HARMONIC STRUCTURES AND THEIR RELATION TO TEMPORAL PROPORTION IN TWO STRING QUARTETS OF BÉLA BARTÓK

by

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ABSTRACT

The String Quartets of Bela Bartok provide a representation of the progressive compositional process spanning the years from 1909 until 1939. The early Quartets show the generating elements which become expanded and more developed through the later Quartets.

Analysis of the _String Quartet No. 1_ and the _String Quartet No. 6_ based on elements of golden-section proportion and harmonic structures reveal a "new outlook" for Bartok's music. Each element in the past has been considered as a separate parameter which has a significant role in the construction of Bartok's music.

TABLE OF CONTENTS

TABLE OF CONTENTS--Continued

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS--Continued

LIST OF ILLUSTRATIONS--Continued

Figure Page

LIST OF ILLUSTRATIONS--Continued

LIST OF ILLUSTRATIONS--Continued

LIST OF ILLUSTRATIONS--Continued

Figure | Page

CHAPTER 1

INTRODUCTION

The past decade has witnessed several analytical approaches to Bela Bartok's music. Each parameter of Bartok's music provides interesting and informative material that enables the theorist to further understand the compositional process. In recent years, analysts have turned to golden proportion and the Fibonacci series in relationship to formal organization in Bartok's music. By taking a pre-determined unit value, such as the number of seconds, or the number of measures and multiplying this unit by 0.618, the golden mean is obtained for that unit.

The successive number series that is simultaneously additive and geometric is referred to as the Fibonacci series. This series named after the Thirteenth Century mathematician who discovered its golden-section properties may have a role in determining formal sections of a composition. By following the successive number series (1, 2, 3, 5, 8, 13, 21...), significant musical events may be discovered and located at these relative distances which approach the golden section ratio of 0.618 for any adjacent pair. Even though golden proportion and the Fibonacci series are more commonly associated with temporal proportion, the Fibonacci series is also associated with harmonic structures. The person most responsible for bringing to light the harmonic language of Bartok has been the

Hungarian scholar, Erno Lendvai. Lendvai has written books and articles about Bartok's music discussing harmonic and temporal elements. Specifically, I refer to his book entitled Bela Bartok: An Analysis of His Music in which he related the golden section and the Fibonacci series to harmonic and formal principles as separate entities.

The harmonic theories of Lendvai concern themselves with the chromatic system and the diatonic system. The chromatic system is based on the golden section and the Fibonacci series which are found in musical motifs, themes and harmonic structures, whereas, the diatonic system is based on the acoustic scale and the acoustic chord. Lendvai also states that golden-section principles are present in intervals and chords including their expansions and contractions.

The Fibonacci series is found in certain harmonic structures of Bartok's music. To narrow this idea even further, the structure of intervals, both vertical and horizontal, can be composed of Fibonacci relationships. In the Sixth Quartet, first movement, a vertical alignment of pitches in the first part of measure 28 produces a Fibonacci value of $5 + 3 = 8$. The G# appearing in the viola acts as an appoggiatura to the G-natural, thus making the G-natural the principal note which is included in the forming of the Fibonacci structure (Figure 1).

Figure 1. Sixth Quartet - First Movement.
Vertical Alignment of Pitches Producing Fibonacci
Structures - Measure 28.

The appearance of Fibonacci structures appearing in a horizonatal manner would incorporate melodic and motivic structures. In the principal theme of the first movement in the Sixth Quartet, the first Violin begins with its nine note theme imitated by the second Violin which alters some of the notes. The first Violin solo contains Fibonacci intervallic values (Figure 2).

Figure 2. Sixth Quartet - First Movement.
Fibonacci Patterns in the First Violin.

Another example which soon follows appears in measures 31 to 33, again in the first Violin. By reducing the horizontal structure to a vertical alignment, there appears another 5 + 3 = 8 Fibonacci value.

Regarding temporal proportion, Lendvai states that formal principles in Bartok's music can be determined by the application of golden section. Through the calculation of units by 0.618, the golden mean is obtained which signifies at that point in the music, some kind of musical event should occur. Continuing the process of golden-proportion calculations upon each obtained proportion, it is possible to divide a unit into smaller sections, or "form cells" as Lendvai calls them, all based on the golden section principle.

Lendvai, in his book, does not go into great detail regarding golden-section (GS) analysis and all of its effects on the music of Bartok. No mention is made of the relationship of the GS with other elements or parameters. There is mention of the GS and Fibonacci in the realm of determining "form cells" based on the Fibonacci series. Taking a unit and determining its golden mean along with its lower-level subdivisions, the results would form patterns based on Fibonacci.

The temporal proportions and harmonic principles have not been studied as one entity. It is true that several studies have been done in the area of temporal proportion and harmonic principles but up to this point, no one has attempted to bring together the temporal and harmonic concepts. During 1974 to 1978, only three doctoral dissertations had been completed in the areas of pitch and temporal proportions as separate entities. One dissertation was on the areas of pitch organization of a Bartok quartet[1]; another dissertation in

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[1]Elliott M. Antokolitz, Principles of Pitch Organization in Bartok's Fourth String Quartet (Ph.D. dissertation, City University of New York, 1975).

axis-based symmetrical structures of two Bartok compositions[2] and the third dissertation discusses the GS and temporal proportions.[3]

These recent facets of research stand as the latest developments in furthering the knowledge of Bartok's formal principles and harmonic principles including GS application and the explanation of golden sections in general.

Purpose of Study

The purpose of this study is to investigate harmonic structures and pitch patterns and their relationship to golden section proportion and the Fibonacci numerical series in two string quartets of Béla Bartók. Research has been completed in the areas of temporal proportion and harmonies (chords and intervals) as separate entities. This study will attempt to bring these two areas of temporal proportion and harmonic language together and formulate a conclusion as to their relationship.

Some of Bartok's harmonic structures are comprised of specific intervallic combinations producing a structured "functional" sonority. As previously mentioned, certain harmonic structures may contain Fibonacci relationships either separate from the "functional" sonorities or within the sonority itself. The GS proportions of each

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[2]Judith E. S. Maxwell, An Investigation of Axis-Based Symmetrical Structures in Two Compositions of Bela Bartok (D.Mus.Ed., University of Oklahoma, 1975).

[3]Michael R. Rogers, The Golden Section in Musical Time: Speculations on Temporal Proportion (Ph.D. dissertation, University of Iowa, 1977).

movement in the First and Sixth String Quartets will be determined according to a particular unit selection. The harmonic structures at these areas will be analyzed and organized to formulate a pattern of occurrence and GS significance.

Bartok's Harmonic Language at Proportion Levels

Before we can delve into the harmonic structures in the First and Sixth Quartets, a basis for chordal analysis must be established. After studying the harmonic structures which appear at golden proportions, the following categories of chord structures have been defined:

Major-Seventh Structures

The harmonic language of Bartok has a unique complexity about it due to the grouping of pitches creating colorful sonorities and a simplistic quality by the use of triadic structures and intervals. Lendvai categorized Bartok's use of chords and intervals into the chromatic system and the diatonic system. This study will concern itself primarily with the chromatic system which is based on the golden section including the Fibonacci numerical series. In addition, pentatony and alpha chords, including their derivatives, belong to this system.

In studying the harmonic structures found in both the First and Sixth Quartets, several recurring chord structures are of importance. There is a large use of the major-seventh and the minor-seventh as a framework for harmonic structures. The minor-seventh will be referred to as a four-note chord. The first of the four types of four-note chords is a "complete" major-major-seventh sonority consisting of a fundamental, a third, fifth and seventh. The second type of four-note chord retains the major-seventh frame but the two inner voices may be altered to produce a new sonority which will be referred to as an "altered" four-note chord. The third structure is altered in a sense too; however, only one of the original pitches is "mistuned" by raising or lowering that pitch one-half step in either direction. Finally, just as there is a complete four-note chord, there can also be an "incomplete" four-note chord with either the 3rd or 5th being omitted (Figure 3).

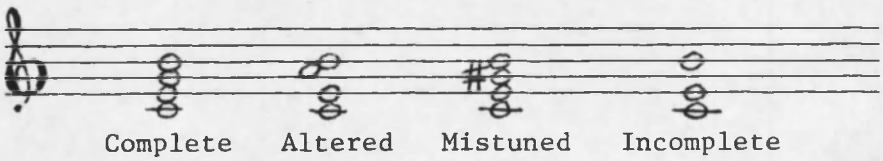

Figure 3. The Four Types of Four-Note Chords.

Minor-Seventh Structures

Numerous minor-seventh chord structures appear in addition to the major-seventh. This minor four-note chord in addition to the major four-note chord can be constructed by reordering the pitches at a GS proportion. The minor-seventh can appear in a variety of arrangements regarding pitches between the root and the minor-seventh, but that minor-seventh quality remains constant. Regarding the minor-seventh, Bartok himself says,

> A visible sign of the consonant character of the seventh [in folk music] is the condition that the regular resolution of the seventh (one degree downward to the sixth degree) does not occur, in reality cannot occur, because the sixth degree is missing.
>
> When the consonant form of the seventh was established the ice was broken: From that moment the seventh could be applied as a consonance even without a necessarily logical preparation.[4]

Fourth Chords

Another chord structure which is prominent in this study is based on fourths. The use of pentatony gave rise to the use of fourths in addition to Hungarian folksongs from which these chord structures are derived. One structure of importance is the fourth-chord which consists of an augmented fourth connected to a perfect fourth (Figure 4).

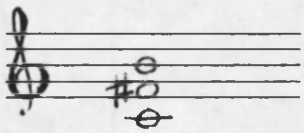

Figure 4. The Fourth Chord.

Regarding the appearance and use of the tritone, Bartok has this to say,

> Roumanian and Slovakian folksongs show a highly interesting treatment of the tritone (the first in a sort of mixolydian mode with minor sixth, the other in a lydian mode) . . . . Through inversion, and by placing these chords in juxta-position one above the other, many different chords are

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[4]John Vinton, "Bartok on His Own Music", The Journal of the American Musicological Society, 14/2 (Summer 1966), 241.

> obtained and with them the freest melodic as well as harmonic treatment of the twelve tones of our present day harmonic system.[5]

Major-Minor Chords and Their Derivatives

The most characteristic chord structure having its origin based on pentatony is commonly referred to as the Bartokian major-minor chord. The structure contains a major third, usually below the root and the minor third, usually above the root (Figure 5).

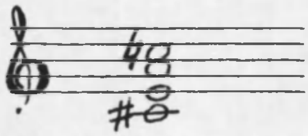
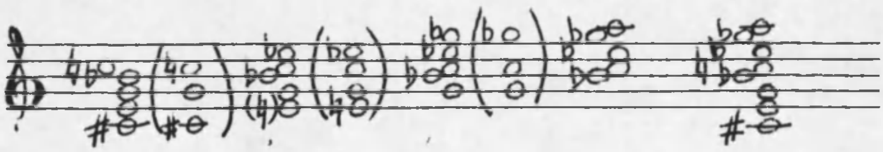


Figure 5. The Major-Minor Chord.

The major-minor chord has Fibonacci relationships between its pitches which also derived from pentatony also having Fibonacci relationships. Lendvai has elaborated the major-minor chord into various structures, each having Fibonacci patterns (Figure 6).[6]



Beta Gamma Delta Epsilon Alpha

Figure 6. Synonym Forms of the Major-Minor Chord.

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[5]Vinton, p. 242.

[6]Erno Lendvai, Bela Bartok: An Analysis of His Music (London: Kahn and Averill, 1971), p. 42.

Fibonacci Structure Chords

Finally, the most frequent chord structures common in almost any place in Bartok's music are those based on the Fibonacci numerical series. The aforementioned derivatives of the major-minor chord according to Lendvai all contain Fibonacci patterns. Simple triadic patterns contain Fibonacci if regrouped in a particular pattern. The most common is the minor triad in second inversion which is 5 + 3 = 8 value (Figure 7).

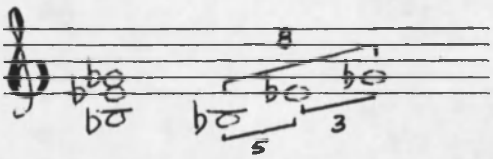

Figure 7. Second Inversion Minor Triad Producing Fibonacci.

Since the second inversion produces a total of 8 in the series, all occurrences of minor sixths are Fibonacci-structured.

