should exactly appear. These are sucessive multiples of the fraction 25/16, with the integer parts dropped. Every alternate one (shown slightly raised: 0,13, etc.)) is a whole number of 32nd notes. Audio example number 21014.

573c. Above Simul - soft - How Close



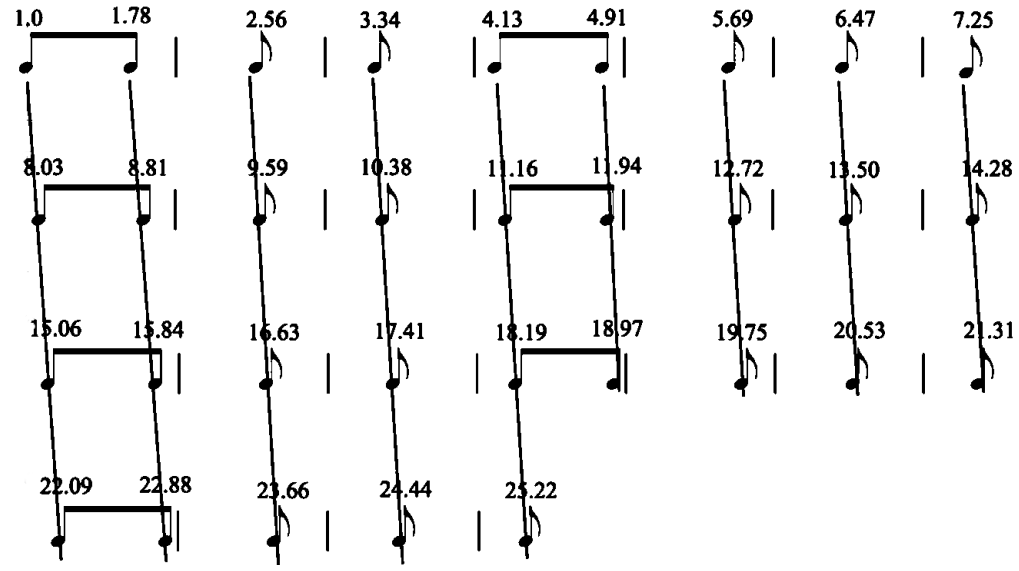
Audio example number 21016.

624. 32/25. Avg=01.40 off



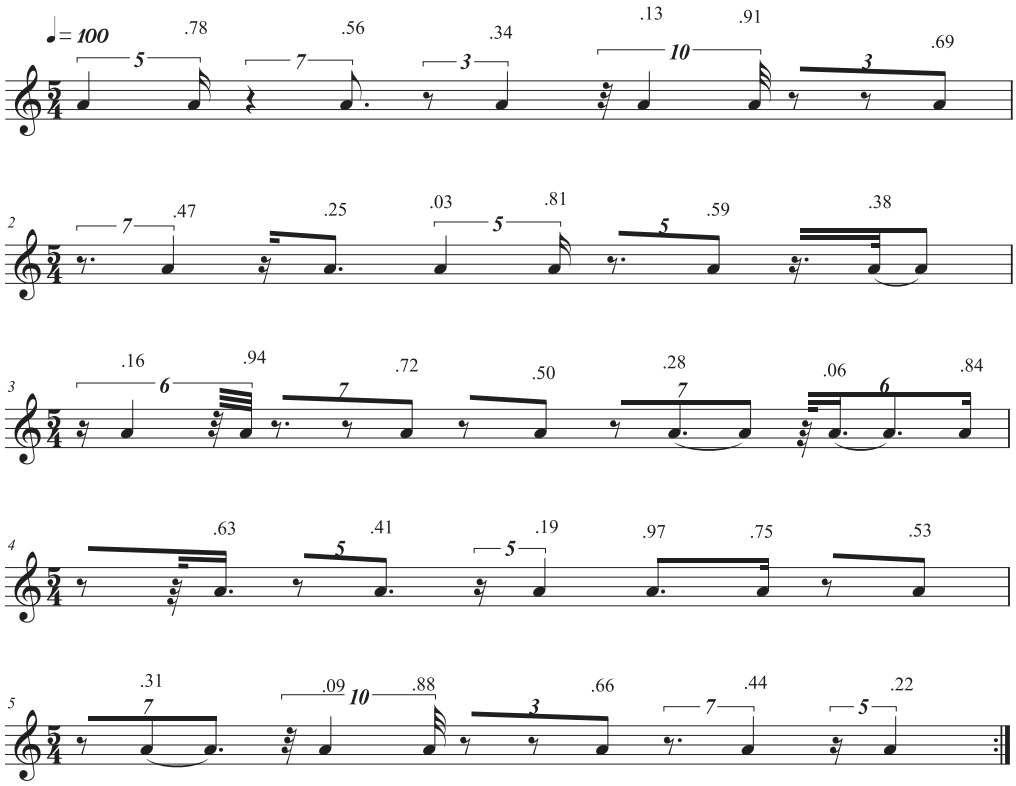
tags: ***Nudged Rats***; ***Yeasty***. Audio example number 6002.

624. w slanted lines



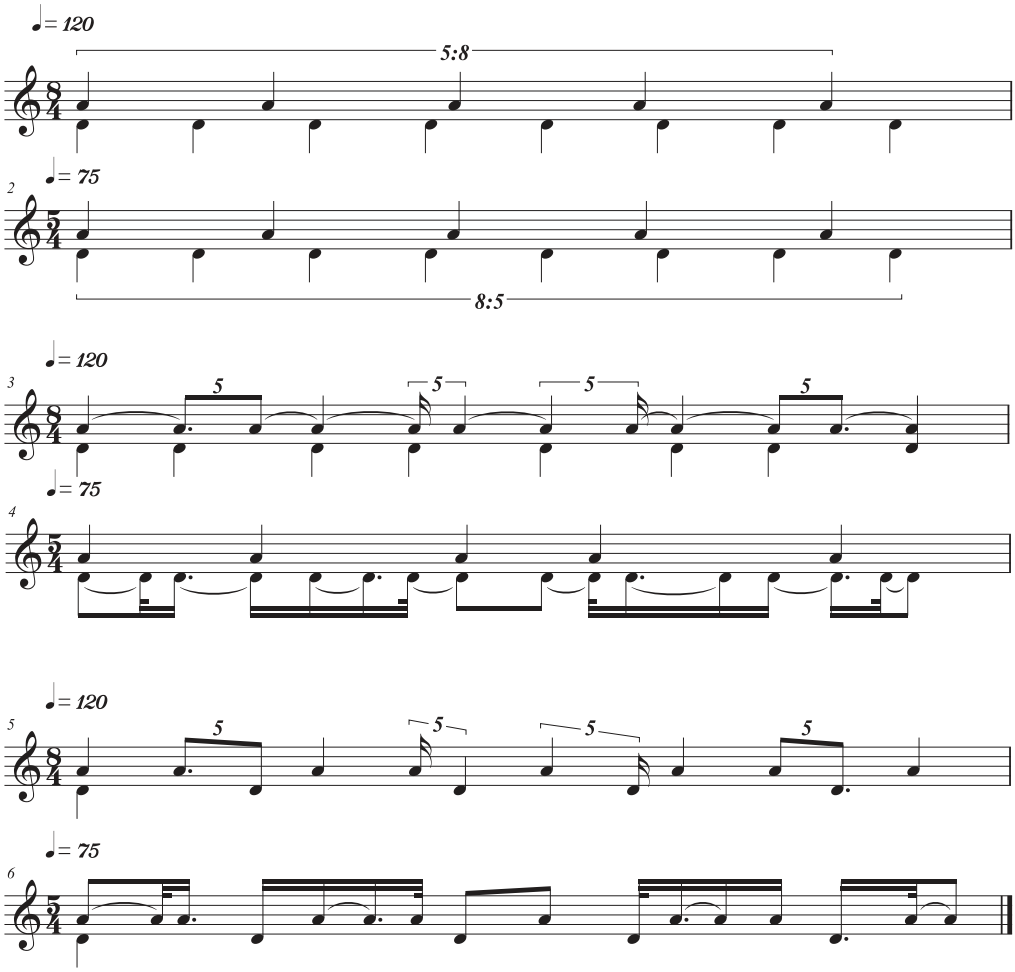
624. Nudged Rats

624. A's. (32:25)



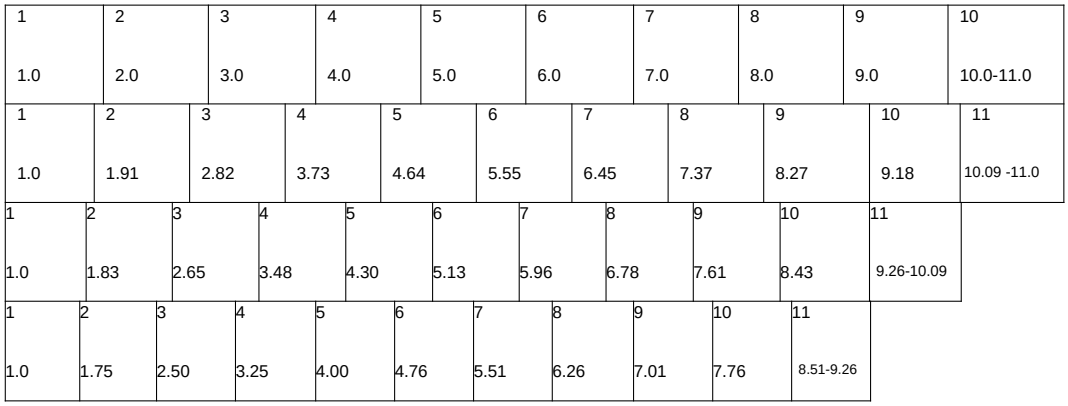
Avg=01.40 off

628. 8:5 & 5:8 Inverts-fast



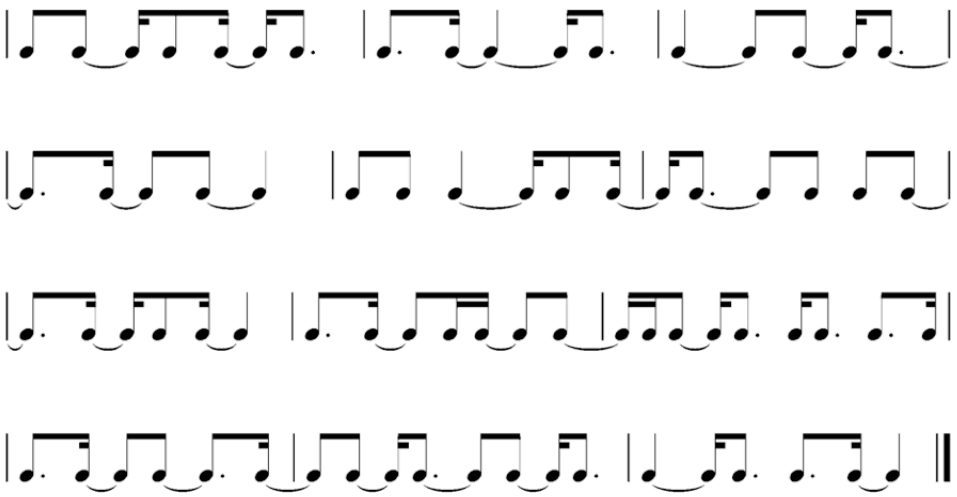
Audio example number 22007.