General Procedures of Study

The following boundaries and goals for the study will be set:

1. The selection of two string quartets from the Six Quartets will include Quartet No. 1, which stands as an early musical example of Bartok's compositional process. Completed in 1909, this Quartet was written during a time in Bartok's composition career in which he experimented with various elements. In the introduction to Lendvai's book, Alan Bush states,

> Mr. Erno Lendvai has disclosed the fact that Béla Bartók, in his early thirties, evolved for himself a method of integrating all the elements of music; the scales, the chordal structures with the melodic motifs appropriate to them, together with the proportions of length as between movements in a whole work, main divisions within a movement such as exposition, development and recapitulation and even balancing phrases within sections of movements, according to one single basic principle, that of the golden section.[7]

Bartok would be in his early "thirties" approximately between the years 1911 to 1915. Even though the First Quartet was completed in 1909 at the age of 27, certain "elements of music" are used in small quantities. A major event which appears in the First Quartet, as Bartok's turning point in his music, is the use of folksong.[8] Folk tunes have a pentatonic flavor which utilizes the Fibonacci series: the melodic steps of a major second, minor third and a perfect fourth.

Figure 8. Pentatonic Scale Showing Fibonacci Patterns.

The Sixth Quartet composed in 1928 will function as a later model in the same genre. The same elements which are discussed in the First Quartet will also be taken into consideration in the Sixth. A comparison will be made of those elements found in the early work with those of the later work. There should be some generalizations

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[7]Lendvai, p. vii.

[8]Janos Karpati, Bartok's String Quartet, Trans. by Fred Macnicol (Budapest: Corvina Press, 1975), p. 66.

possible about Bartok's use of chord structures, golden section analysis as well as Fibonacci in each example.

2. Conducting an intensive analysis of each Quartet will involve all the proportional elements based on the number of measures, the number of seconds, the number of eighth-notes and proportions based on the Fibonacci numerical series. After the golden mean and its lower level subdivisions have been found, the pitch structures occurring at these levels will be analyzed and the findings categorized according to the harmonic principles discussed earlier.

3. Based on the findings of harmonic structures that have been categorized, the information will be studied to determine if a relationship between harmonic structures and the golden-section principle is present. If a positive relationship occurs, then certain structured pitch patterns will occur at golden-section areas.

4. Other elements that play a vital role in relationship to harmonic structures will also be studied. This would include the role of tonality and the use of symmetry between pitch patterns in addition to symmetry of tonalities.

Prior to the discussion of proportional units used in the analysis of the First and Sixth Quartets, one must determine the process of calculation. In determining proportional delineation by the golden section and its lower level subdivisions of the First and Sixth String Quartets, four means of analysis will be incorporated and compared. The first means of analysis will determine the proportions based on the number of measures within each movement; the second means will be based on the number of seconds; the third, the number of eighth-notes and finally the fourth will be determined by the use of the numbers in the Fibonacci series (in relation to measure numbers).

Once the golden mean has been determined (multiply the total number of units by 0.618), that figure will in turn be multiplied by 0.618 to determine the next level of subdivision. This process of calculation will continue until the smallest level appears which shows any harmonic significance relevant to this study.

Each movement will contain a positive versus a negative section, "which tends to push ahead"[9] to a climactic point. A negative versus a positive relationship will be used after the principle golden mean until the end of the movement. Since Lendvai has cited the Sonata for Two Pianos and Percussion and the Music for Strings, Percussion and Celesta as having a positive followed by a negative section, the continuation of his idea will be used in the two Quartets.

After the study has reached this point, a discussion will follow in the harmonic structures at each of these divisions. Certain harmonic structures which are common in the music of Bartok have been discussed by Lendvai and Karpati. Lendvai has revealed structures which are based upon the GS principle and Fibonacci while Karpati has approached harmony having its influence based on folk-music and modal

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[9] Jonathan Kramer, "The Fibonacci Series in Twentieth-Century Music", The Journal of Music Theory, 17/1 (Spring 1973), 120.

elements in addition to functional elements. The combination of both theories with my own findings will be the basis for discussion concerning the harmonic structures.

Once the harmonic structures have been analyzed at each cell in each movement, a comparison will be made to determine if there is a relationship between harmonic structures and proportion cells determined by any one of the four means of unit analysis.

Considering the Fibonacci series and the relationship to proportional delineation, an analysis will be made as to the golden mean determined by Fibonacci. For example, 89 measures would follow the series with 55 appearing at the next lowest level, then 34, 21, etc. The analysis using Fibonacci definitely does have significance to this thesis in proportional delineation but also serves as a means for determining harmonic structures.

In Lendvai's book on formal principles, the Fibonacci series is touched upon only slightly in regard to formal symmetrical structures. Discussion is primarily made on the effect of Fibonacci in "the law of natural growth". The remainder of his discussion deals with the natural growth concept of the Fibonacci series. It is interesting to note in reference to Lendvai's study of the Fibonacci series in the discussion of formal principles, that the selected works of Bartok's music fall into an even symmetrical structure, meaning that the works that Lendvai includes are Fibonacci related according to significant musical events occurring at m. 89, 55, 34 . . . . ., etc.

Regarding the two string quartets, this may not be the normal occurrence in each movement.

When significant musical events occur near Fibonacci points, a deviation of one or possibly two measures either before or after the point of proportion is permissable. The precision of calculation in determining the golden mean and Fibonacci cells in addition to significant musical events may occur due to variables in timings of seconds based on a particular recording, as in the case of the First Quartet. To support this, Jonathan Kramer's article of the Fibonacci series states,

> Actually, these proportions of Lendvai are not quite as elegant or significant as they might at first appear. They are less than elegant because they are approximate For example, the climax [Music for Strings, Percussion and Celesta, 1st Movement] occurs after 55 bars (i.e., in bar 56) while the mutes are removed and the timpani enter in bar 34 (i.e., after 33 bars).[10]

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[10]Kramer, p. 120.

SPECIFIC QUESTIONS

The following specific questions will also be considered during the course of study:

1. What is the relationship between golden proportion and harmonic structures?
2. What is the relationship between the Fibonacci number series and the use of harmonic structures?
3. How do these relationships compare within separate movements in the First Quartet and the Sixth Quartet? How do they compare between both Quartets?
4. Do Fibonacci-related pitch structures occur independently of golden section formal patterns?
5. Do large-scale pitch relationships (tonal centers) as well as individual chords exhibit Fibonacci relationships?
6. Do scales or melodic events as well as vertical structures exhibit Fibonacci relationships?

CHAPTER 2

ANALYSIS OF STRING QUARTET NO. 1

Proportions

Proportions Based on the Number of Measures

In computing the golden mean based on the number of measures in each movment of the First Quartet, there are two significant results that the computations show. First, there seems to be no correlation between the number of measures, the Fibonacci series or the number of seconds. In certain movements, the measure numbers occur independently of the measures in which the seconds occur as well as the Fibonacci series. Secondly, there does seem to be a relationship between either the number of measures in relation to the measures determined by the proportions based on the number of seconds and the number of measures in relation to the Fibonacci series or in one instance, both.

In the second and third movements, there is a close Fibonacci relationship in the calculation of measure numbers. (The Introduzione has been excluded in calculations and analysis.) Upon computing the golden proportions based on the number of measures, one finds that certain measures fall into the Fibonacci series. In the First Quartet, second movement, measure 33.08 can be considered as 34 if variables are allowed in calculation just as measure 20.44 can be 21 and so forth. In the breakdown of golden proportions into its smallest possible units Fibonacci series appears also in measure numbers. The third movement shows this concept starting with measure 234.84 (233 in the Fibonacci series). (Figures 9 and 10)

Proportions Based on the Number of Seconds

There is a correlation between the number of seconds and that of measure numbers in the first movement only. In determining the lower levels of golden proportion based on seconds, calculations were made as to their approximate occurrence in a measure. In comparing these findings with those of proportions based upon measure number, there is some relation between measures where the proportion based on the number of seconds and measures. In the first movement, a subdivision at 207.76 seconds into the movement places this timing at approximately measure 26 or 27. Another subdivision also occurs at measure 27 in the delineation based on the number of measures. This also occurs in the following levels based on seconds (Figure 11).

Fibonacci Series	Proportions based on the number of Measures
34	33.08
21	20.44
13	12.63
8	7.80
5	4.82
3	2.98

Figure 9. First Quartet-Second Movement. Relationship of Golden Section Levels of Subdivision with the Fibonacci Series.

Fibonacci Series	Proportions based on the number of Measures
233	234.84
144	145.13
89	89.09
55	55.42
34	34.25
21	21.16
13	13.08
8	8.08
5	4.99
3	3.08
2	1.90
1	1.17

Figure 10. First Quartet-Third Movement. Relationship of Golden Section Levels of Subdivision with the Fibonacci Series.

	Proportions based on the Number of Seconds		
	G.S. by Number of Seconds	Corresponding Measure Number	Proportions Based on the number of Measures
G.S.L. 1	336.19	46	43.87
G.S.L. 2	207.76	26/27	27.11
G.S.L. 3	128.39	16	16.75
G.S.L. 4	79.35	9	10.35
G.S.L. 5	49.03	6	6.40

Figure 11. First Quartet-First Movement. Relationship of Measures Based on Proportions Based on the Number of Seconds with those of Measure Numbers.

[G.S.L. (Golden Section Level) signifies the specific levels of proportional analysis with GSL 1 being the Golden Mean, GSL 2 the next lower level, etc.]

Proportions Based on the Number of Eighth-Notes

In the first movement, there is a close relationship between measures containing golden section points determined by the number of eighth-notes with those measures determined by seconds. The golden mean in both cases is the same measure (measure 46) with the first lower level division also being the same (measure 27). The remainder of the levels are one measure apart (Figure 12).

	Proportions Based on The Number of Seconds		Proportions Based on The Number of Eighth-Notes	
	Seconds	Measure	Eighth-Notes	Measures
G.S.L. 1	336.19	46	342	46
G.S.L. 2	207.76	26/27	212	27
G.S.L. 3	128.39	16	131	17
G.S.L. 4	79.35	9	81	10
G.S.L. 5	49.03	6	50	7
G.S.L. 6			31	4
G.S.L. 7			19	3
G.S.L. 8			12	2

Figure 12. First Quartet-First Movement. Relationship Between Seconds and Eighth-Notes.

In the second movement, two golden-section levels based on eighth-notes are in direct relationship with two levels of golden section proportion determined by seconds. The third level of both proportions coincide as the seventh level of eighth-note proportion coincides with level six of proportions by seconds (Figure 13).

	Proportions Based on The Number of Seconds		Proportions Based on The Number of Eighth-Notes	
	Seconds	Measure	Eighth-Notes	Measure
G.S.L. 1	313.94	244	1347	228
G.S.L. 2	194.01	123	832.59	141
G.S.L. 3	119.90	88	514.54	88
G.S.L. 4	74.09	53	317.98	55
G.S.L. 5	45.79	28	196.51	35
G.S.L. 6	28.36	14	121.44	22
			75.05	14

Figure 13. First Quartet-Second Movement.
Relationship Between Seconds and Eighth-Notes.

In the third movement, only one direct relationship occurs between the sixth levels of both proportions (Figure 14).

	Proportions Based on The Number of Seconds		Proportions Based on The Number of Eighth-Notes	
	Seconds	Measure	Eighth-Notes	Measure
G.S.L. 1	369.56	244	2030	238
G.S.L. 2	228.39	140	1256.62	137
G.S.L. 3	141.14	96	775.35	94
G.S.L. 4	87.22	76	479.16	59
G.S.L. 5	53.90	49	296.12	37
G.S.L. 6	33.31	23	183	23
G.S.L. 7	20.58	20	113.07	15
G.S.L. 8			69.87	9
G.S.L. 9			43.19	6
G.S.L. 10			26.69	4

Figure 14. First Quartet-Third Movement.
Relationship Between Seconds and Eighth-Notes.

Proportions Based on the Fibonacci Series

In the first movement, the large formal structure is ternary (ABA). Looking at the first part of the three-part form, a Fibonacci pattern occurs; however, the series appears as 1, 8, 13. In measure one, imitation occurs between the first and second violin. Having a polyphonic texture immediately at the onset of the work is a significant musical event in itself. The third and fifth measures have no appearance of any important musical event (i.e., formal delineation point, change in texture, timbre, dynamics, etc.) since both measures continue to proceed with material leading to the entrance of the viola and cello in measure 8. Also, a metric change occurs. In measure 13, the musical event is a crescendo to forte up to the third quarter beat.

The second part of the three-part form beginning in measure 33 can also be broken down into a numerical series based on the Fibonacci principle. The first number of the series (measure 33) contains open fifths with the viola entry. The open fifth also appears at a Fibonacci series point in the second movement at measure 160. In the third of the series (measure 35), a metric change occurs with a continuation of previous material. The fifth (measure 37), also has a meter change to $\frac{3}{4}$. The eighth (measure 40) starts immediately with a tonality of F# moving to the tonality of B^b. From measure 33 to 39 the tonal center was C, so the tonal shift would definitely be of significant value. In the thirteenth of the series (measure 45), the cello enters with primary thematic material as the three remaining voices continue the sixteenth-note texture.

With the return of the first section at measure 53, the only series number which may have importance would be series number (hereafter abbreviated SN) thirteen (measure 65) where the quarter note becomes more prominent. SN 13 was determined by beginning the Fibonacci series at measure 53, which would be SN 1, with measure 55 as SN 3, etc., up to SN 13 at bar 65 (Figure 15).

Fibonacci Series Number	Measure Number
A SECTION	
1	1
(3)	(3)
(5)	(5)
8	8
13	13
B SECTION	
1	33
3	35
5	37
8	40
13	45
A SECTION	
1	53
(3)	(55)
(5)	(57)
(8)	(60)
13	65

Figure 15. First Quartet-First Movement. Relationship of Fibonacci Series to Measure Numbers. The parenthesis () signifies the normal occurrence of the generating Fibonacci series in which no significant musical event occurs.

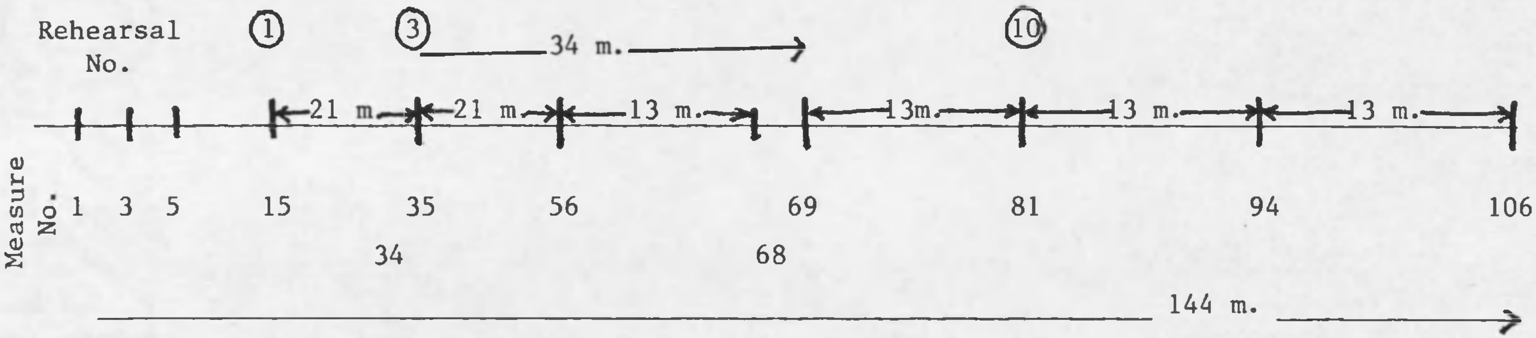
In the second movement, smaller numerical values of Fibonacci occur at the beginning in the third measure, the $\frac{2}{4}$ meter with the two quarter beats of rest. In the eighth measure, the phrase concludes; in the twenty-first measure the Allegretto appears which begins the Exposition. The Development (measure 140) can be subdivided into two overlapping sections also showing Fibonacci patterns. Measure 140 begins with the first three voices in addition to the tempo change. The third in the series (measure 142) returns to the three voices like measure 140 with altered pitches. SN 5 (measure 144), the four voices come to a close as the first violin continues on introducing an idea to be imitated in SN 8 (measure 147) in contrary motion. SN 13 (measure 152) a new tempo occurs with the three lower voices in unison reiterating the motive heard at measure 140. SN 21 appears in measure 160 at which the open fifth pedal heard in measure 33 of the first movement is not with all voices. Finally, at SN 34 (measure 173) a slight pause of an eighth-rest appears followed by four voices at fortissimo.

The last movement can be approached in two ways in determining the Fibonacci series. One way is to look at the opening section and see how the thematic material appears at Fibonacci points, which also includes accompaniment. This would be a horizontal approach to the series. For example, obviously, the first bar begins the movement with a single e^2. The third measure contains a three-note chord and adds another voice to the texture. The fifth measure begins with the principal theme for the movement. Following the theme through the remainder of the page up to measure 35, no major changes in thematic content occur at a Fibonacci point.

The second way of looking at this section is to consider any event that has a vital role in the fabric of the entire section. For example, in addition to the aforementioned findings, those at measures 1, 3, and 5, events were found in measures 8, 13, 21 and 34. Measure 8, the accompaniment 'f^2' in the first violin moves to an $f\#^2$ forming a new color; measure 13, the accompaniment ceases altogether; measure 21, the driving rhythm is replaced by whole-notes which have been tied over with the pulsating 'b' in the cello continuing; and finally, measure 34 concludes the first section under discussion as the texture ends and a new idea begins starting off in a new meter. These additional observations may be trivial at first but they all work together to form this marvelous opening section.

Looking at the movement as a whole, within sections and between sections, Fibonacci series patterns are formed. The series may discontinue existing, but a new series may begin a few measures after the preceding series topped (Figure 16) earlier, too.

EXPOSITION



DEVELOPMENT

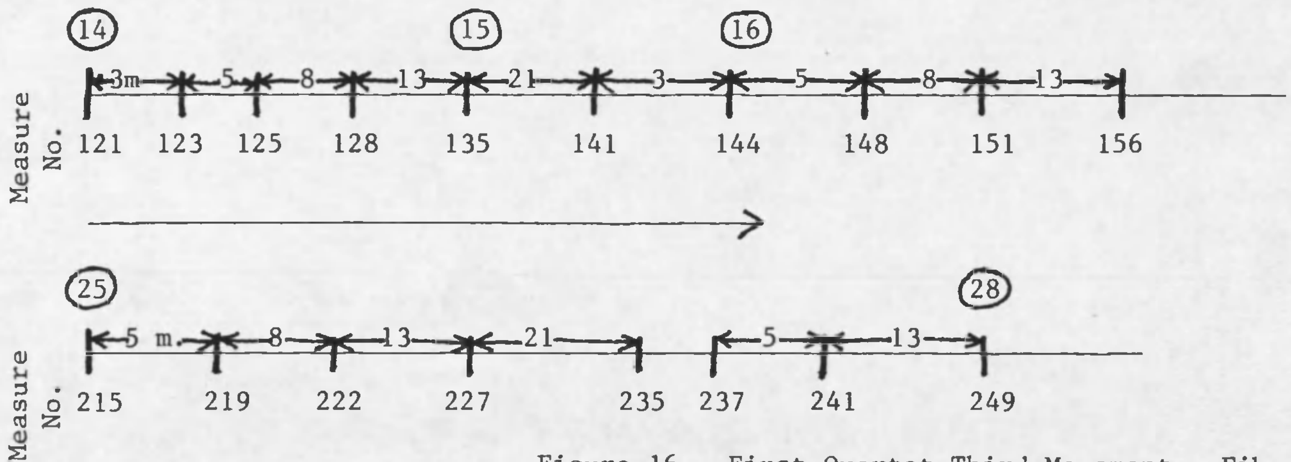


Figure 16. First Quartet-Third Movement. Fibonacci Patterns Within Sections of the Sonata Form Occurring at Formal Sections and at Rehearsal Numbers.

Harmonic and Pitch Structures at GS Levels

Dyads

In looking at the selected measures in the First Quartet calculated to determine the golden sections, a motivic pattern occurs. This pattern becomes most prominent in the second movement. It consists of two separate dyads, the first a minor second and the second dyad a major second. The two dyads are also Fibonacci related; the minor second (Interval Class 1) and the second of the major second (Interval Class 2) total to three. These dyads ('x' and 'y'), usually appear within the same measure but appear as separate entities as well. X can be found in numerous places in the first movement but in linear fashion, specifically in melodic material. In vertical structures the dyad is not as predominant.

The majority of occurrence of the y dyad appear in the second movement, at the very beginning of the movement the x dyad appears between the A-A# and A#-B which reiterates itself in measure 2. In the four-bar phrase after the measure of rest, there appears a combination of the x dyad with the y dyad (measure 5, D-C). The half-step whole-step pattern occurs throughout the movement. In the exposition at measure 20, the x dyad appears as a perpetual accompanying figure in the first violin.

In looking deeper into both dyads, in x the first note being a half-step could be analyzed as a leading tone to the second note of the dyad. The second note of x would have a chord tone function.

In dyad y, the first note would function as the chord tone followed by the second note which would be non-harmonic. Another possibility is to reverse the order and have the first note be non-harmonic and the second note function as the chord tone. The choice of analysis would depend primarily on the other chord tones and/or non-harmonic tones at that point.

In measure 33 of the second movement there are three successive y dyads in linear motion and three successive vertical structures of dyad y. Dyad x appears on each quarter beat in the cello, D#-E, d-e^b and A-B^b. Dyad y occurs between the viola and cello parts being formed on the second eighth-note of each beat, E-f#, E^b-f and B^b-c^2 (Figure 17).

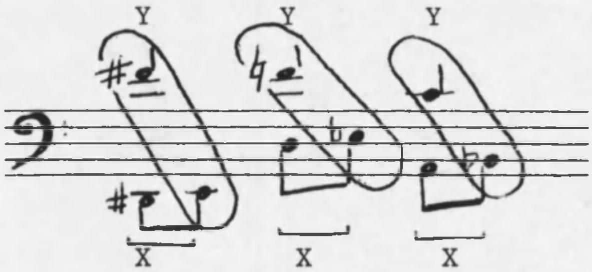


Figure 17. First Quartet-Second Movement.
X and Y Dyads in Measure 33.

The y dyads happen to be parallel in melodic function. The viola f#-f-c^2 is paralleled by E-e^b-B^b at a major second below displaced the octave. The eighths occurring on each beat function as non-harmonic tones but also parallel the viola at a minor third lower. Combining all of these pitches forms three clusters having Fibonacci patterns (Figure 18).

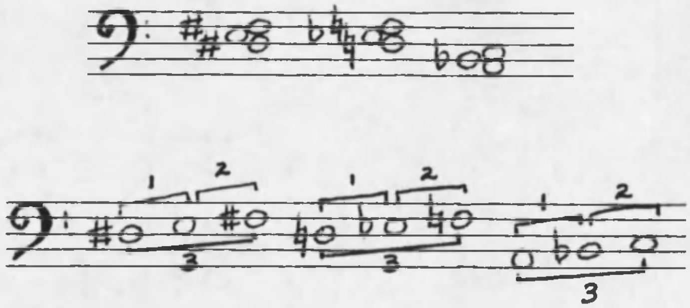


Figure 18. First Quartet-Second Movement.
Fibonacci Structures in the Combined X and Y Dyads.

In measure 53, vertical and horizontal dyads of x and y appear. The vertical dyad x occurs between the $g\#^{1}$ in the viola and the a^{1} in the first violin followed by dyad y between the $g\#^{1}$ in the viola and the $a\#^{1}$ in the first violin. Another y dyad appears on the third eighth-note between the F# and the G# in the viola and on the C# on the fourth eighth-note, a dyad x is formed with the B# of the second violin.

Structured Chords

The first structured chord, consisting of four notes, is comprised of a major triad with a major seventh above the root producing a major-major seventh sonority. The important element of this structure is the major seventh which appears in the remaining four-note structures as a constant element. The third and the fifth may be altered in the complete four-note structure to produce a new sonority. This variable in the structure will be referred to as an 'altered' four-note chord. A variation of the 'altered' chord could occur in the two inner voices which are altered to produce a new sonority regardless of whether they are slight deviations of the third and fifth pitches or completely different pitches altogether. A third type of four-note chord is called a 'mistuned' chord. All four notes of the structure are present; however, one or possibly two pitches--usually the two inner voices--are 'mistuned' either above or below the original pitch. This would produce an augmented or diminished structure should only one pitch be 'mistuned' as in the case of the fifth. The final chord based on the four-note idea is the 'incomplete' four-note chord, which in itself sounds contradictory but one note of the four-notes is omitted, usually the fifth.

Taking into consideration the golden proportion analysis by number of measures, seconds, eighth-notes and Fibonacci, and through the re-ordering of harmonic structures at these proportion points, there are approximately four complete, two mistuned and one incomplete four-note chords in the first movement.