647. Triple Nest

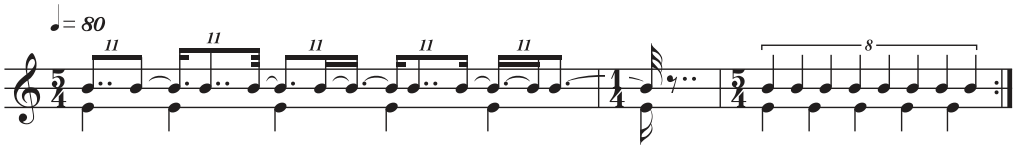


7.3

257. rotate - same NV-Ties



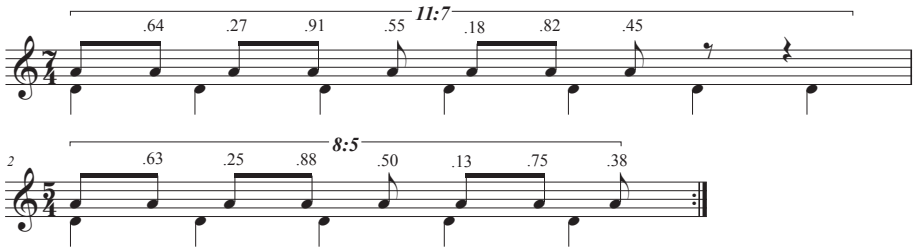
543. 8:5 - 11:7 AproPo



1st 8 of 11:7 = .0429 Avg. off

tag: ***Near Rats*** Audio example number 18009.

543e. 8:5 - 11:7 proportional

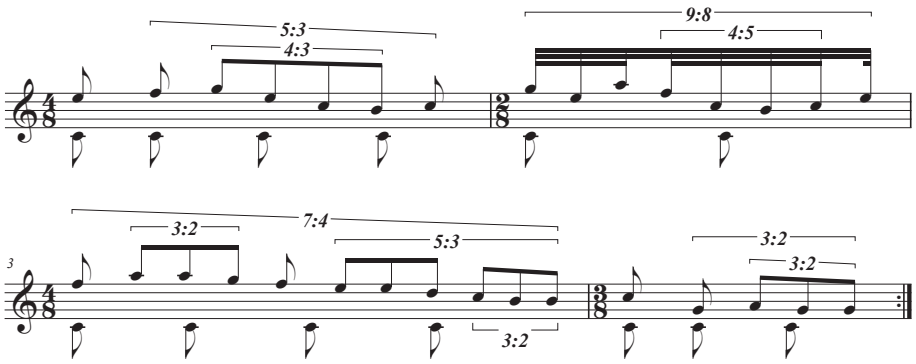


tag: ***Near Rats***. Audio example number 18009.

543d. figuring

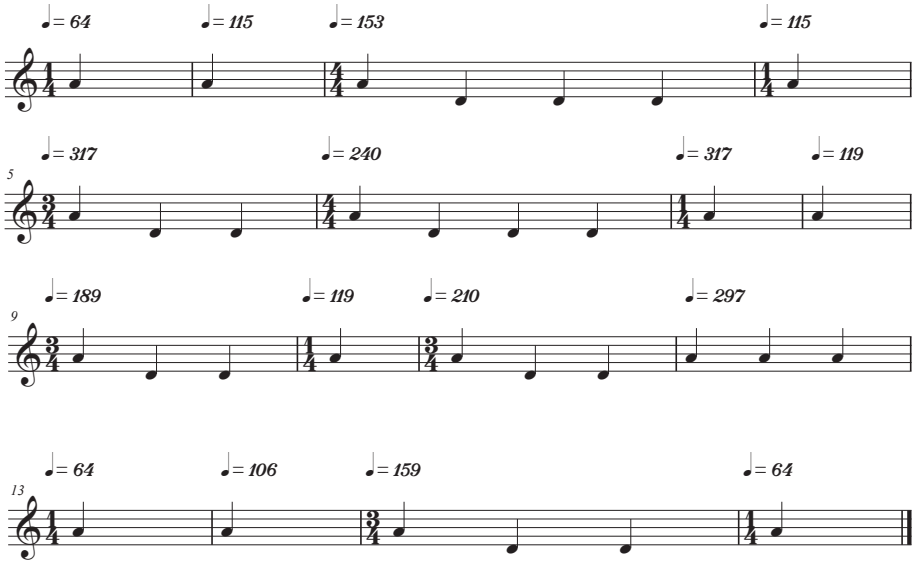
543.			
Note #	**11:7**	**8:5**	**Difference**
1	1.00	1.00	
2	1.64	1.63	1
3	2.27	2.25	2
4	2.91	2.88	3
5	3.55	3.50	5
6	4.18	4.13	5
7	4.82	4.75	7
8	5.45	5.38	7
9	6.09		total = 30
10	6.73		Avg. = 4.29
11	7.37		
	1.00		

583g3. fast-Haydn 260

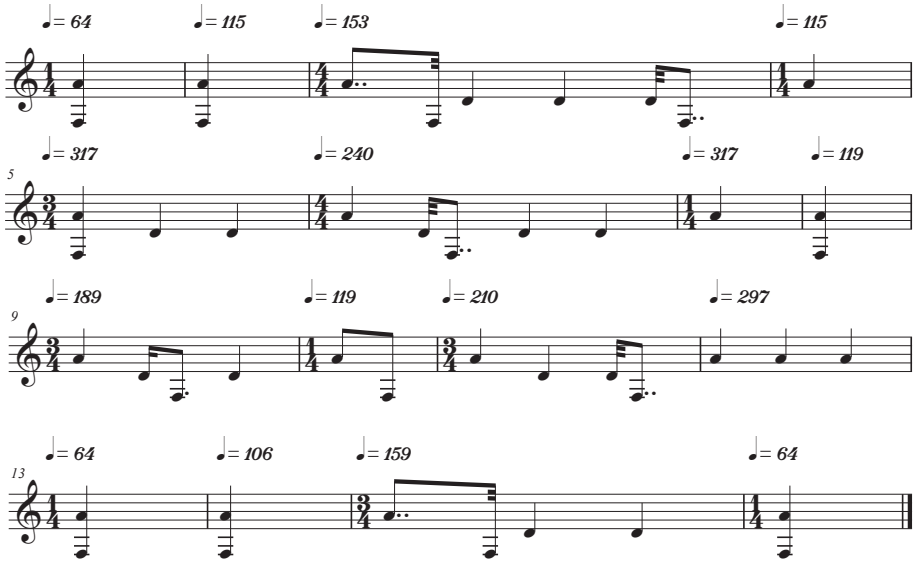


Audio example number 5010.

583e. Hear



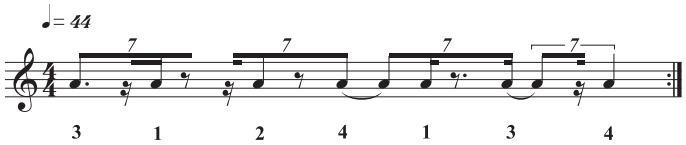
583e2. w Beat



583f. fig

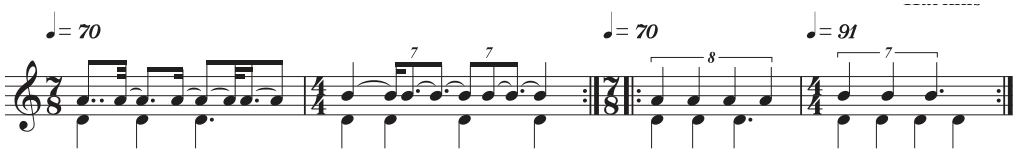
Drew				Dur	Tempo
# Notes	Dur			1.00	64
				0.50	128
1	1.00			0.25	256
1	0.60			0.125	512
4	0.45				
1	0.60				
3	0.22				
4	0.28				
1	0.22				
1	0.57				
3	0.38				
1	0.57				
3	0.34				
3	0.23				
1	1.00				
1	0.67				
3	0.44				
1	1.00				
# 583					
Tempi Sorted	Durs Sorted				
64	1.00				
106	0.67	1.0 - .67 = .33	.33/.50 = .67	1.67 x 64 = 106	
115	0.60				
119	0.57				
(128)	(0.50)				
153	0.45	.50 - .45 = .05	.05 / .25 = .20	1.20 x 128 = 153	
159	0.44				
189	0.38				
210	0.34				
240	0.28				
(256)	(0.25)				
297	0.23	.25 - .23 = .02	.02 / .125 = .16	1.16 x 256 = 297	
317	0.22				
(512)	(0.125)				

593. 7:4 w differ sound durs



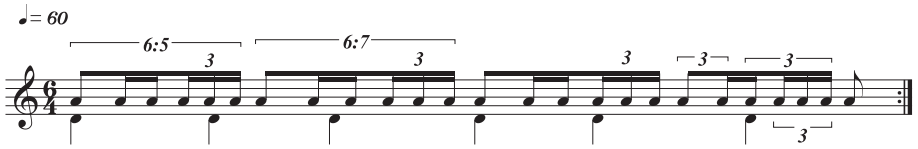
tag: ***Diff Dur Rat notes***. Audio example number 17006.

555. 7/8 & 8/7



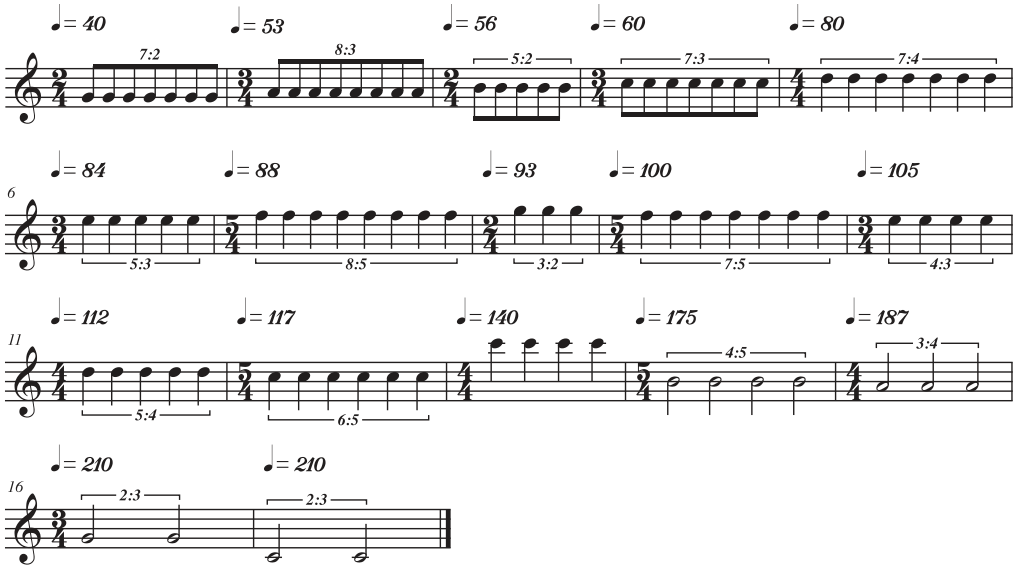
tags: ***Q Q.***; ***Show Beat***. Audio example number 20007.

565. Throw and Scale patt over Differ Durs, Rit



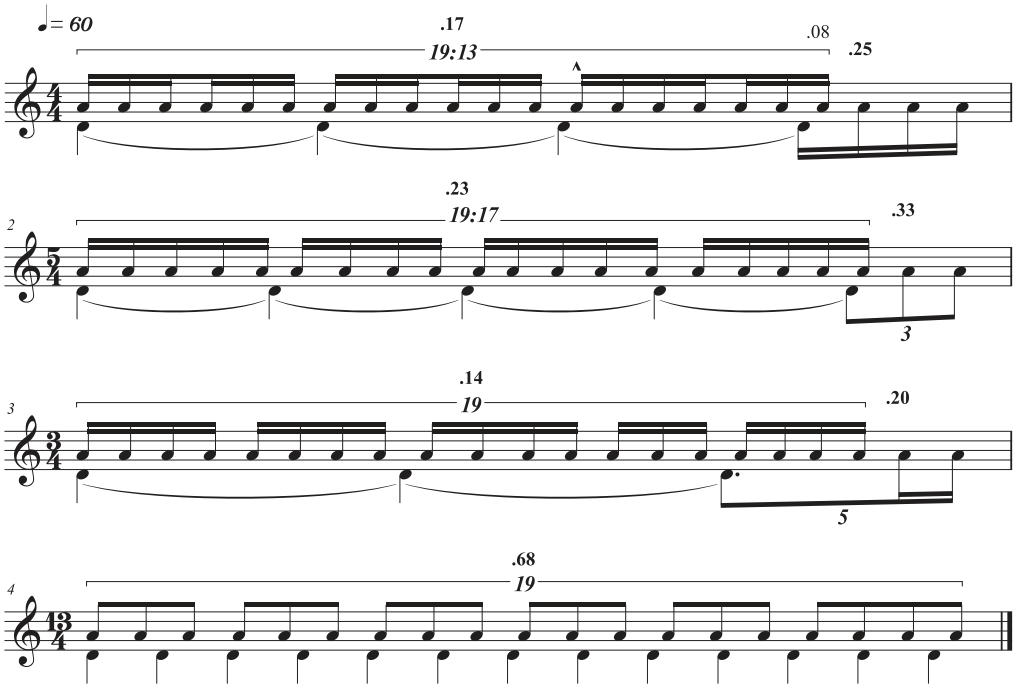
tags: ***Scale it to fit***; ***Short-Hand/Patt 1st***; ***Show Beat***. Audio example number 27006.