Two complete four-note chords appear in measure 65 which is more prominently heard since the basic duration is the quarter note. The first chord (D-F#-A-C#) appears in first inversion as the second appears in root position. In measure 16 the complete four-note chord appears on the fourth beat (A-C#-E-G#). The chord is weaker because the major seventh does not appear until the last sixteenth-note. The chord appears on the second sixteenth-note of the second beat. The D-D-natural in the first violin could function as a suspension. The chord (D-F#-A-C#) appears in third inversion. The incomplete chord in measure 2 (E^b-B^b-D) has the third missing on the first half of the measure. (When discussing incomplete chords, the omitted note will be indicated by the use of the parenthesis ()). The two mistuned chords in measure 27 and 10 have an augmented fifth above the root. In measure 27, the fourth beat of the chord (G-B-D#-F#) can be aligned omitting the C#, as the chord in measure 10 appears on the last eighth beat in first inversion (B^b-D-F#) not including the A^b.

In the second movement, two altered four-note chords appear. In measure 226 the altered note is the inclusion of a minor seventh with the major seventh and the omission of a third. A very audible major-seventh chord appears in measure 142 (SN 3) where an inner voice is omitted and a lowered third is included. This would not fall into the category of an incomplete chord since the lowered third appears instead of the major third. Two measures later in measure 144 (SN 5) there appears a complete mistuned chord with a lowered third which is followed by an altered chord.

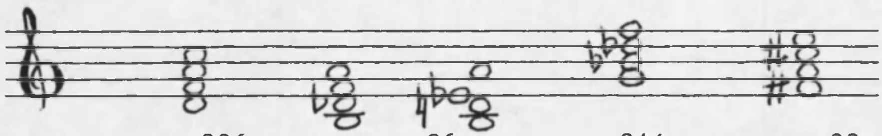
Other Seventh Structures

Almost every proportional point in each movement of the First Quartet contains numerous examples of minor-seventh structures and a few diminished-seventh structures. We saw that the major-seventh interval was the constant factor which was characteristic of each of its four different types. The minor-seventh is also a constant factor but it has been decided not to categorize the varying types since the variety is larger than those of the major-seventh structure. In the first movement, three minor-seventh structures appear, each with a different inner-voice alignment (Figure 19).

m. 43 last eighth | m. 27 2nd beat | m. 16 1st Chord

Figure 19. Different types of Minor Seventh Structures.

In the second movement, again several varieties of minor sevenths occur (Figure 20).



m. 226 | m. 86 | m. 244 | m. 22

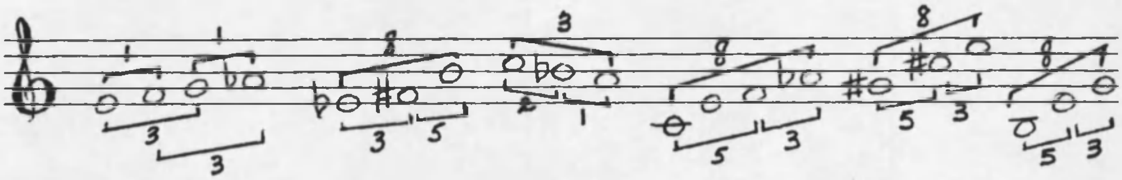
Figure 20. First Quartet-Second Movement. Different Types of Minor Seventh Structures.

There is a tendency for the complete minor-minor sonority to appear more frequently than other combinations at proportion points.

In the third movement, most of the minor-seventh structures are not complete. There are two minor-seventh chords which are complete (see measures 89 and 322).

Fibonacci Pitch Structures at Proportion Points

Fibonacci pitch structures are evident at locations determined by proportional measure numbers and the Fibonacci series. The fibonacci structures are determined by regrouping pitches which appear vertically or horizontally. At the onset of the first movement, Fibonacci pitch structures appear at measures of the Fibonacci series. In the first measure all five pitches form two fibonacci patterns. In measure 3 the three notes heard, excluding the first violin note of f_2 which is tied from the previous bar, form a 3 + 5 = 8 value. The second violin part in measure 5 (last four notes) form a 2 + 1 = 3 and in measure 8 the two entries of the subject in the viola and cello form a 3 + 5 = 8 value. Finally, in measure 13, Fibonacci pitch structures appear on beats 2 and 4, both equaling 3 + 5 = 8 (Figure 21).



m. 1 m. 3 m. 5 m. 8 m. 13

Figure 21. First Quartet-First Movement. Fibonacci Pitch Patterns Which Occur in Measure of Fibonacci.

In the return of the first section (measure 53), the first two Fibonacci pitch patterns are the same. In series number 5 (measure 57) the two violins form Fibonacci intervals (Figure 22).

Figure 22. First Quartet-First Movement. Fibonacci Patterns in Violin I & II, Measure 57.

In the second section (measure 33) there are fewer occurrences of Fibonacci pitch structures. The first structure appears in SN 3 (measure 35) with the articulation of 'a' over the open fifth forming a 3 + 5 = 8. In SN 13 (measure 40) vertical Fibonacci patterns form when a chord is of a minor sonority in second inversion. These appear in the sixteenth-notes in the upper three string parts (Figure 23).

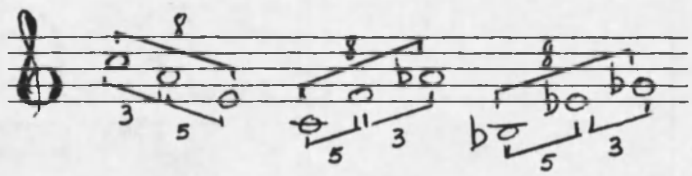


Figure 23. First Quartet-First Movement.
Fibonacci Patterns in a Second Inversion Minor Triad.

In the same measure (measure 45) a horizontal fibonacci pattern occurs in the cello. The four pitches are regrouped into three notes and three notes creating an elision (Figure 24).

Figure 24. First Quartet-First Movement.
Horizontal Fibonacci Pattern in the Cello, Measure 45.

In the second movement, the simultaneous appearance of Fibonacci pitch structures with the Fibonacci series is not as extensive. In measure 1 the first three notes in the viola and cello form a 1 + 1 = 2 value while an expanded pattern occurs in measure 8 in a linear fashion forming a 2 + 3 with the three notes in the first violin. Further expansion is found in measure 34 with a vertical alignment of the four pitches A-C-D-F which equals 3 + 2 + 3 = 8. Another 5 + 3 occurs with a vertical appearance of the pitches C#-F#-G#-A (5 + 2 + 1 = 8) in measure 89.

Few examples of fibonacci pitch structures are found in the last movement. In the third bar, where the pulsating accompaniment continues and expands from e^2 to d^2, e^2 and f^2 a 2 + 1 = 3 value occurs. A regrouping of the C#-E-G# in measure 13 to second inversion creates a 5 + 3 = 8 value.

Beginning with the second theme (measure 94) another fibonacci series starts. With measure 98 having the number 5 in the series, a vertical appearance on beat 2 (if the G in the cello could be analyzed as a retardation) would form F-A^b-B^b-D^b or a 3 + 2 + 3 = 8 pattern. If all pitches in measure 98 were regrouped accordingly, the number 8 would appear (Figure 25).

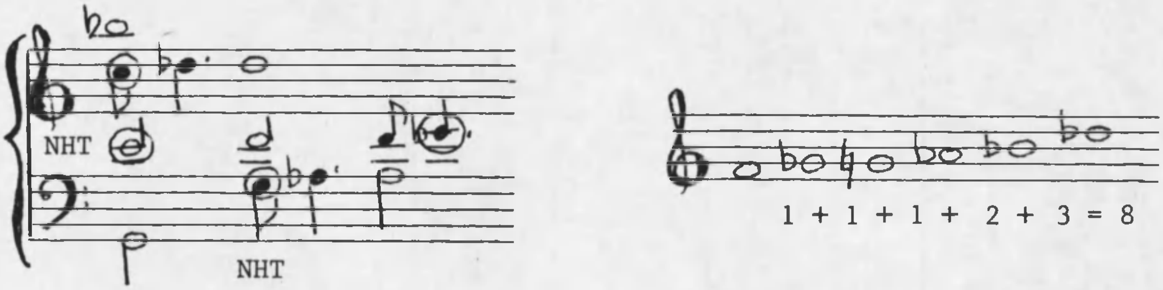


Figure 25. First Quartet-Third Movement. Regrouped Pitches in Measure 98 Showing a Fibonacci Total.

In measure 101, another vertical appearance on beat 2 happens to form a 3 + 2 + 3 = 8 value.

Measure 162 combines the triple stop in the cello with the F# Major descending triad in the viola to form a 3 + 3 + 2 = 8 between the correlating thirds in each instrument. The stop in the cello is reduced to a simple e-minor triad as is the already existing F# triad (Figure 26).

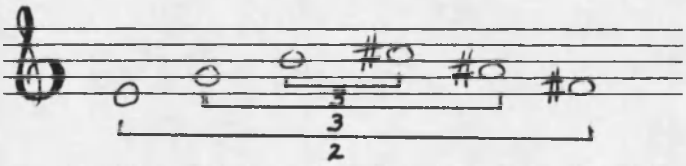


Figure 26. First Quartet-Third Movement. Fibonacci Relationship Between Two Triads.

Smaller inner fibonacci relationships occur in this same pattern (Figure 27).

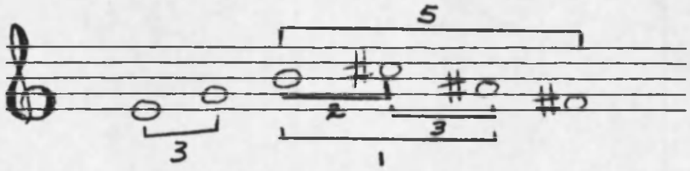


Figure 27. First Quartet-Third Movement.
Inner Fibonacci Relationship.

In the Recapitulation (measure 250), excluding some non-harmonic function pitches, linear consideration of notes can formulate fibonacci pitch structures. Measure 254 (SN 5) has three key notes of importance, the G#, C#, and the pulsating e_2. This forms a 5 + 3 = 8 value. Beginning another series based on fibonacci at measure 266, the key pitches would be C#, E, and F# while the G# could be passing to the note in measure 267. These pitches would create a 3 + 2 = 5 value; however, if as in bar 254 the C#-E-G# were to be of importance, another 5 + 3 = 8 value would appear excluding the F#.

Fibonacci Structures

The chordal structure based on the Fibonacci series is a familiar and significant concept concerning Bartok's use of harmony. All pitch patterns discussed in this study will use only Fibonacci values of 1, 2, 3, 5, and sometimes 8. As mentioned in Chapter 1, motivic and melodic elements also utilize the Fibonacci principle but it is not as frequent as the use in harmonic structures.

At the proportion points, the various notes within that measure (or specific eighth-notes) will be analyzed and regrouped to see if any Fibonacci values occur. In making a comparison with the amount of Fibonacci structures used to that of other harmonic structures, one learns that there are more structures based on the Fibonacci principle.

In the first movement, there are approximately fourteen proportional points where one or more Fibonacci structures appear. The majority of these occurrences are formulated by grouping pitches which are linear in the measure into a vertical fashion. Pitches are not grouped over the entire measure but are limited to one or possibly two beats within the measure. For example, in measure 5 of the first movement, there is a two-voice pattern of moving eighth-notes. The Fibonacci structure occurs in the last four notes of the second violin (c^1-$b^b{}_1$-a^1) which is a 2 + 1 = 3 value. If the g^1 in the first violin were added to this structure, since it sounds simultaneously with the c^1 which was already heard in the second violin, the pattern would be 2 + 1 + 2 = 5 (or 2 + 3 and even 3 + 2 = 5).

Other appearances of Fibonacci structures are the vertical occurrences of a chord which is articulated together by all four voices of the strings. In measure 16, this is the case where the chord immediately on the downbeat, excluding the Bb since it functions as an appoggiatura, is C-Eb-Gb-Ab forming a value of 3 + 3 + 2 = 8.

The second movement has more actual vertical structures present than those found in the first movement. Although the linear motion of each individual part is important, the vertical structures formed by all four independent lines are just as significant. On the second beat of measure 34, a clearer example of a Fibonacci structure appears. The four pitches would include the eighth-note of d in the first violin and exclude the e^1 forming an A-C-D-F or a 3 + 2 + 3 = 8 value. The following values (in the series 55 and 89) also have Fibonacci structures which form themselves on the second beat in each measure all of which are in the formal section of the second thematic idea.

In the third movement, practically all Fibonacci structures are found in vertical alignment. For example, measure 101 of the second theme produces a Fibonacci value of 3 + 2 + 3 = 8 on the second beat with D-F-G-Bb. This structure is very similar to that structure in measure 98 (SN 5) on the second beat. Measure 98, second beat, forms a 3 + 2 + 3 = 8 value constructed on F-Ab-Bb-Db. Both structures have a minor-minor sonority, the first built upon the root G and the second upon Bb, both in second inversion.

What has happened thus far is that vertical and linear pitches within the small time span of a GS proportion have been considered to see if they formulate chords built on Fibonacci.

Now the discussion will move to the more highly structured Fibonacci chords which Lendvai has categorized in his study of Bartok's harmony, and which includes beta, gamma, delta, epsilon and the alpha chords (see Figure 6). In the entire First Quartet only one structure of this type occurs. In the last movement, measure 23, a gamma chord can be found when all vertical and horizontal pitches are grouped to form the values 3:3:2:3.

Taking the fundamental note as B and building upwards, the vertical structure would appear as follows:

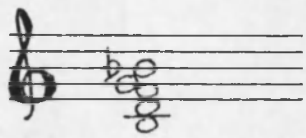


Figure 28. First Quartet-Third Movement. Gamma Chord in Measure 23.

The one difference is that the A# is replaced enharmonically by the Bb, even though the sound remains the same. If one were to consider the A# to be a lower neighboring tone, then the structure would still retain the Fibonacci patterns; however, the values would total 8 (3 + 3 + 2 = 8).

The gamma chord has within itself a major-minor chord which has a pentatonic flavor (Figure 29).

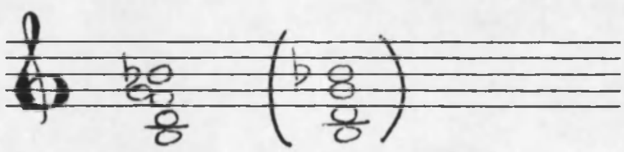


Figure 29. The Major-Minor Sonority Within the Gamma Chord Showing Pentatonic Elements.

<u>Golden-Section Levels and Form</u>

Upon gathering all the information about each unit of proportional analysis, a comparison was made as to whether any of the four units of proportion would delineate large formal sections. Proportions based on the number of seconds had absolutely no relation to formal delineation as did the proportions based on the number of measures in the last movement of the First Quartet. Each and every GS and its lower level subdivisions for each unit analysis did not delineate form in every case, but one or two proportions of each unit did delineate a section or two in the overall form.

In the first movement, proportions based on the number of measures did show that at measure 43 (the overall golden mean itself) the second section of the second part of the larger three-part form began with a new accompaniment pattern in cello one measure later. Proportions based on the number of eighth-notes have a formal delineation occurring with measure 7 which ends the first entry group of the first theme. True, this does not delineate a larger section but is a significant factor in dividing entries based on the opening subject. Just one measure later (measure 8) the Fibonacci unit SN 8 begins the second entry group and is the only Fibonacci number having a relationship to formal sections.

In the second movement, two major sections appear where proportions based on the number of measures fall in measure 140 which begins the Development and in measure 20 which begins the second thematic idea. A close relationship occurs when the proportions based on the number of eighth-notes have a GS level which corresponds to the beginning of the Development. In addition to this, Fibonacci proportions also delineate themselves so that measure 140 appears as SN 1 at the onset of the Development.

In the final movement, proportions based on the number of eighth-notes show that a point occurs in measure 94 which begins the second thematic idea. The larger proportions based on Fibonacci are found in the last movement.

Looking at the entire movement from the standpoint of Fibonacci, series numbers are present between points where texture changes or where significant musical events occur as well as the occurrence of large formal delineations. At some points, measure 56 for example, the final measure of the series becomes the first measure of the following series. Measures 36 to 56 come to a total of 21 measures with measure 56 being SN 21. Another Fibonacci section begins right at measure 56 (SN 1). (See Figure 16).

Role of Tonal Centers

In Colin Mason's article which touches upon tonal symmetry, he states that it was a middle-period interest with Bartok as early as the year 1903.[11] Since the First Quartet was after the initial 'starting point' in Bartok's career, one would expect some symmetry of tonal centers to appear. In fact between the three movements, tonal symmetry is present. The tonality of A seems to be the main focal point of harmonic concern. The first movement (a major third below the opening tonality) begins with the tonal center of F as the last movement centers around C#. The second movement combines a relationship of A and C# as both seem to recur in the final movement.

With the tonality of A as the axis, there appear symmetrical tonal centers on either side of the axis (Figure 30).

[11] Colin Mason, "An Essay in Analysis: Tonality, Symmetry and Latent Serialism in Bartok's Fourth Quartet", Music Review 18:3 (August 1957), 189-201.

1st Movement = F
2nd Movement = A
3rd Movement = C#

Figure 30. First Quartet. Symmetry of Tonal Centers of Each Movement.

Also between the two outer symmetrical tonalities, a Fibonacci value of 8 is present, the value from F to C# equals an 8 pitch class. The F-A-C# tonal pattern can be considered as a "mistuned" triad which is common with harmonic structures we have discussed already (Figure 31).

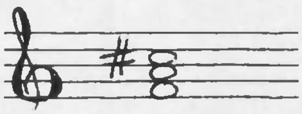


Figure 31. A Mistuned Triad formed from the Three Principal Tonalities.

As was pointed out in Mr. Gow's article[12], the major third is a significant unifying element in the quartet both in tonal centers and thematic material. At measure 16, there is an Ab major-minor chord in first inversion which is a tonic substitution for F but in the previous measure there was an A Major chord in second inversion immediately followed by an a minor chord in second inversion. The a minor six-four chord is another foreshadowing to the axis of A in the second movement which was previously announced with the A/a contrast in bar 7. The F tonality with the AbMm6/4 tension at

[12]David Gow, "Tonality and Structure in Bartok's First Two String Quartets", Music Review 34:3/4 (August-November 1973), 259-271.

measure 16 has a Fibonacci value of 3. The opening imitation on the pitches F to C is a unifying element within this A section.

Since the B section begins with the tonality of C, another Fibonacci relationship of tonal centers occurs between the foreshadowed A/a and C forming another Fibonacci value of 3. A value of 2 is produced with the shift from C to Bb in the middle section (Figure 32).

Measure 7 & 15	A	] 3
Measure 33	C	] 2
Measure 51	Bb	

Figure 32. Fibonacci Relationships Formed Between Tonal Centers.

In the second movement, there is a combination of A and C# which forms no Fibonacci value unless one were to invert the two tonalities to C# and A thereby forming a Fibonacci value of 8.

At the beginning of the Exposition, the ostinato violin centers around C# and F#. There would be a tendency to put this opening part in F# because of its strong leading tone and the absence of a strong leading tone to the C#. If this is the case, the A-F# forms a value of 3.

At measure 94, C# becomes more noticeable and concludes on the dominant substitution based on E, thereby forming a Fibonacci value of 3 between the two dominants.

With the closing theme (measure 103), a semitone bitonality exists between the reiterated D# of the cello with the C-double-sharp of the first violin which ascends on a whole-tone scale. The same semitone bitonality follows between the C in the cello and the B in the first violin at measure 111. According to Karpati's discussion of this concept, he points out that Bartok used this bitonality a semitone apart to create tension.

The idea of bitonality brings up the need for discussion of polytonality. Karpati theorizes about the semitone relationship:

> The chromatically adjacent notes to the fundamental note, however, can be regarded as the notes most alien to it, for they come in the uppermost section of the overtone series where the notes are so to speak indistinguishable, and taken on the basis of fifth relationship the chromatic adjacent note is separated from the fundamental note by seven fifths, and the diatonic semitone neighbor comes at a distance of five fifths from the fundamental. In this way the adjacent chromatic note relations really mean the negation, in the philosophical sense of the word, of the acoustic-tonal order, the greatest possible antithesis to the thesis of tonality.[13]

Another bitonal relationship occurs adjacent to each other in measures 125 to 128. The underlying tonal point at measure 125 is Ab followed in measure 127 by a G tonality immediately returning to Ab. In the final movement, there is a bitonal flavor in the second theme (measure 94) between the Eb major theme against the c^b-minor accompaniment. The "c^b minor" is a mistuned minor triad because the G is used instead of the Gb (Figure 33).

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[13]Karpati, p. 165.

Measure	Tonal Center		
1	E		
14	A	5	
16	B	2	
29	E^b		2
56	a	2	
65	C#		
72	E	3	
89	F		
94	E^b	2	
105	C	3	
106	A	3	8
144	g#	1	
156	D^b	5	

Figure 33. First Quartet-Third Movement. Fibonacci Relationships Formed Between Tonalities in the Exposition.

The F/C relationship that opens the first movement is used also on a large scale level as a unifying element. The tonic-dominant *dux* and *comes* is expected in a contrapuntal texture based on imitation; however, the tonality of the *comes* is the central tonal center at the B section in measure 33. With the tonality of C and the foreshadowed A/a, a Fibonacci value of 3 is formed with a value of 2 being produced with the shift of tonality from C to B^b within the middle section.

In the third movement, two poles and their respective counterpoles are present after the strong cadence in A at measure 16 (b-E and F-B-natural). Both are the fourth so characteristic of pole/counterpole relationships but they are also separated by a semitone.

A pole/counterpole relationship occurs between the tonality of the first theme with that of the second theme (A and E^b). At the second theme (measure 94), there is a bitonal flavor between the established tonal center against the c^b-minor accompaniment where actually the c^b chord is mistuned because of the G rather than the G^b.

The same pole/counterpole relationship is again used in the first part of the Development section. The first violin begins on the dominant note as it did at the beginning of the movement establishing the tonality of A. At measure 129, the viola enters very prominently on the E^b as the closing theme material is slightly developed. A very contrasting section at measure 144 based on the subdominant axis of G# begins with a very tonal or diatonic accompaniment.

The 'Pesante' section is the main portion of the Development. This section exploits the pole/counterpole relationship or bitonal relationships if the reader will permit the author to use this terminology. There is a combination of two bitonalities based on harmonic accompaniment and melody.

The opening bars center primarily around a D^b(C#) tonality thereby emphasizing the A/C# relationship common in this work. At measure 163, a relationship begins on E and A^b in the alternating cello accompaniment. Above this the violin is introducing a bitonal relationship of D and A^b as both poles function as a structural basis for the motive element.

This pattern of two bitonal planes destroys the function of tonality completely because both bitonal groups are separated by a diminished fifth which, as discussed earlier, Bartok used in contrapuntal textures. The tonality becomes even more unstable with the entrance of the second violin. One would analyze the entry in A^b but underneath is a perfect fifth relationship of A^b-D^b and B-E.

The same bitonal idea appears in measure 170 where the first violin enters like the viola line in measure 158 (D^b), but now the stable accompaniment is not underneath because of the continuation of the linear line. The G-C# pattern continues in the second violin in addition to a third bitonal pattern at measure 175 of A^b and E which appears more stable in measure 178-180.

The final entry in the cello centers on the D^b tonality (C#) again which reiterates the G-C# bitonality at measure 185.

At measure 191 the breakdown of these relationships takes place only a little as the music dissipates into a highly constructed contrapuntal passage. At measure 191, the G-C# begins and is answered with a C#-to-G pattern. Beneath this in stretto the same motivic pattern uses a B to F pole/counterpole relationship, imitated again on an inversion of the poles (F to B). Underneath this is a G# to E^b structure which breaks down the bitonality. However, the Eb chord could be considered as a 'mistuned' D-natural thus retaining the bitonal concept only mistuned from G# to D# rather than D-natural. Finally, the last bitonal pattern is in the viola and cellos of D to Ab (G#).

CHAPTER 3

ANALYSIS OF STRING QUARTET NO. 6

At the beginning of each movement in the Sixth Quartet, there is a slow introduction which becomes more developed as each introduction occurs. Research has shown that these introductions were not written immediately at the onset of the Quartet, but were added at a later date.

The Mesto to the first movement, the viola solo is constructed of thirteen measures, thereby establishing a Fibonacci value. The second movement introduction appears to have no Fibonacci formal structure. In the introduction to the Marcia, the introduction builds to a climax in measure 13 and contains 20 measures with measure 21 starting the Burletta. Finally, the fourth movement Mesto contains thematic material which is based on themes from the first movement which is a unifying element. Measures continuing significant musical events having Fibonacci relationships are 13, 22 (21) and 55.

Proportions

Proportions Based on the Number of Measures

Back in Chapter 2, discussion was provided on the two directions that analysis would show in determining the golden mean based on the number of measures. A double relationship occurs in the last movement of the Sixth Quartet, where the number of measures delineate themselves in a manner which corresponds to the Fibonacci series, rounding off the calculations to the next highest whole number. This would exclude the golden mean itself since it falls two measures below the value of 55. In correlation with the numbers, in determining the golden sections based upon the number of seconds and the measure numbers in which the second delineations appear, a Fibonacci series appears with the two highest (the golden mean) falling one number below 55 and 34 of the series (Figure 34).