435. Beat Accel fixed



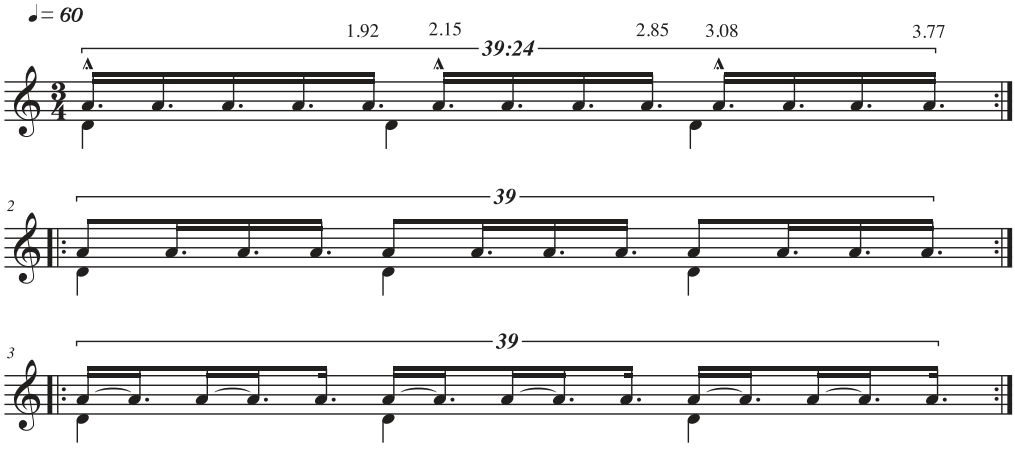
tag: ***HAMs***. Audio example number 7019.

592. Dec Rats. 19 against 3.25, 4.33, 2.6, and 13



Audio example number 12007.

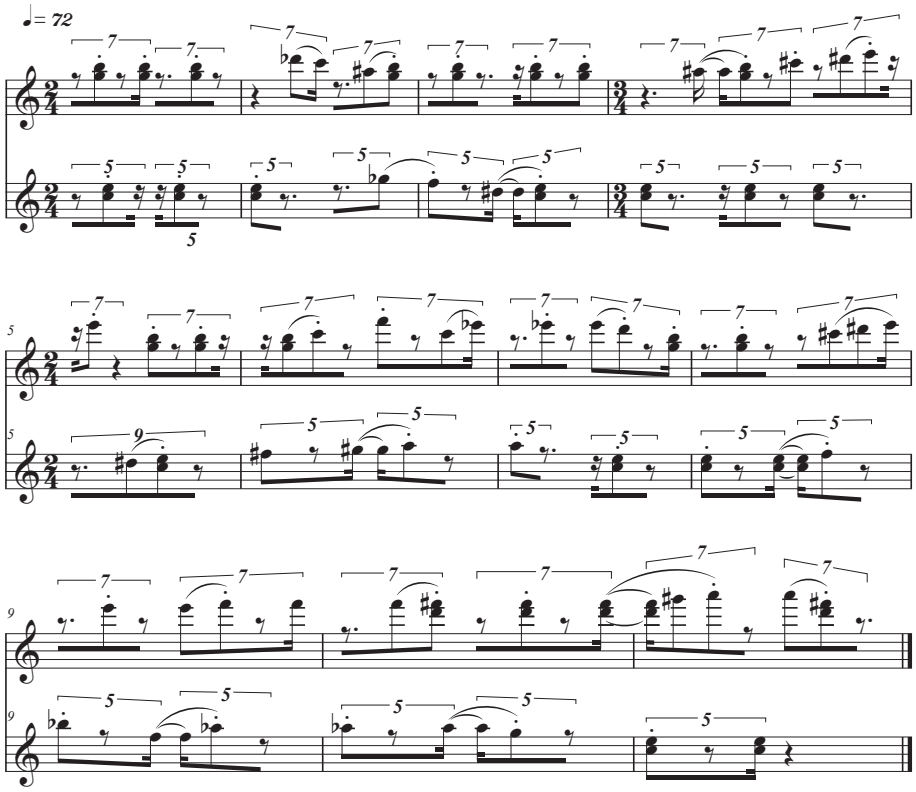
608. 39:24 = 3-13:8s



Audio example number 18013.

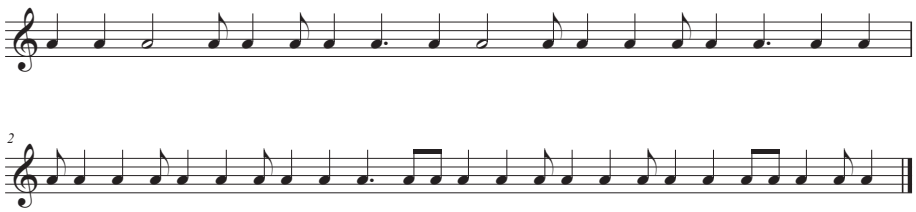
7.4

560. Original Usher - Notes+Rests 5&7



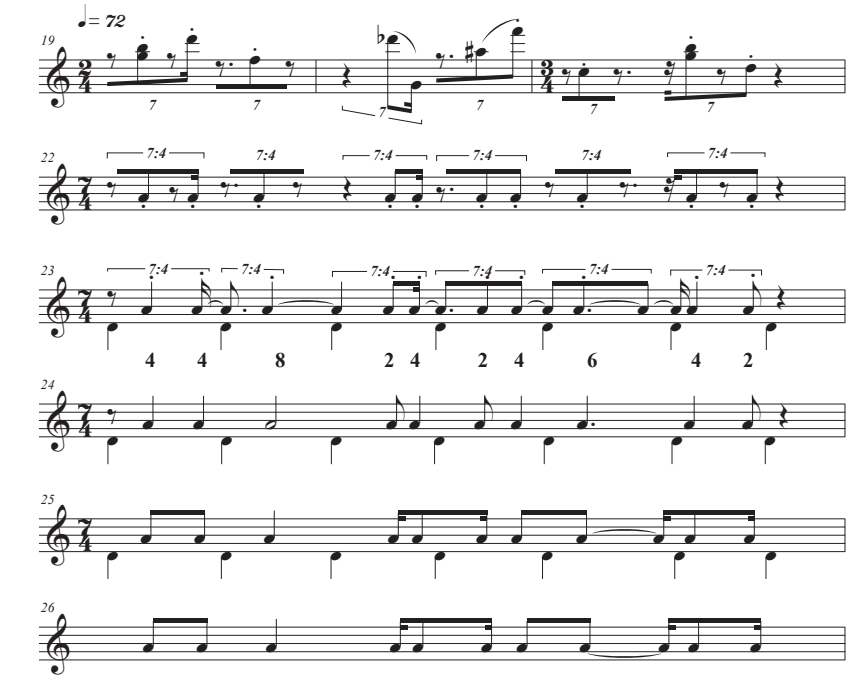
tags: ***Decimals***; ***Diff Dur Rat notes***; ***Full Value***; ***Long-Hand***; ***New Tempi / Rats***; ***ReTempo/ReRatio***; ***Same Patt/Differ Rat***; ***Show Beat***; ***Simul/Sequent***; ***Yeasty***. Audio example number 8004.

560b2. Full value Rhythm w Lines



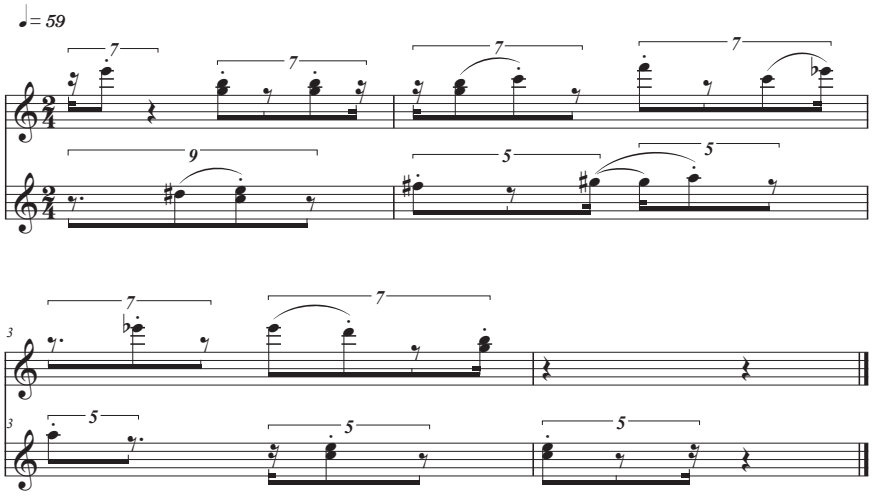
Audio example number 8008.

560. new 11-septuplets & quints



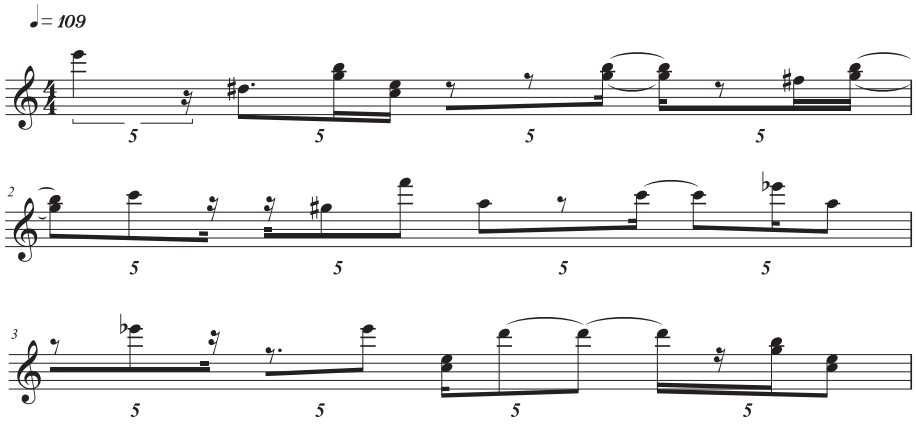
Audio example number 8008.

560e4. Bars 5-8 of orig 7 & 5:1



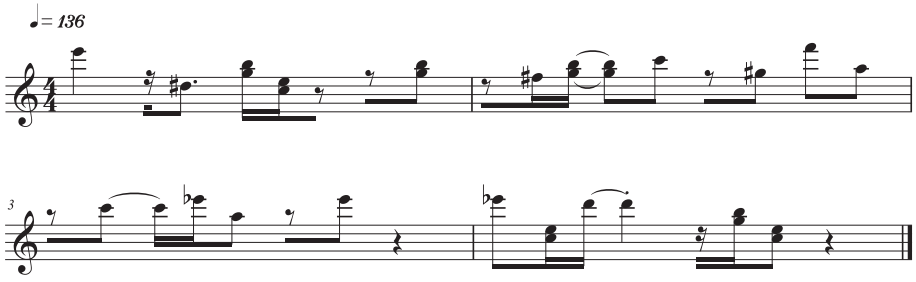
Audio example number 8011.

560M. Composite-done w 1 instru-5:1



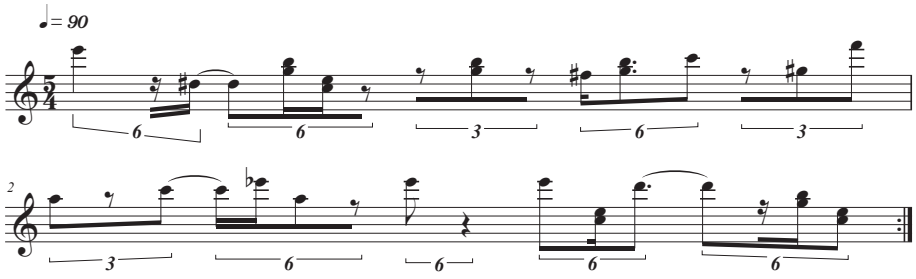
Audio example number 8010.

560e6. 4-1



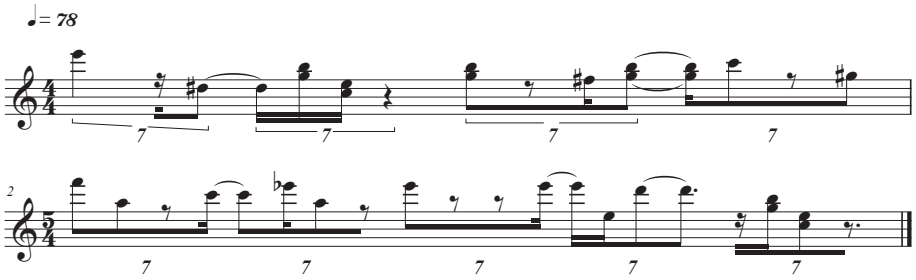
Audio example number 8014.

560k. 6:1



Audio example number 8015.

560L. 7:1



Audio example number 8016.

560. Propor Tempi

Proportionality

Ratio x Tempo = same sound

5:1		♩ = 109
4:1	5/4x109=	♩ = 136
6:1	5/6x109=	♩ = 91
7:1	5/7x109=	♩ = 78

560. durations

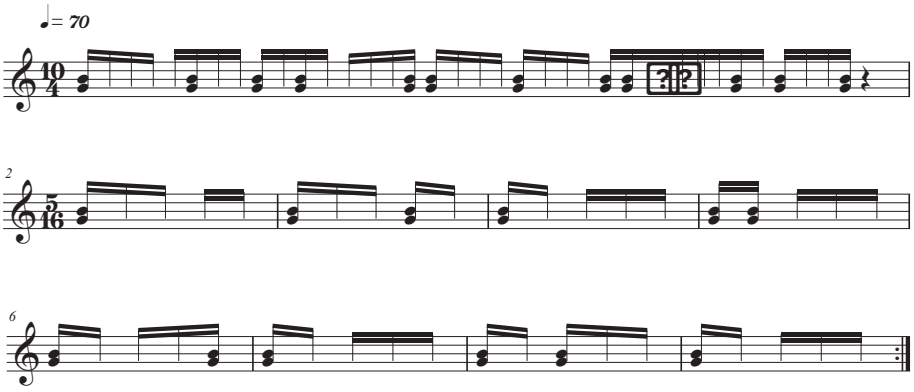
#'s = duration in 16th note sextuplets (n = note, r = rest)
Read Left to Right

4n	1r	3n	1n	1n	4r	2n
2r	1n	3n	2n	2r	2n	2n
2n	2r	3n	1n	2n	2r	2n
4r	2n	1n	5n	1r	1n	2n

Chapter 8

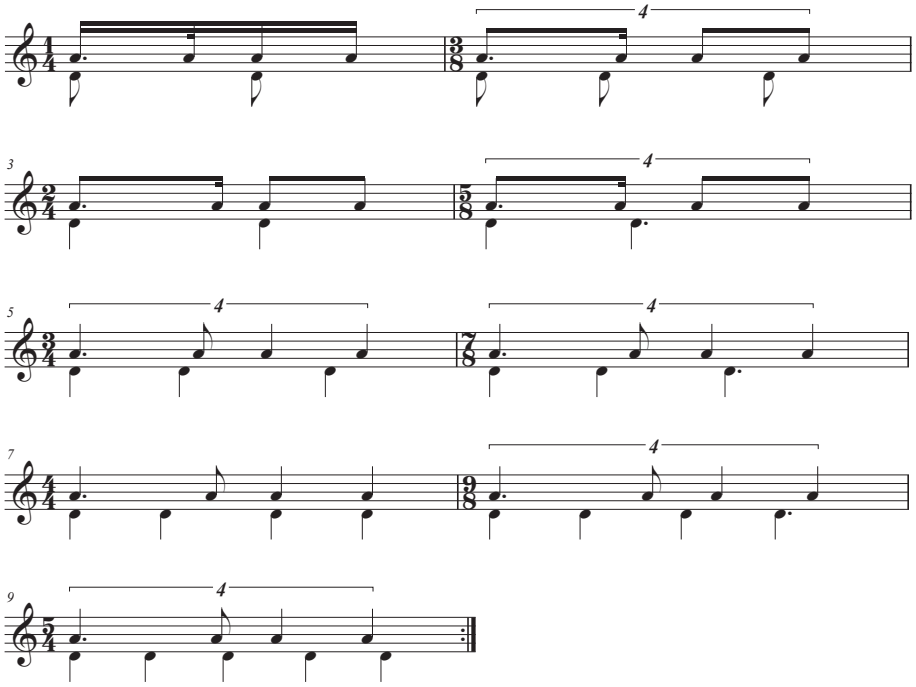
8.1

587.8. 4, 3+2s



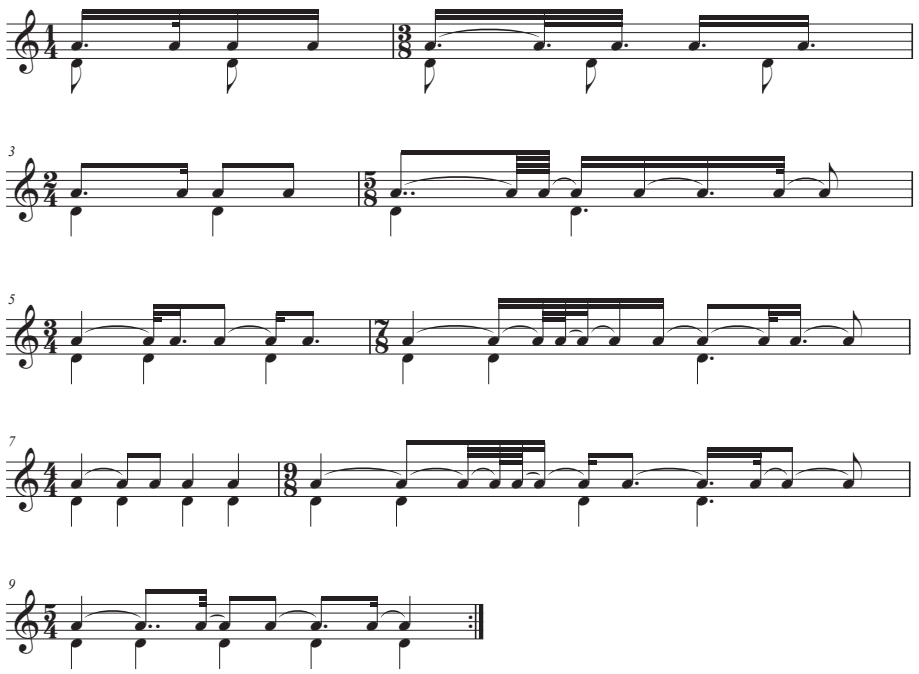
Audio example number 19010.

626.1. Short Hand-Jersild

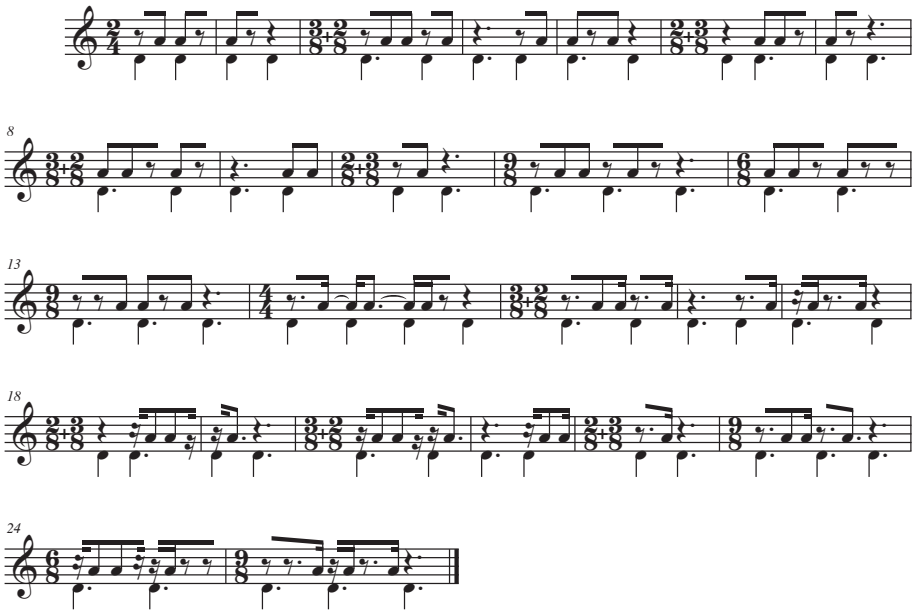


Audio example number 23004.

626. Same-Pat/Dif-Rat Long Hand



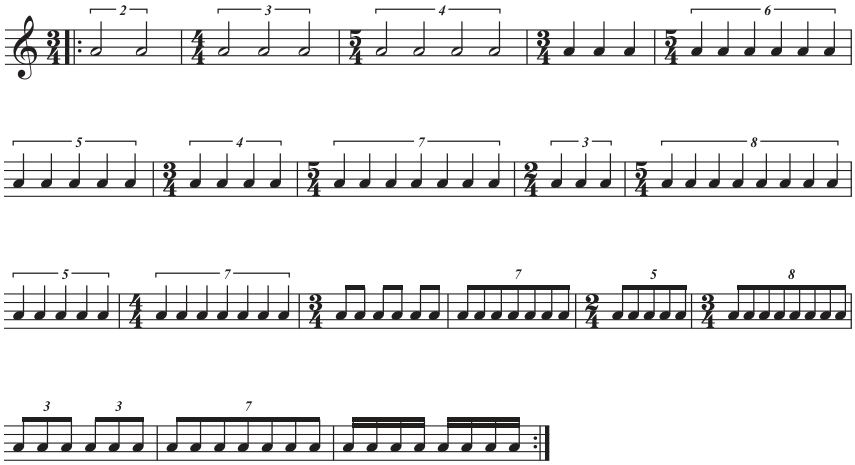
405. simple patt in all contexts



tags: ***Fun***; ***Short-Hand/Patt 1st***. Audio example number 5006.