	Proportions Based on The Number of Seconds		Proportions Based on The Number of Measures
	Seconds	Measure	
G.S.L. 1	210.12	54	53
G.S.L. 2	129.85	33	33
G.S.L. 3	80.24	21	20
G.S.L. 4	49.59	13	13
G.S.L. 5	30.64	8	8
G.S.L. 6	18.94	5	5

Figure 34. Sixth Quartet-Fourth Movement. Relationships Between Proportions Based on The Number of Seconds and The Number of Measures.

In the first movement, the number of measures delineate themselves into 8, 13, 21, and 34 at which point the deviation of two whole numbers occurs and continues to expand. There seems to be some relationship between the lower levels of GS delineation with those Fibonacci numbers which are also small. As the higher levels of GS appear, the Fibonacci numbers do not lie in a direct relationship.

Proportions Based on the Number of Seconds

A correlation occurs between the delineation based on the number of seconds and that of measure numbers in the final movement. This same correlation occurred in the first movement of the First Quartet. In the last movement of the Sixth Quartet, Fibonacci series, measure numbers and seconds delineations occur simultaneously (see Figure 35).

In the second movement, a proportion unit falls at measure 82 (137.49 seconds) which is one measure from the large B section that starts in measure 81. The same happens in the third movement when a proportion at 127.74 seconds appears in measure 69 or 70. At bar 70, the B section begins showing that this proportion delineates a formal section.

Proportions Based on the Number of Eighth-Notes

Proportions based on the number of eighth-notes show some correlation to those proportions based on the Fibonacci series and those based on the number of seconds. In the first movement, more relationship is noticed between proportions based on Fibonacci. These correlations happen in the Exposition of the first movement (Figure 34).

	Proportions Based on the Number of Eighth-Notes		Proportions Based on the Fibonacci Series	
	Eighths	Measure	SN.N. #	Measure
G.S.L. 1	1371	249	89	112
G.S.L. 2	847	165	55	78
G.S.L. 3	524	111	34	57
G.S.L. 4	324	77/78	21	44
G.S.L. 5	200	57	13	36
G.S.L. 6	124	44	8	31
G.S.L. 7	76	36	5	28
G.S.L. 8	47	31/32	3	26
G.S.L. 9	29	27		
G.S.L. 10	18	26		

Figure 35. Sixth Quartet-First Movement. Relationship Between Proportions Based on Eighth-Notes and the Fibonacci Series.

In the second movement, a close relationship is present between eighth-note proportions and proportions based on measure numbers at the measure where each of the two proportions occur (Figure 36).

Proportions Based on The Number of...

	Measures		Eighth-Notes		Seconds	
	Proportion	Measure	Eighths	Measure	Seconds	Measure
G.S.L. 1	107.53	124	871	124	222.48	127
G.S.L. 2	66.45	83	539	84	137.49	82
G.S.L. 3	41.06	58	333	59	84.97	60
G.S.L. 4	25.38	42	206	43	52.51	45
G.S.L. 5	15.68	32	127	33	32.45	34
G.S.L. 6	9.69	27	79	27	20.05	28

Figure 36. Sixth Quartet-Second Movement. Relationship of Proportions Based on Measures, Eighth Notes and Seconds.

Even a more distant relationship appears between the proportion on the number of eighths and proportions based on the number of seconds. It is interesting to add that the calculations based on the number of seconds show close Fibonacci values from 12.39 to 52.51.

In the third movement, one relationship is present between the proportions based on the number of eighth-notes with the proportions based on the number of seconds at measure 70 in both proportion units. At that point, 123.74 seconds falls into measure 70 and the eighth-note proportion occurs with the 397th eighth-note also appearing in measure 70.

In the final movement, the greatest amount of interconnections are present between almost every proportion of every unit of proportional analysis (Figure 37).

Proportions Based on the...

	Number of Measures	Number of Seconds		Number of Eighth-Notes		Fibonacci Series
	Measure	Proportion	Measure	Proportion	Measure	Measure
G.S.L. 1	53.14	210.12	54	347	58	55
G.S.L. 2	32.84	129.85	33	214	36	34
G.S.L. 3	20.29	80.24	21	132	22	21
G.S.L. 4	12.54	49.59	13	82	14	13
G.S.L. 5	7.75	30.64	8	51	9	8
G.S.L. 6	4.79	18.94	5	31	6	5
G.S.L. 7	2.96	---	-	19	4	3
G.S.L. 8	1.82	---	-	12	2	1

Figure 37. Sixth Quartet-Fourth Movement. Proportional Relationship Between All Four Means of Proportion Analysis.

It can be seen that a Fibonacci relationship forms between measures based on proportions calculated on the number of eighth-notes from measures 4 to 22 (Figure 38).

Measure	4	6	9	14	22
Fibonacci Value	2	3	5	8	

Figure 38. Sixth Quartet-Fourth Movement. Fibonacci Relationship Between Measures Based on the Number of Eighth-Notes.

Proportions Based on the Fibonacci Series

In the first movement, each large formal section can be broken down into a Fibonacci series pattern. The Exposition consisting of 134 measures contains musical events of significance up to number 89 in the series. The Development's 129 measures in length, is divided into two sections. The first section has musical events up to 55 while the second section up to 89 totals to 144. The Recapitulation, 176 measures in length, has events occurring up through 34 in the series while the subordinate theme uses series numbers up to 21. The Coda of the first movement also utilizes the series number 21.

Harmonic and Pitch Structures at GS Levels

Structured Chords

The appearance of the four-note structure is very common in the Sixth Quartet. As with the First Quartet, the linear aspect proves to create a challenge in the alignment of vertical pitch patterns, with many non-harmonic tones being found in the majority of the GS levels.

Four complete four-note chords are found in the first movement. Two of the three chords occur on a passing chord or are based upon a non-harmonic tone. The four-note chord in measure 30 is mistuned, B-D-F#-A#; measure 44 is also mistuned with the enharmonic major seventh included, C#-E#-G#-C-natural. The vast amount of four-note chords falls into the altered form of the chord.

Altered four-note chords occur primarily in measures which are part of the Fibonacci series. In measure 28 (SN 5), the g in the viola and the G# in the cello are non-harmonic. On the second beat an altered and mistuned chord appears (A#-C-D-A-natural). The C-D major second are the altered notes just as the same relationship occurs in measure 36 (SN 13) between the F#-G# in another altered/ mistuned chord (B#-F#-G#-B-natural). In measure 57 (SN 21) a few altered chords occur because they fall on non-harmonic points. The two inner voices have G-B which in traditional harmony would be a suspension over the bass resolving on the second eighth note forming a complete four-note chord on D (D-F#-A-C#). The third eighth-note again has a non-harmonic function since the two inner voices are now a step below the complete chord. On the second part of the bar, the d in the cello resolves to a G (dominant-tonic) but this note moves to a G# (leading-tone function). Enharmonically, the fifth eight-note chord would be a Db Major in second inversion with the A in the cello functioning as a non-harmonic tone.

In measure 165 (SN 8) a six-note chord appears spelled D-G-C#-F-Bb-Eb. In the lower three notes a major seventh is outlined with a perfect fourth in the middle. Other altered four-note chords all appear in a Fibonacci series in measures 191, 212, 234, 268, 287, 319, 365 and 383.

Fourth Chords

In the first movement of the Sixth Quartet, three fourth chords are found. The first fourth-chord appears in measure 31 (SN 8) by reordering the three ascending notes before the high d^3. The pitches $g\#^1$-C#-d^2 originally constitute a perfect fourth and minor second but when reordered produce D-G#-C#. In the next series number, which would be 13 (measure 36), an enharmonic fourth-chord is found within a four-note structure, if one were to consider the G# which enters later in that measure. The sustained pitches from the viola upwards, f#-b#-b^1 natural is a fourth chord. The f# in the viola when displaced an octave higher produces the closed structure of this chord. The b# would be considered as C-natural thereby allowing the perfect fourth to occur.

Another structure based on C-F#-B appears on the very first eighth-note in measure 187 (SN 8 of the overlapping Fibonacci series in the Development). The pitches would be reordered to produce the desired structure.

Other Seventh Structures

In the first movement, four minor sevenths are complete chords (either mistuned or altered) while the remainder are incomplete or altered. As mentioned earlier, the breakdown of the minor seventh structure into the four types of chords which was used in the four-note chord structure will not be used here; however, mention needs to be made on some of the inner voice structures which take place between the minor-seventh frame.

In the second movement, two minor seventh chords are present at golden section levels which happen to be in complete fashion.

In the third movement, at measure 52 there is harmonic parallelism that when combined to form vertical structures creates different inner voice combinations within the minor seventh frame. Independent from minor sevenths are quartal chords which are found here in addition to a linear contraction of interval size. Two sets of dyads can be pointed out here. First, the regrouping of the four pitches in the two violins form the minor-seventh outline (Figure 39).

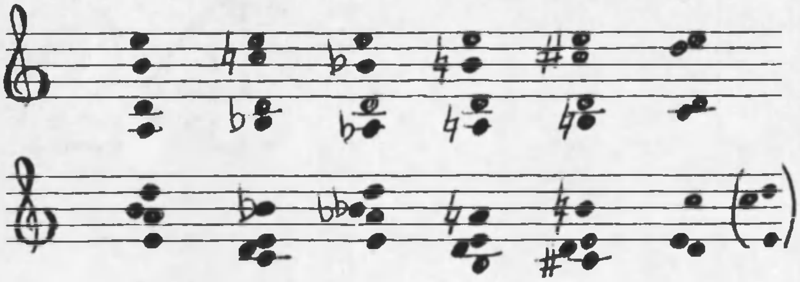


Figure 39. Sixth Quartet-Third Movement. Harmonic Parallelism Which Forms Minor Seventh Vertical Structures.

Note that the two inner voices form a major-second dyad. These can be regrouped to form a dyad which is reiterated on the notes D-E with another dyad moving underneath it (Figure 40).

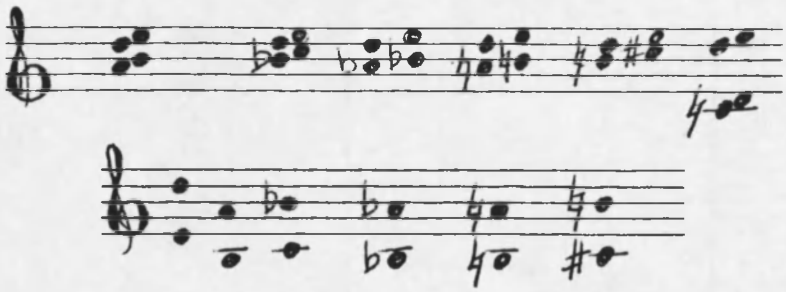


Figure 40. Sixth Quartet-Third Movement.
Re-Ordering of Harmonic Parallelism in Measure 52
to Showing Dyads.

The top dyad is an inverted minor seventh as well as the moving dyads which accompany it.

Fibonacci Pitch Structures at Proportional Points

As we discovered in the presentation of Fibonacci pitch structures in the First Quartet, the majority of structures appeared in the first movement with a decrease as the quartet continued to the last movement. The same pattern is found in the Sixth Quartet.

Looking at the Exposition, series number 5 (measure 28), a reordering of the four pitches D-E-G-A#, form a 2 + 3 + 3 = 8. The second vertical alignment occurs in SN 34 (measure 57) on the first eighth-note regrouped, B-C#-D-G forming a 2 + 1 + 5 = 8. In the Development's first section (measure 158-179 where the second section enters and overlaps the Fibonacci series which originated in measure 158); SN 34 (measure 191) has a linear as well as a vertical occurrence. The G-D#, on the fifth eighth-note, forms 8 in the series as the descending pattern E-D#-C# forms 1 + 2 = 3.

With the overlap of the second Fibonacci numerical series starting in measure 180 of the Development, measure 182, SN 3, produces another linear pattern now in ascending fashion from the pattern in measure 191 and transposed down one-half step, C-D^{b}-E^{b} which is 1 + 2 = 3. Measure 184, SN 5, has the same pattern as in measure 191 (SN 34).

SN 21 (measure 200), the first half of the measure can be aligned to form a 5 + 3 = 8 between the viola and the cello. The number value of 5 is formed from the viola's a#^{1}-e#^{1} and the value 3 from the cello, f-double-sharp-a-g-natural. Two separate patterns occur in the remainder of that measure. G-E form value 8 and B-C-D form 3. All four-notes in the viola, if considered as two separate individual structures, can equal 13.

In the Recapitulation, measure 307, SN 21, the open fifths in both outer voices combined form a 3 + 2 + 3 = 8. The first chord is regrouped, C-E^{b}-F-A^{b} as is the next chord, A-C-D-F.