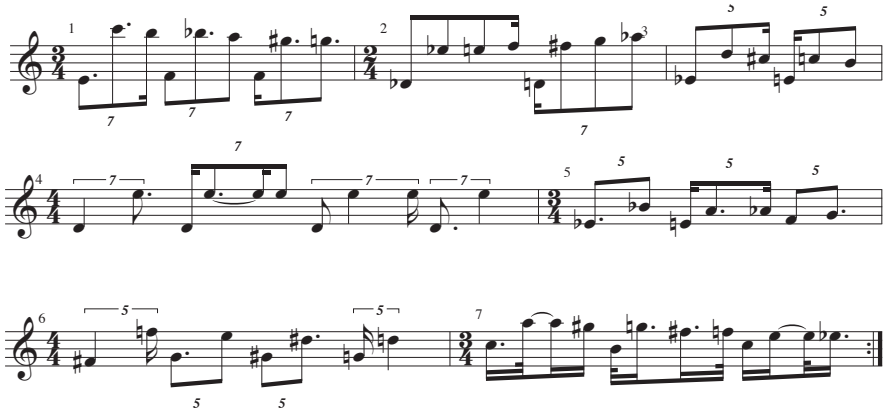
8.2

391. Rats accel w Beat



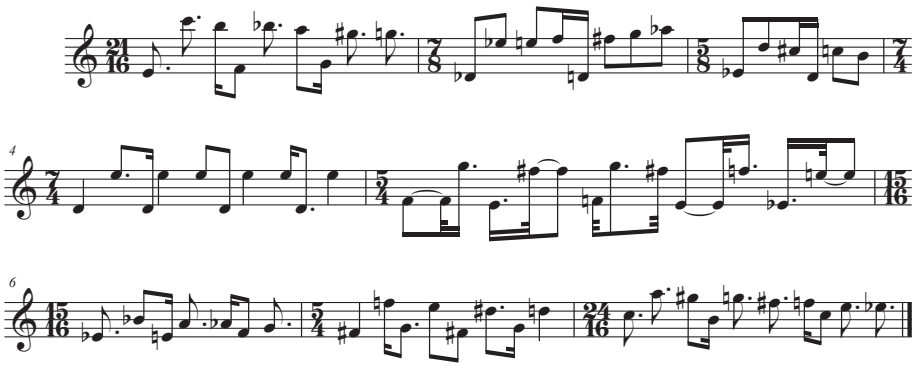
Audio example number 5003.

347d1. Orig Ratios - 7. Fast



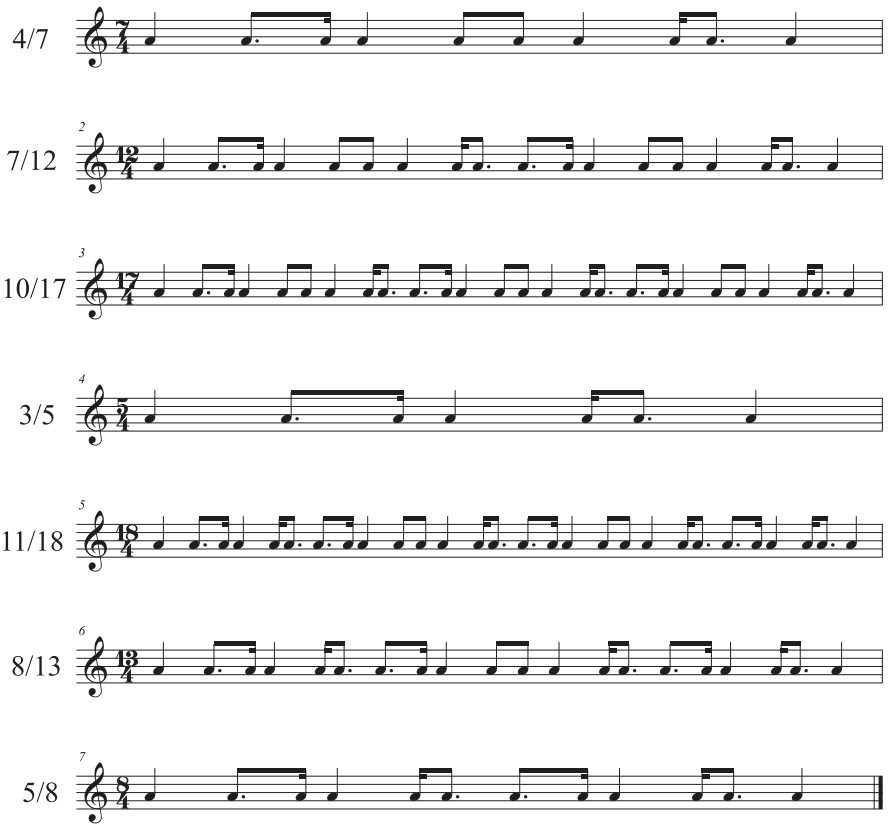
tags: ***Invert***; ***Show Beat***.

347b. Invert Rats-Fix Beat Instruction - 8.



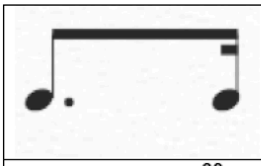
The high notes are to be vocalized and the low notes, regardless of the notation, are to be equally spaced beats and not vocalized.

646. 7 Composite Rat Patts

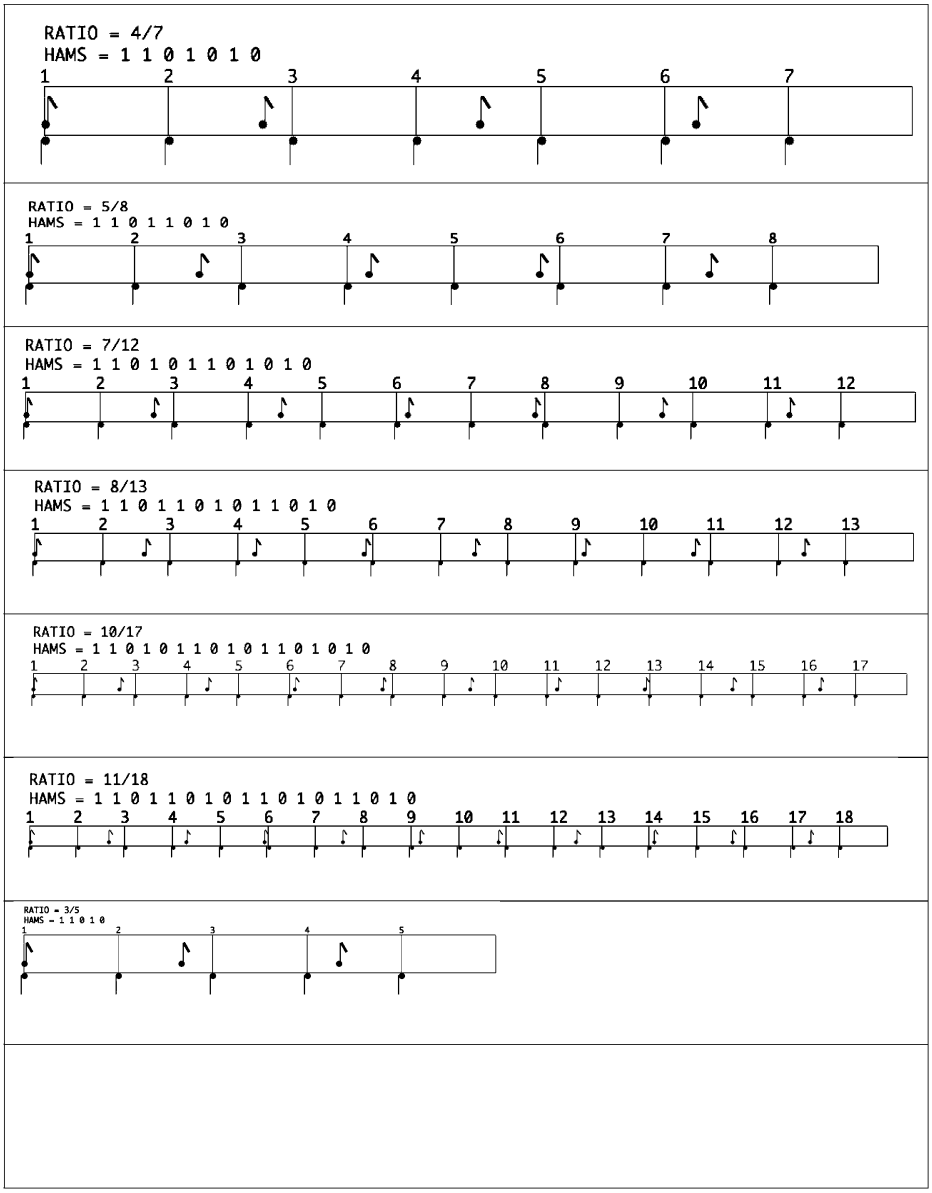


tag: ***Composite Ratios***. Audio example number 31004.

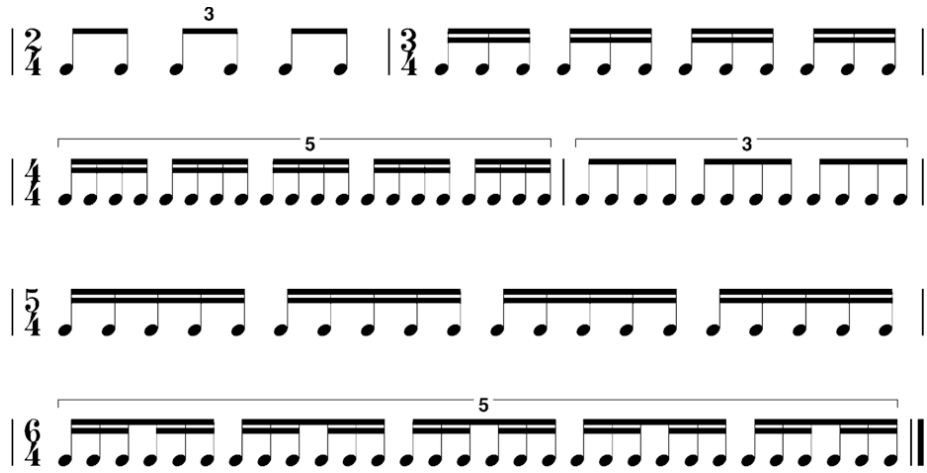
646. 7 Rats, components w dec

					
.60		.40		.09	
.63		.43		.10	
.64		.45		.13	
.67		.50 - 3		.14	
.70		.55		.18	
.71		.57		.20 - 2	
.73		.60		.25 - 2	
.75 - 2				.27	
.80 - 2				.29	
.82				.30	
.86				.33	
.88				.36	
.90				.38	
.91				.40	
		For Ratios -			
		4/7			
		7/12			
		10/17			
		3/5			
		11/18			
		8/13			
		5/8			

646. 7 Word/pdf

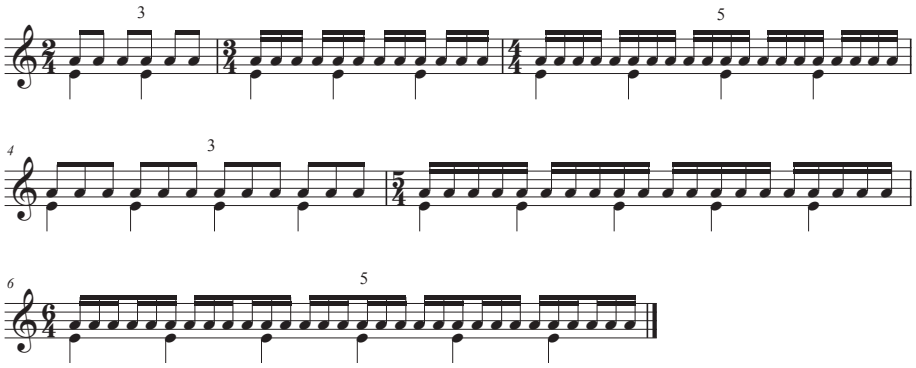


104. ReGroup



tag: ***ReGroup***.