Within the Burletta, numerous vertical appearances of Fibonacci pitch structures occur within a relatively short time span and are at Fibonacci series points. Beginning with SN 3 (measure 23) two independent structures totalling 8 appear on the full-sounding chords. The first is reordered to form the pattern, A^{b}-B-D^{b}-E which is 3 + 2 + 3 = 8 and the second reordered A^{b}-B^{b}-D^{b}-E which forms a 2 + 3 + 3 = 8. In the second, the B-natural is altered to B^{b}.
In SN 5 (measure 25) the major-minor sonority in the viola-cello

on E can be put into first inversion thereby creating a Fibonacci pitch structure of 3 + 3 + 2 = 8.

Several vertical Fibonacci pitch structures occur at proportional points which were determined by the number of seconds. The most interesting of those few is in measure 29. They are of special interest because the Fibonacci patterns are formed by combining notes from the melody and the accompaniment instead of looking at just the melody as opposed to the accompaniment (Figure 41).

Figure 41. Sixth Quartet-Third Movement. Burletta - Measure 29. Fibonacci Structures at a GS Level.

Fewer occurrences of Fibonacci pitch structures are found in the final movement: one at a Fibonacci series level and the remainder at proportion levels based on the number of measures. A vertical structure occurs in measure 5 which is also SN 5 on the third eighth-note. Reordered, the four notes are E#-E-F#-A which forms a 3 + 2 + 3 = 8.

Golden Section Levels and Form

In the Sixth Quartet, several golden section levels appear one measure prior to or after a larger formal section. Fewer formal sections fall in direct alignment with those golden section levels, using the different methods of proportional analysis.

In the first movement, GS level 6 in proportions based on the number of measures appears at the beginning of the Transition. This exact occurrence also is found when proportion is based on the number of eighth-notes. In addition to this, the second theme begins on GS level 4 in the same proportional unit of eighth-notes. There seems to be more relation between GS levels and formal sections when looking at the use of the Fibonacci series. The Exposition begins at GS 1, the first section of the Development at GS 1 (m. 158) and the second section of the Development at GS level 1 (m. 180) keeping in mind that the Fibonacci Series begins over with each new large formal section.

In the second movement, the proportions based on the number of measures does not necessarily delineate large formal sections but they tend to delineate texture in addition to thematic material.

The most common occurrence between GS levels and form is at measure 70 in the Third movement which begins the large B section. Proportions based on measures has a GS level 1 at measure 71, one measure from the beginning of the B section while the proportions of seconds falls right at measure 70 with GS level 1 as well as proportions of eighth-notes.

Role of Tonal Centers

In the first movement (again, excluding the Introduction) the tonality begins in d minor moving to F at the second theme forming a Fibonacci value of 3. The Development at measure 158 settles upon no definite feeling of tonality because of its contrapuntal texture; of the principal theme in augmentation, however, just as the first appearance of the principal theme began with the A to D notes which helps to define the tonality of D, then the Eb-Ab pattern at measure 158 would place the tonality in Ab. The Ab tonality here is the tonic substitution for D as well as its counterpole on the axis system. Immediately upon the change in tempo in measure 166, the tonal center has shifted to G minor, a subdominant axis to D. Its counterpole of C# was prominent in the concluding measure of the second theme in measure 98.

Measure 180 to 193 prove to be most interesting. There are two layers of staggered ostinatos. Both contain the same pitches (except one) but in inversion and in retrograde to each other (Figure 42).

Figure 42. Sixth Quartet-First Movement. Layered Ostinatos-Measures 180-193.

Reiteration of the notes B and F form a bitonal function which is also a symmetrical formation. Not only are the two centers a diminished fifth apart but they are counterpoles on the axis-system. Tonal levels which are a diminished fifth apart are a characteristic technique of Bartok. Here in measure 180, the ostinato pattern starts as the developed thematic idea begins in measure 182, resolving on F as the 2nd violin begins in measure 184 and ends the phrase on B. What we have here is a tonic substitution for the developed appearance of the theme. The tonality of D is substituted by a tonic pole/counterpole relationship of B and F. A similar bitonal relationship is in measure 276 and on where the D-G# tonalities are combined forming a "non-thematic" section leading to the recapitulation. Here the original tonic is used with its counterpole. These examples are proof that the polytonal concept was used by Bartok.

In the first movement, a rise in tension is created by the pole/counterpole relationship. The Exposition begins in D moving to Ab at the Development and descends again to D at the Recapitulation. The tension can be considered elevated when the coda begins on the subdominant of G and concludes on the tonic of D but now in the parallel major tonality.

The second movement incorporates a traditional tonal relationship of tonic to dominant but one difference here is that the counterpole of the dominant is used instead of the principal dominant of F#.

The last movement, which is a culmination of previous material, still develops further. The main tonal centers are again the D and F (measures 46 and 55, respectively). The opening structure is a three-note chord, A-C-E. The three pitches unify the opening portion because E is predominate at measure 8 and C at measure 13; both shifts in tonality occur at a Fibonacci value as well. The counterpole to D(G#) begins in measure 22 with a unison pattern at a louder dynamic than the preceding section. Prior to the return of the first movement's principal theme at measure 46, in D, the "piu andante" in measure 40 has an interesting tonal pattern (Figure 43).

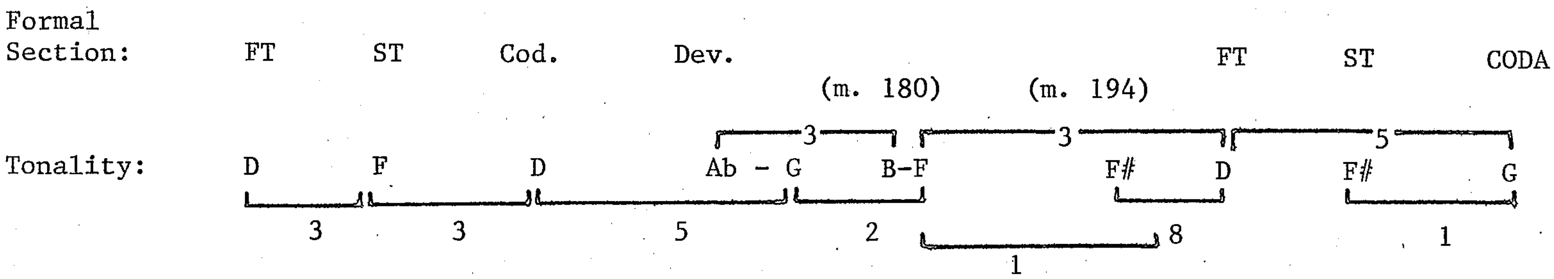
Measure	40	41	42	43	44	45	46
Tonality	E	A	Bb	B	Eb-A	(Eb)	D
Axis	T	D	S	S	D	(D)	T

Figure 43. Sixth Quartet-Fourth Movement. Symmetry of Tonal Centers and the Axis-System.

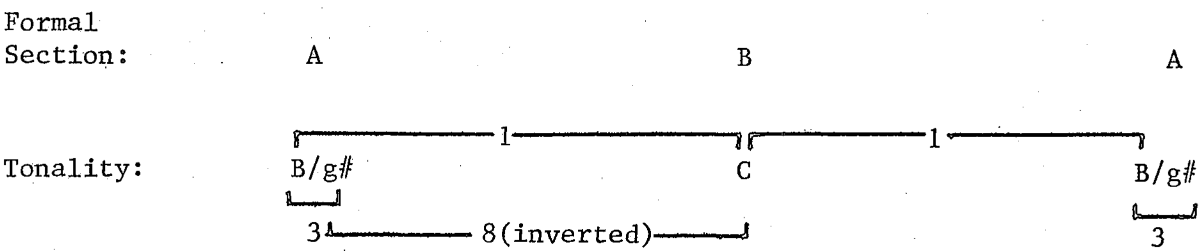
These axis form a tonal symmetry pattern in themselves with two tonic poles followed by two dominant and at the mid-point, two subdominant structured chords.

Fibonacci values also occur between tonal centers in the first movement and among the remaining three movements. Only principal tonalities have been listed (Figure 44).

First Movement



Second Movement



Third Movement

Formal Section:	A				B		A		
Measure:	30	46	51	55	70	102	107	123	153
Tonality:	E – c#	G	F	G	D/A	E	C#	G	F

Fibonacci spans: E–c# 3; c#–G 5 (inverted); G–F 2; F–G 2 | D/A–E 5; E–C# 3; C#–G 5 (inverted); G–F 2

Fourth Movement

Measure:	1	3	5	9	13	22	46	55	70	79
Tonality	A	f#	B	E	C	G#	D	F	G	D/F

Fibonacci spans: A–f# 3; f#–B 5; B–E 5; E–C 8; C–G# 8; A–B 2; f#–E 2 | D–F 3; F–G 2; G–D/F 5; D–G 5; G–D/F 2

Figure 44. Sixth Quartet. Principal Tonal Centers and Fibonacci Relationships.

CHAPTER 4

CONCLUSIONS

The study of harmonic structures and pitch patterns and the role they play in relation to proportion is a new approach to the music of Bela Bartok. To date, individual surveys have been completed in these two elements of music as separate analytical topics. As suggested in the Introduction, the purpose of this paper is to bring together the two elements of harmony and proportion.

In order to accomplish this task of making comparisons and making conclusions, each entity of harmony and proportion will be discussed separately.

Relationship Based on Proportions

Each type of proportional analysis showed its own relationship to the Fibonacci series, relationship to other proportion units and its function in determining formal sections. Each method of proportional analysis produced its own results but similarities can be found among the four approaches. Similarity occurs between one method of proportional analysis and another, more specifically between lower level golden section divisions.

In the First Quartet, several similarities between proportion units were determined. The first movement shows correlation between golden section levels of seconds with measures and eighth-notes with seconds. The second movement and the third movement show relationships between measure numbers and the Fibonacci series in addition to eighth-note with seconds. Based on these findings, there tends to be a greater amount of relationship between golden section levels based on eighth-notes with those based on the number of seconds.

The Sixth Quartet shows a larger amount of connection between proportion units and their levels of GS division. The relationship of eighth-notes with seconds is only hinted at in the Sixth Quartet. It seems to be overridden by a correlation between eighth-notes with the remaining three other units. The first movement has relationship between measures and the Fibonacci series, eighths and Fibonacci and some has relationship with eighth-notes and seconds. The second movement uses one relationship between eighth-notes and measure numbers with the eighth-notes to second correlation again being slight. The third movement has seconds with measures, eighth-notes with Fibonacci series and Fibonacci series with measures and seconds with again our slight relationship between eighth-notes and seconds.

In comparing the two Quartets, the main point of interest is the continual pattern of levels which are related between the number of eighth-notes with those of the number of seconds. The First Quartet has a larger number of relationships which tend to decline compared to that of the Sixth Quartet.

Proportion and Formal Delineations

The golden section subdivisions of the golden mean into the subsequent lower levels had some influence on formal delineation.

These lower levels present themselves at places where formal sections began or concluded, be it major formal sections or smaller divisions of a larger section. In some instances, a few GS levels were extremely close to formal delineation points by one or two measures.

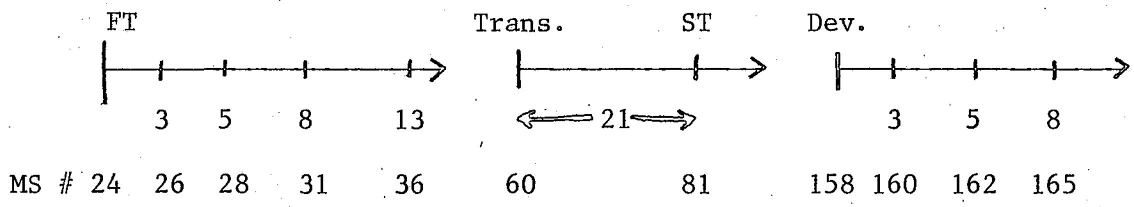
The First Quartet seemed to employ the Fibonacci series as a means of breaking down formal sections (see Figures 14 and 16). Even more specifically, between certain measures a Fibonacci number appeared. A change in texture or timbre may have been the determining factor for this appearance of the Fibonacci patterns.

The Sixth Quartet had some golden section levels delineate sections of greater length. As with the First Quartet, the Sixth Quartet consists of sections (measures) which group themselves according to Fibonacci patterns (see Figure 44).