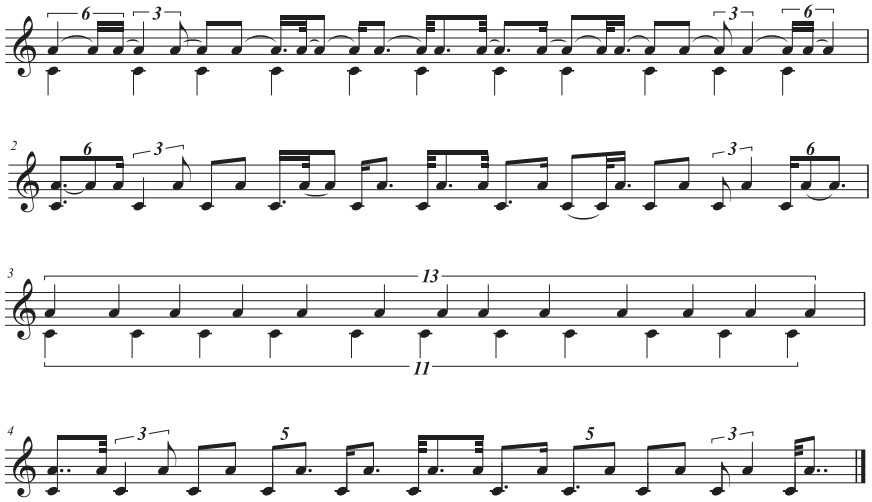
104d. With Beat



Audio example number 14014.

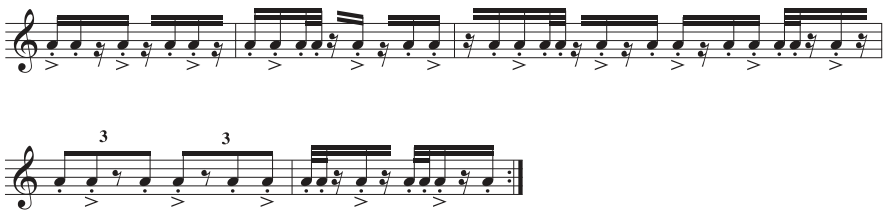
8.3

632. 13:11 + apro and 2-hands



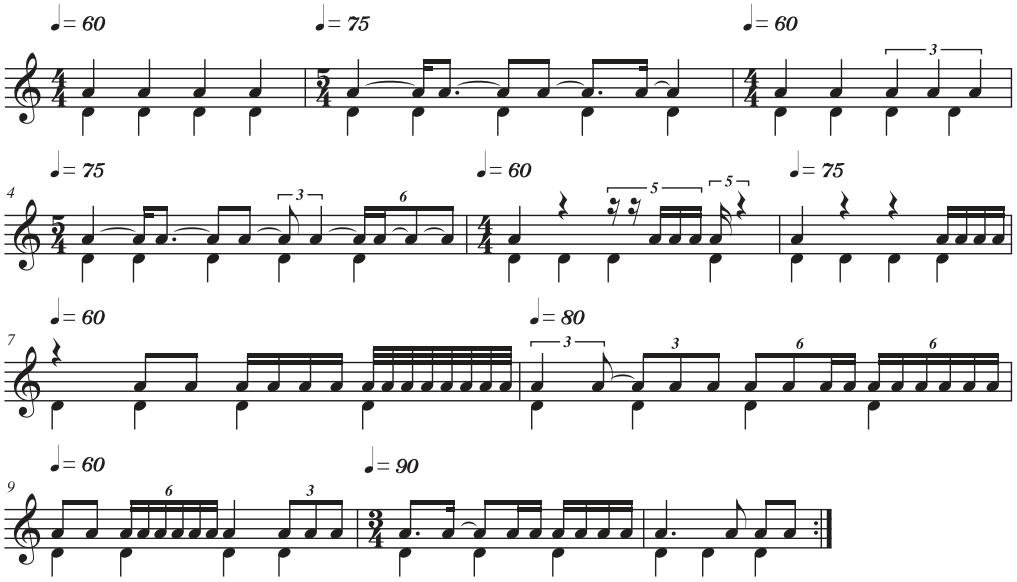
Audio example number 20008.

179. tempo warp



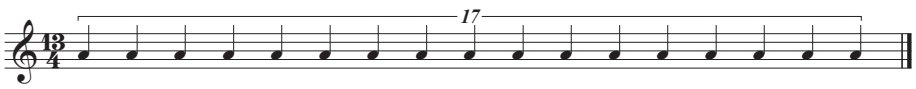
Audio example number 22009.

273. MetMod retempi



Audio example number 6011.

610f. 17:13 show no beats

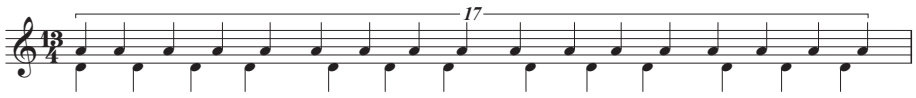


Tag: ***Yeasty***.
The term “Yeasty” was used by the composer John Silber to describe ideas or artifacts that grow over time. Revisit these and you may see more than was there before. See also: 133; 133b; 62; 362; 355a; 374; 374b; 355a; 395; 422; 440; 603f; 542; 618.10; 542b; 542c; 624; 583; 62.

610a. 17:13 fig

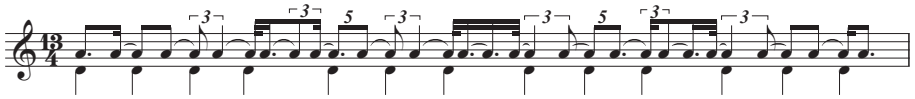
17:13	Conv	off
1.00	1.00	.00
1.76	1.75	.01
2.53	2.50	.03
3.29	3.33	.04
4.06	4.13	.07
4.82	4.83	.01
5.59	5.60	.01
6.35	6.33	.02
7.12	7.13	.01
7.88	7.88	.00
8.65	8.67	.02
9.41	9.40	.01
10.18	10.17	.01
10.94	10.88	.06
11.71	11.67	.04
12.47	12.50	.03
13.24	13.25	.01
		avg .024

610e2. 17:13 w beat & simul

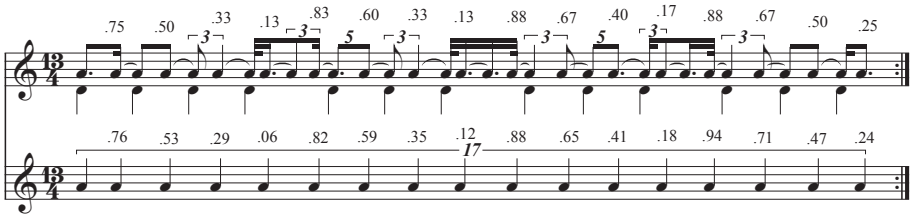


Audio example number 22012.

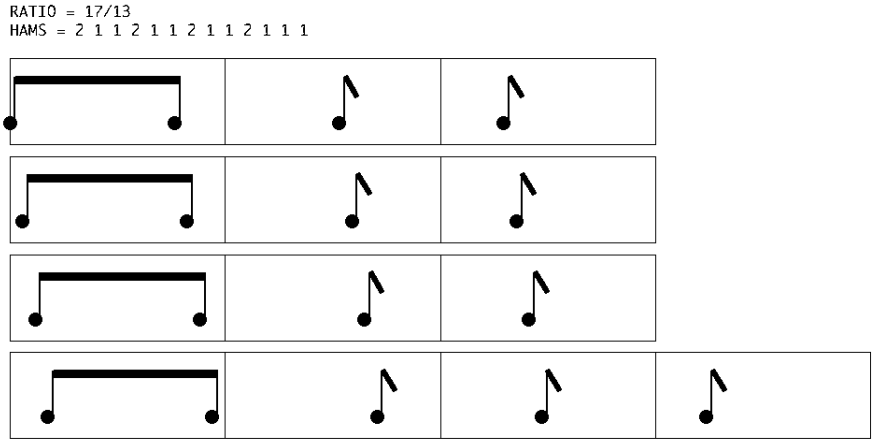
610g1. 17:13 Apro



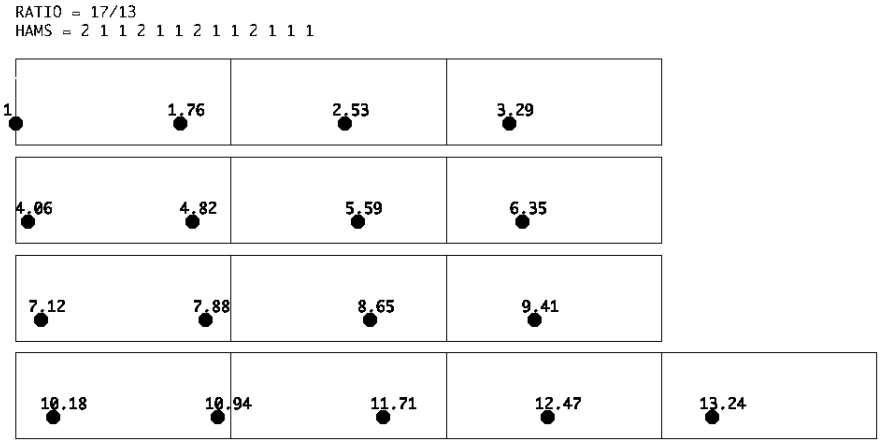
610. same w dec



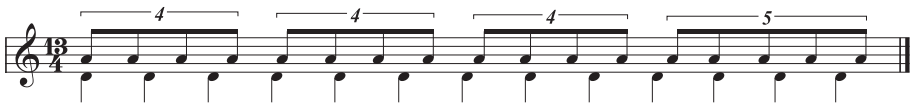
610b. 17:13 Hark vert & HAM



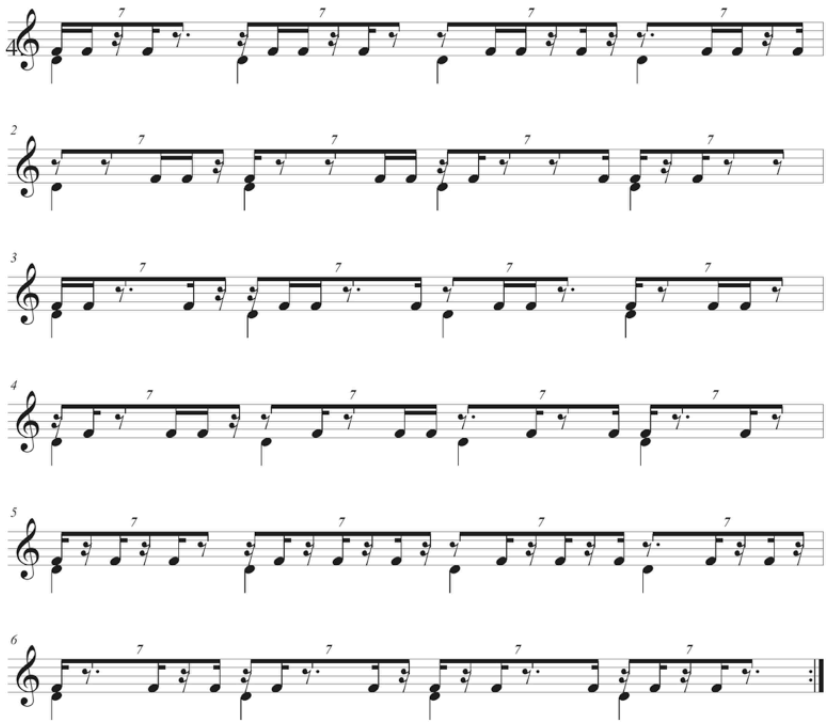
610c. 17:13 Hark dec vert



610j. same w 8th notes & simul

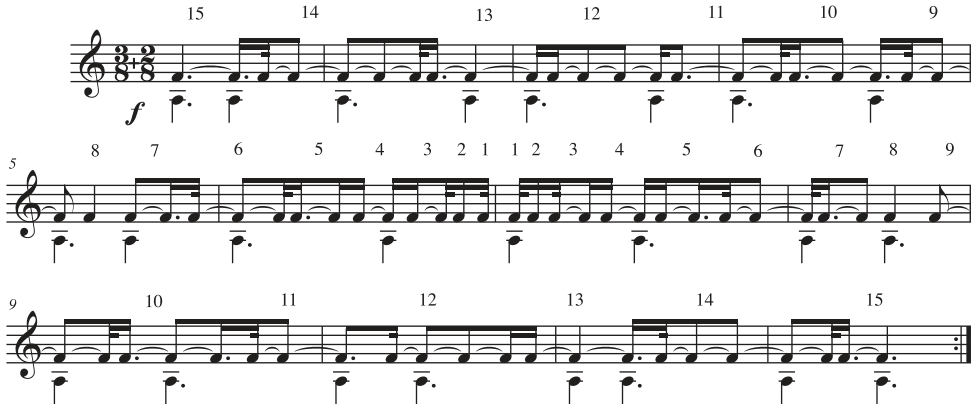


4. rotate



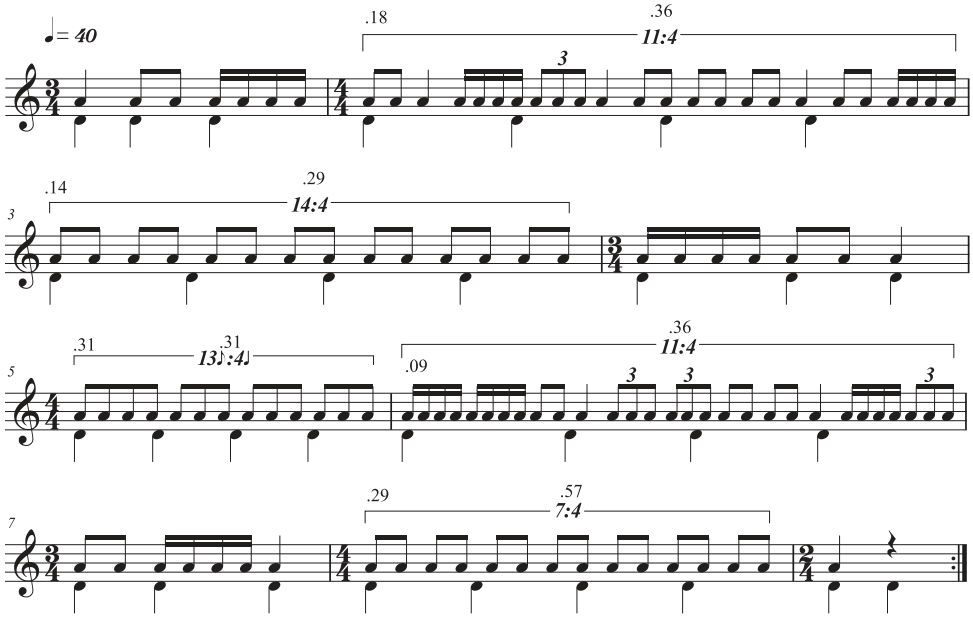
Audio example number 6017.

172b1. 15,14,13

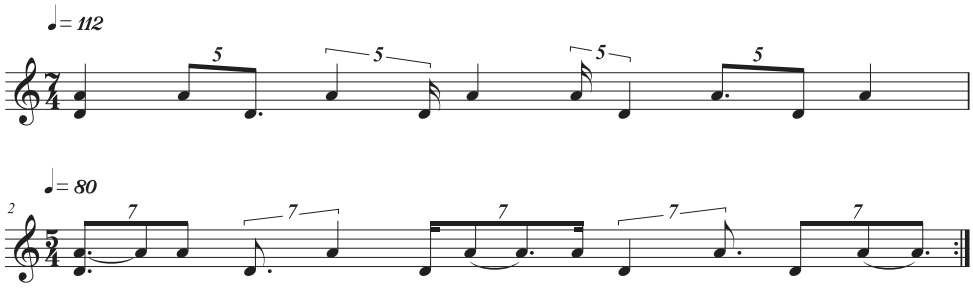


Audio example number 18012.

617. Magadini

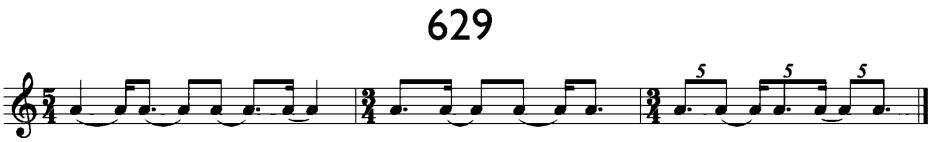


627. 7:5 & 5:7 Inverts



tag: ***Invert***. Audio example number 24011.

629. Ratio subd as Basis for apro Div



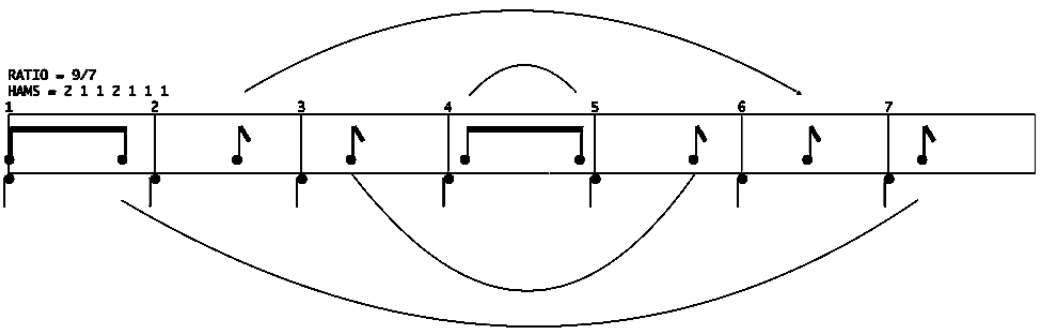
4:5		4:3		5:3	
11:5	3323	10:3	3223	15:3	33333
12:5	3333	11:3	3323	16:3	43333
13:5	4333	12:3	3333	17:3	44333
14:5	4433	13:3	4333	18:3	44433
15:5	4443	14:3	4433	19:3	44443
16:5	4444	15:3	4443	20:3	44444
17:5	5444	16:3	4444	21:3	54444
18:5	5544	17:3	5444	22:3	55444
19:5	5554	18:3	5445	23:3	55544
20:5	5555	19:3	5455	24:3	55554
21:5	6555	20:3	5555	25:3	55555
22:5	6655	21:3	6555	26:3	65555
23:5	6665	22:3	6655	27:3	66555
24:5	6666	23:3	6665	28:3	66655
		24:3	6666	29:3	66665
				30:3	66666

+ other orderings,eg –4333, 3433,3343,3334

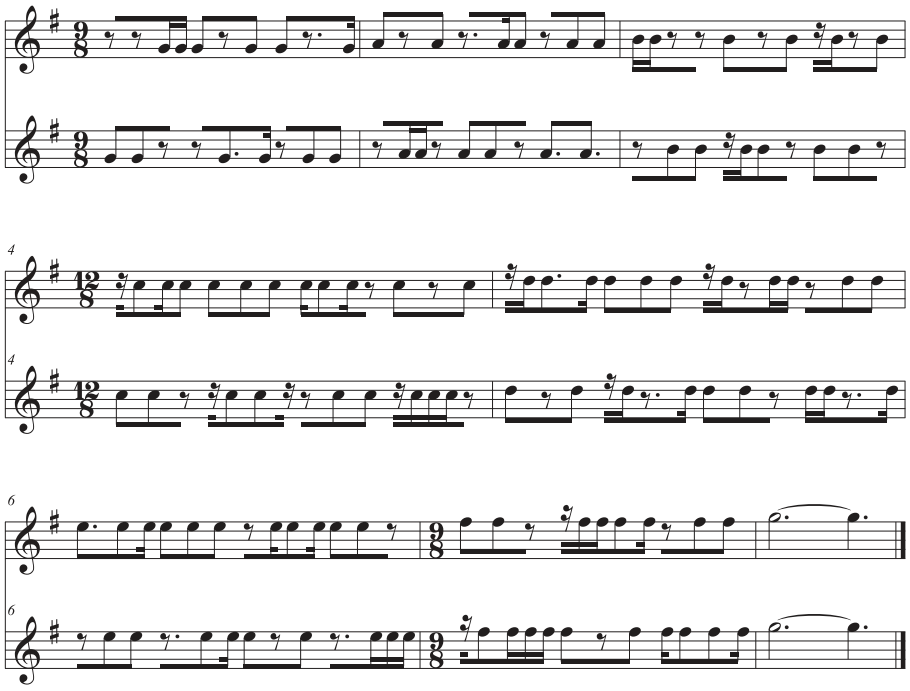
3 simple ratios as basis for aprox division

tags: ***Nudged Rats***; ***Subdiv Rats***.

639. Rat symmetry



534cc. hocket



Audio example number 16018.

8.4

535a. HAMs by rat

1:1	1.000	1		13:5	.385	332 32
2:1	.500	2		13:6	.462	322222
3:1	.333	3		13:7	.538	2222221
3:2	.667	21		13:8	.615	221 221 21
4:1	.250	4		13:9	.692	21 21 21 211
4:3	.750	211		13:10	.769	211 211 2111
5:1	.200	5		13:11	.846	211111 2111111
5:2	.400	32		13:12	.923	2+1x11
5:3	.600	221		14:1	.071	14,
5:4	.800	2111		14:3	.214	554
6:1	.167	6		14:5	.357	333 32
6:5	.833	21111		14:9	.643	221 21 21 21
7:1	.143	7		14:11	.786	211 2111 2111
7:2	.286	43		14:13	.929	2+1x12
7:3	.429	322		15:1	.067	15,
7:4	.571	2221		15:2	.133	87
7:5	.714	21 211		15:4	.267	4443
7:6	.857	211 111		15:7	.467	3222222
8:1	.125	8		15:8	.533	22222221
8:3	.375	332		15:11	.733	21 211 211 211
8:5	.625	221 21		15:13	.867	211111211111
8:7	.875	2111 111		15:14	.933	2+1x13
9:1	.111	9		16:1	.063	16,
9:2	.222	54		16:3	.188	655
9:4	.444	3222		16:5	.313	43333
9:5	.556	22221		16:7	.438	322 3222
9:7	.778	211 2111		16:9	.563	22221 2221
9:8	.889	21111 111		16:11	.688	21 21 21 21 211
10:1	.100	10,		16:13	.813	2111x2+21111
10:3	.300	433		16:15	.938	2+1x14
10:7	.700	21 21 211		17:1	.059	17,
10:9	.900	211111111		17:2	.118	98
11:1	.091	11,		17:3	.176	665
11:2	.182	65		17:4	.235	5444
11:3	.273	443		17:5	.294	43 433
11:4	.364	3332		17:6	.353	333 332
11:5	.455	32222		17:7	.412	32 32 322
11:6	.545	222221		17:8	.471	32222222
11:7	.636	221 21 21		17:9	.529	222222221
11:8	.727	21 211 211		17:10	.588	2221+221x2
11:9	.818	2111 21111		17:11	.647	221+21 x4
11:10	.909	2111111111		17:12	.706	2121211 21211
12:1	.083	12,		17:13	.765	211x3+2111
12:5	.417	32 322		17:14	.824	2111+21111x2
12:7	.583	2221 221		17:15	.882	2,+1x6+2,+1x
12:11	.917	21111111111		17:16	.941	2+1x15
13:1	.077	13,		18:1	.056	18,
13:2	.154	76		18:5	.278	443 43
13:3	.231	544		18:7	.389	332 32 32
13:4	.308	4333		18:11	.611	221x3+ 21

535b. HAMs by dec

25:1	.040	25,		25:6	.240	544444
24:1	.042	24,		4:1	.250	4
23:1	.043	23,		23:6	.261	444443
22:1	.045	22,		19:5	.263	44443
21:1	.046	21,		15:4	.267	4443
20:1	.050	20,		11:3	.273	443
19:1	.053	19,		18:5	.278	443 43
18:1	.056	18,		25:7	.280	443 43 43
17:1	.059	17,		7:2	.286	43
16:1	.063	16,		24:7	.292	43 43 433
15:1	.067	15,		17:5	.294	43 433
14:1	.071	14,		10:3	.300	433
13:1	.077	13,		23:7	.304	433 4333
25:2	.080	13,12		13:4	.308	4333
12:1	.083	12,		16:5	.313	43333
23:2	.087	12,11		19:6	.316	433333
11:1	.091	11,		22:7	.318	4333333
21:2	.095	11,10		25:8	.320	43333333
10:1	.100	10,		3:1	.333	3
19:2	.105	10,9		23:8	.348	33333332
9:1	.111	9		20:7	.350	3333332
17:2	.118	98		17:6	.353	333332
25:3	.120	988		14:5	.357	33332
8:1	.125	8		25:9	.360	33332 3332
23:3	.130	887		11:4	.364	3332
15:2	.133	87		19:7	.368	3332 332
22:3	.136	877		8:3	.375	332
7:1	.143	7		21:8	.381	332 332 32
20:3	.150	776		13:5	.385	332 32
13:2	.154	76		18:7	.389	332 32 32
19:3	.158	766		23:9	.391	332 32 32 32
25:4	.160	7666		5:2	.400	32
6:1	.167	6		22:9	.409	32 32 32 322
23:4	.174	6665		17:7	.412	32 32 322
17:3	.176	665		12:5	.417	32 322
11:2	.182	65		19:8	.421	32 322 322
16:3	.188	655		7:3	.429	322
21:4	.190	6555		23:10	.435	322x2+3222
5:1	.200	5		16:7	.438	322 3222
24:5	.208	55554		25:11	.440	322+3222x2
19:4	.211	5554		9:4	.444	3+ 2x3
14:3	.214	554		20:9	.450	3222 32222
23:5	.217	554 54		11:5	.455	3+ 2x4
9:2	.222	54		24:11	.458	3+2x4,3+2x5

535c. HAMs by Family

5's & 4's	4's & 3's	3's & 2's	2's & 1's	2's & 1's
9:2 54	7:2 43	5:2 32	3:2 21	8:5 221 21
14:3 554	10:3 433	7:3 322	4:3 211	12:7 2221 221
19:4 5554	13:4 4333	9:4 3222	5:4 2111	16:9 22221 2221
24:5 55554	16:5 43333	11:5 32222	6:5 21111	20:11 222221 22221
	19:6 433333	13:6 322222	7:6 211111	24:13 2222221 222221
9:2 54	22:7 4333333	15:7 3222222	8:7 2111111	
13:3 544	25:8 43333333	17:8 32222222	9:8 21111111	8:5 221 21
17:4 5444		19:9 322222222		13:8 221 221 21
21:5 54444	7:2 43	21:10 3222222222	5:3 221	18:11 221 221 221 21
25:6 544444	11:3 443	23:11 32222222222	7:4 2221	23:14 221 221 221 221 21
	15:4 4443	25:12 322222222222	9:5 22221	
	19:5 44443		11:6 222221	10:7 2121 211
22:5 54 544	23:6 444443	5:2 32	13:7 2222221	17:12 2121 211 21 211
		8:3 332	15:8 22222221	24:17 2121 211 21 211 21 211
23:5 554 54	11:3 443	11:4 3332	17:9 222222221	
	18:5 443 43	14:5 33332	19:10 2222222221	11:8 21 211 211
	25:7 443 43 43	17:6 333332	21:11 22222222221	18:13 21 211 21 211 211
11:2 65		20:7 3333332	23:12 222222222221	25:18 21 211 21 211 21 211 211
16:3 655		23:8 33333332	25:13 2222222222221	
21:4 6555				
	17:5 43 433		7:5 21 211	12:7 2221 221
17:3 665	24:7 43 43 433	12:5 32 322	9:7 211 2111	17:10 2221 221 221
23:4 6665		16:7 322 3222	11:9 2111 21111	22:13 2221 221 221 221
	23:7 433 4333	20:9 3222 32222	13:11 21111 211111	
13:2 76		24:11 32222 322222	15:13 211111 2111111	16:9 22221 2221
19:3 766			17:15 2111111 21111111	23:13 22221 2221 2221
25:4 7666		12:5 32 322	19:17 21111111 211111111	
		17:7 32 32 322	21:19 211111111 2111111111	16:13 2111 2111 21111
20:3 776		22:9 32 32 32 322	23:21 2111111111 21111111111	21:17 2111 2111 2111 21111
			25:23 21111111111 211111111111	
15:2 87		13:5 332 32		19:16 21111 21111 211111
22:3 877		18:7 332 32 32	7:5 21 211	25:21 21111 21111 21111 211111
		23:9 332 32 32 32	10:7 21 21 211	
23:3 887			13:9 21 21 21 211	17:14 2111 21111 21111
		13:5 332 32	16:11 21 21 21 21 211	23:19 2111 21111 21111 21111
17:2 98		19:7 3332 332	19:13 21 21 21 21 21 211	
25:3 988		25:9 33332 3332	22:15 21 21 21 21 21 21 211	
			25:17 21 21 21 21 21 21 21 211	

535d. HAMs by Family 2

X	: 2		X	: 6		X	: 8
21	3:2		111110	5:6		21111111	9:8
32	5:2		222221	11:6		32222222	17:8
43	7:2		333332	17:6		43333333	25:8
54	9:2		444443	23:6		54444444	33:8
			555554	29:6			
X	: 3					21,211,211	11:8
110	2:3		211111	7:6		32,322,322	19:8
221	5:3		322222	13:6		43,433,433	27:8
332	8:3		433333	19:6		54,544,544	35:8
443	11:3		544444	25:6			
554	14:3					221,221,21	13:8
665	17:3		X	: 7		332,332,32	21:8
			100,1000	2:7		443,443,43	29:8
211	4:3		211,2111	9:7		554,554,54	37:8
322	7:3		322,3222	16:7			
433	10:3		433,4333	23:7		22222221	15:8
544	13:3					33333332	23:8
655	16:3		10,10,100	3:7		44444443	31:8
			21,21,211	10:7		55555554	39:8
X	: 4		32,32,322	17:7			
1110	3:4		43,43,433	24:7		X	: 9
2221	7:4					1000,10000	2:9
3332	11:4		110,10,10	4:7		2111,21111	11:9
4443	15:4		211,21,21	11:7		3222,32222	20:9
5554	19:4		322,32,32	18:7		4333,43333	29:9
6665	23:4		433,43,43	25:7			
						10,10,10,100	4:9
2111	5:4		1110,110	5:7		21,21,21,211	13:9
3222	9:4		2221,221	12:7		32,32,32,322	22:9
4333	13:4		3332,332	19:7		43,43,43,433	31:9
5444	17:4		4443,443	26:7			
6555	21:4					110,10,10,10	5:9
			1111110	6:7		221,21,21,21	14:9
X	: 5		2222221	13:7		332,32,32,32	23:9
11110	4:5		3333332	20:7		443,43,43,43	32:9
22221	9:5		4444443	27:7			
33332	14:5					11110,1110	7:9
44443	19:5		2111111	8:7		22221,2221	16:9
55554	24:5		3222222	15:7		33332,3332	25:9
			4333333	22:7		44443,4443	34:9
10000	1:5		5444444	29:7			
21111	6:5					111111110	8:9

536a. Various Ratio Reckon-by rat

Ratio	HAM	Ratios Sequence	Parents (& Crams)	Equiv Ratio	Subdl Uneq	Pat 1st	Speed up	X+ Y:Z	Dec
3:2	21					•		•	.6666
3:4	1110					•			1.333
4:3	211					•		•	.7500
4:5	11110								1.250
5:2	32					•	•		.4000
5:3	221					•	•	•	.6000
5:4	2111					•		•	.8000
5:5	21111		2:5 (33) 3:5 (222)	3:2 1/2 2:1 2/3					.6333
7:2	43						•		.2857
7:3	322					•	•	•	.4286
7:4	2221					•	•	•	.5714
7:5	21,211	3:2 + 4:3							.7143
8:3	332		4:3 (2222) 2:3 (44)	2: 3/4 4:1 1/2		•	•	•	.3750
8:5	221,21	5:3 + 3:2	4:5 (22) 2:5 (44)	2:1 1/4 4:2 1/2			•		.6250
8:7	2111,111		4:7 (2222)						.8750
9:2	54		3:2 (333)			•			.2222
9:4	3222		3:4 (333)			•	•		.4444
9:5	22221		3:5 (333)						.5555
9:7	211,2111	4:3 + 5:4							.7777
10:3	433		2:3 (55)	5:1 1/2		•			.3000
10:7	21,21,211	3:2 + 3:2 + 4:3							.7000
11:2	65				323 434				.1818
11:3	443					•			.2727
11:4	3332					•			.3636
11:5	32222								.4545
11:7	221,21,21	5:3 + 3:2 + 3:2							.6363
11:8	21,211,211	3:2 + 4:3 + 4:3							.7272
11:9	2111,21111	5:4 + 6:5							.8181
12:5	32,322	5:2 + 7:3	3:5 (444) 4:5 (3333) 2:5 (66)	— 3:1 1/4 6:2 1/2					.4166
12:7	2221,221	7:4 + 5:3	3:5 (444)						.5833
13:2	76			13:2	433 544				.1538
13:3	544					•			.2308
13:5	332,32	8:3 + 5:2							.3846
13:6	4333								.4615
13:8	221,221,21	5:3 + 5:3 + 3:2							.6154
13:9	212121,211	(3:2 x3) + 4:3							.6923
14:3	554		7:3 (2222222) 2:3 (77)	— 7:1 1/2					.2143
14:5	33332								.3571
15:2	87		3:2 (555) 5:2 (33333)						.1333
15:4	4443		3:4 (555) 5:4 (33333)			•			.2666
15:7	3222,222		4:7 (4344)						.4666

536b. Various Ratio Reckon-by Decimal

Ratio Reckoning (non-long-hand)

Ratio	HAM	Ratios Sequence	Parents (& Crams)	Equiv Ratio	Subdi Uneq	Pat1st	Speed up	X+ Y:Z	Dec
25:3	988		5:3 (55555)						.1200
15:2	87		3:2 (555) 5:2 (33333)						.1333
20:3	776		4:3 (5555) 5:3 (44444)	5:3/4 4:3/5					.1500
13:2	76				433 544				.1538
19:3	766	(3:2 x 5) + 4:3	5:3 (44344)						.1579
25:3	988		5:3 (55555)						.1200
23:4	6665				3222223 4333334	•			.1739
17:3	665		4:3 (4544)		32223 43334				.1765
11:2	65				323 434				.1818
16:3	655		4:3 (4444) 2:3 (88)	4:3/4 8:1 1/2					.1875
21:4	6555		3:4 (777) 7:4 (3333333)		34333 45444				.1905
24:5	555,54		3:5 (888) 4:5 (6666) 8:5 (33333333	— 6:1 1/4 —					.2083
19:4	5554								.2105
14:3	554		7:3 (2222222) 2:3 (77)	— 7:1 1/2					.2143
23:5	554,54	14:3+9:2	4:5 (6566)						.2174
9:2	54		3:2 (333)			•			.2222
22:5	54,544	9:2+13:3	7:5 (3334333)						.2273
13:3	544					•			.2308
17:4	5444					•			.2353
21:5	54,444		7:5 (3333333) 3:5 (777)						.2381
25:6	544444								.2400
19:5	44443		5:3 (44344)						.2632
23:6	444443								.2632
15:4	4443		3:4 (555) 5:4 (33333)			•			.2666
11:3	443					•			.2727
18:5	443,43	11:3 +7:2	3:5 (666)						.2777
7:2	43						•		.2857
24:7	43,43,433	7:2x2+10:3	4:7 (6666)						.2917
17:5	43,433	7:2 + 10:3	4:5 (4544) 3:5 (656)						.2941
10:3	433		2:3 (55)	5:1 1/2		•			.3000
23:7	433,4333	10:3+13:4	4:7 (6566)						.3043
16:5	43,333		4:5 (4444) 2:5 (88) 8:7 (22222222	4:1 1/4 8:2 1/2 2: 7/8					.3125
19:6	433333								.3158
22:7	4333333								.3182
25:8	43333333								.3200
23:8	33333332								.3478
20:7	3333332		4:7 (5555)						.3500

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