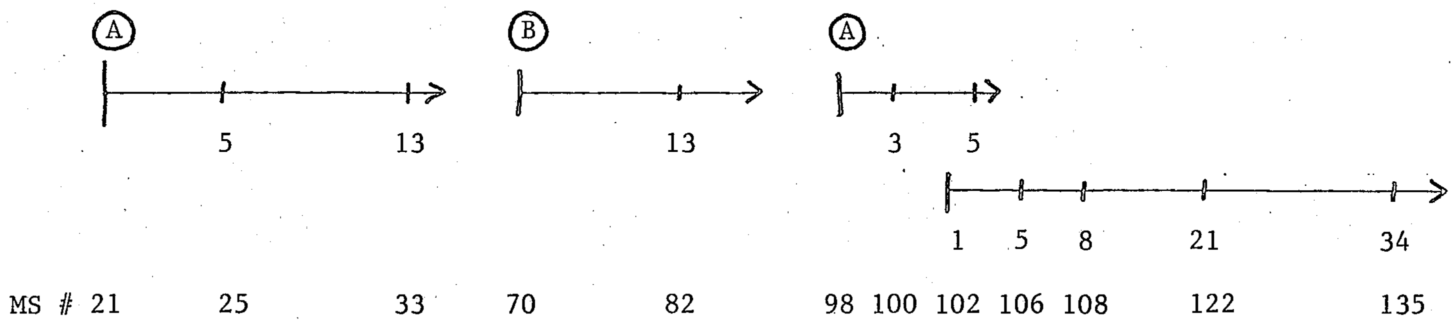
It therefore seems that textural and timbral, in addition to thematic, sections can be delineated by the Fibonacci series based on measures between these musical events. There are more occurrences of this type of relationship than that of proportional unit levels correlating with formal sections.

First Movement

Exposition



Third Movement



Fourth Movement

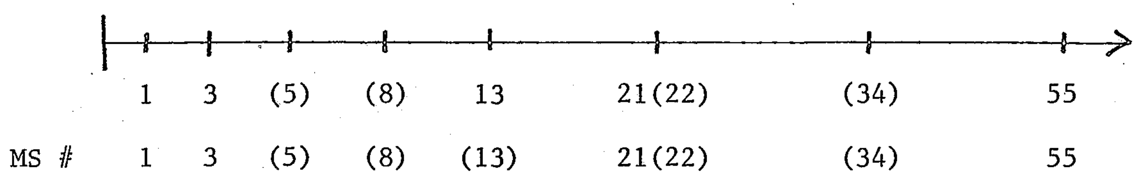


Figure 45. Sixth Quartet. Fibonacci Patterns Within Formal Section.

Harmony

In recent years, the theories established by Erno Lendvai have been the basis for analysis of Bartok's music and researchers have relied heavily upon these theories. In this study the facts reported support Lendvai's theories to a certain extent. It was learned that some chordal structures were founded on the laws of golden section and the Fibonacci Series. It was also learned that the few appearances of the "major-minor" chords (alpha, beta, gamma, delta and epsilon) contained Fibonacci patterns.

In looking at chordal structures appearing at golden section levels, it was discovered that certain arrangements of the pitches would yield a "new" chordal structure not cited by Lendvai. The four-note chord containing the major-seventh structure with its variants was a common recurring element.

Whether it is coincidental or not, the major-seventh quality may be a variant of the so called "major-minor" chord. Even though the minor seventh is written as such, it could be considered enharmonically, as a major seventh as the third note in the "major-minor" could be considered a mistuned note, creating a substitution for the "major-minor" structure (Figure 46).

Figure 46. The "Major-Minor" Chord as an Enharmonic Major Seventh Chord.

The minor-seventh structure has its foundation in the harmonic or overtone series. The minor-seventh would be an overtone over the fundamental note of the structure. In the overtone series, the complete minor-seventh chords occur with numbers 4, 5, 6, and 7 of the series.

Fibonacci Structures Within Harmonic Limitations

Another proven theory of Lendvai is the use of the Fibonacci series in vertical structures. In the First Quartet, chords comprised of Fibonacci numbers appeared more frequently at GS levels determined by the total number of measures. Lendvai discusses the Fibonacci series relating to the chromatic system of works by Bartok, but makes no connection between their occurrence at a proportion level. For example, Lendvai discusses the successive hierarchy of harmony from the principal theme to the closing theme in the Sonata for Two Pianos and Percussion.[14] No discussion is made as to whether the occurrence of these Fibonacci patterns bears a relationship to the location of their appearance. He says the principal theme (beginning in measure 35) has a 2 + 3 + 2 order but what is the significance of measure 35? Does measure 35 have a proportional unit function? If one were to answer these questions, one would have to complete an analysis of proportions to see if indeed measure 35 is proportionally significant.

In considering the types of Fibonacci structures (alpha, beta, gamma, delta and epsilon) it was learned that these particular

[14]Lendvai, p. 38.

structures were practically non-existant at GS levels. This fact brings up a discrepency between Lendvai and this study. Lendvai has this to say concerning these structures: "This type occurs as frequently in Bartok's music as do the seventh-chords in nineteenth-century music."[15]

In his book, the examples cited which contain these kinds of structures are numerous with the earliest example being from the year 1914, The Wooden Prince (1914-16), and the 15 Hungarian Peasant Songs (1914-17). If these are the representative examples in all of Bartok's works, then it could be assumed that the importance of the type of "major-minor" chords did not materialize until around the year 1914. This assumption would be relatively false since some "major-minor" variants were analyzed in the First Quartet. Whether Mr. Lendvai reordered the pitches or not, in looking at the examples in his book, he found these structures clearly in the music. Here the issue arises as whether or not pitches should be regrouped in order to form Fibonacci variants.

If Lendvai says that these are frequent, then he probably is referring to the later works rather than the earlier ones, since the majority of examples cited in his book are after the year 1921.

In the Sixth Quartet, which would fall into this time period with the examples cited in Lendvai's book, there are four "major-minor" chord variants at GS levels in relation to the First Quartet which has only one gamma chord.

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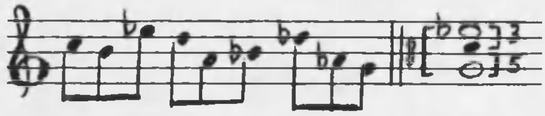
[15] Lendvai, p. 42.

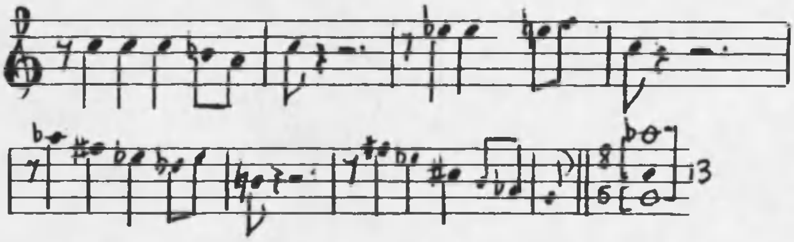
If these types of "major-minor" structures are common, then one should expect to find numerous examples, especially in the final Quartet.

Let us now turn the discussion of Fibonacci relationships towards melodic events. In Lendvai's book, several examples of melodies and themes incorporating Fibonacci values from other Bartok works are analyzed. One example cited from Bartok's music is from the first movement of the Sonata for Two Pianos and Percussion. The Leitmotif is constructed on a 3 + 5 = 8 Fibonacci value with the principal theme on a 5 + 8 = 13 and the secondary theme on 13 and 21 (Figure 47).

Leitmotif



Principal theme



Secondary theme

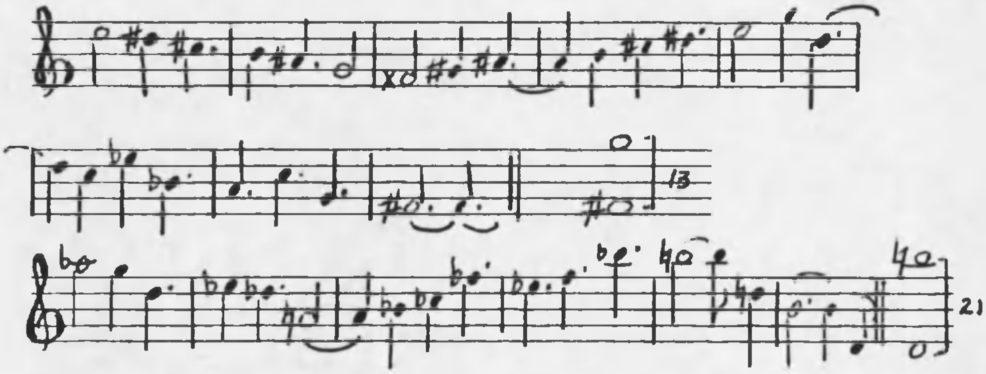
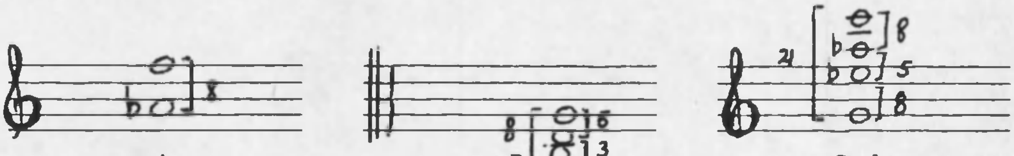


Figure 47. Bartok: Sonata for Two Pianos and Percussion. Fibonacci Values in Thematic Material.

In the First Quartet, the first interval heard is the minor sixth before the second violin enters with the same thematic idea, upon which the clearness of the theme and its imitation becomes confused. If one takes the primary interval of the minor sixth, a Fibonacci value of 8 is formed. The second section has the viola beginning the thematic idea starting on e to an a and down to the lowest pitch of c#. The three-notes form another Fibonacci value of 8 which can be broken down into a 3 + 5 = 8 value.

Finally, the Coda (measure 67) forms the highest level of GS order based on the first violin. The three pitches or thematic structure forms a value of 21 (Figure 48).



A m. 1 | B m. 33-34 | Coda m. 67

Figure 48. First Quartet-First Movement. Hierarchy of GS Order Between Formal Sections.

In the second movement, the principal theme contains some Fibonacci values. The opening second violin phrase itself contains no Fibonacci values but in measure 25 beginning with the g-natural to the Bb or in measure 27 if the A-natural could be considered an appoggiatura resolving upwards. Another Fibonacci value appears in the Recapitulation of the Second theme (measure 217).

In the Sixth Quartet, numerous examples of thematic material show Fibonacci values. The Mesto Introduction contains numerous values (Figure 49).

Figure 49. Sixth Quartet-Mesto. Thematic Material Showing Fibonacci Value.

The principal theme is constructed of Fibonacci values (Figure 50).

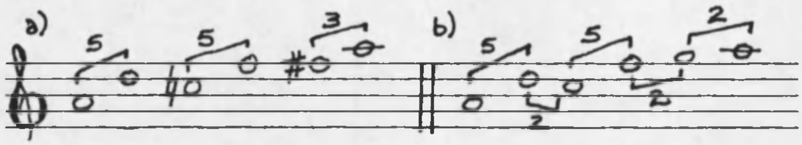


Figure 50. Sixth Quartet-First Movement, Principal Theme. Thematic Material Showing Fibonacci Values.

Even the pentatonic structure of this same theme has Fibonacci values (Figure 50b).

The same theme in measure 24 has no Fibonacci values, but the mistuned second violin entry contains a value of 13 (A to A#).

The second theme shows a whole-tone scale in descending and ascending contour. The whole-tone scale is determined by GS order based on 2 + 2 + 2.

The Mesto to the Marcia has fewer Fibonacci values than the opening Mesto (Figure 51).

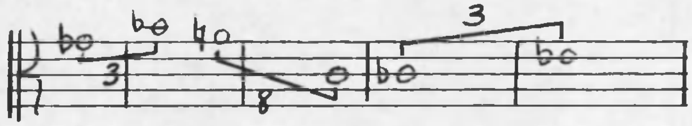


Figure 51. Sixth Quartet-Mesto to the Marcia. Thematic Material Showing Fibonacci Values.

The Marcia itself has a 5, 3 and 3 value within the opening two-and-a-half bars (Figure 52).

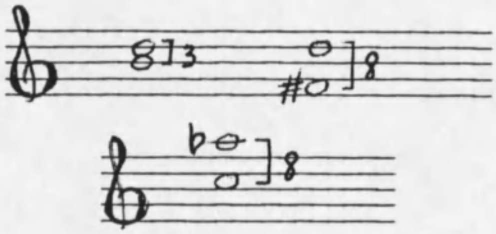


Figure 52. Sixth Quartet-Marcia. Thematic Material Showing Fibonacci Values.

The Burletta contains numerous Fibonacci values which primarily are 3 in value because of the folk-influence (Figure 53).

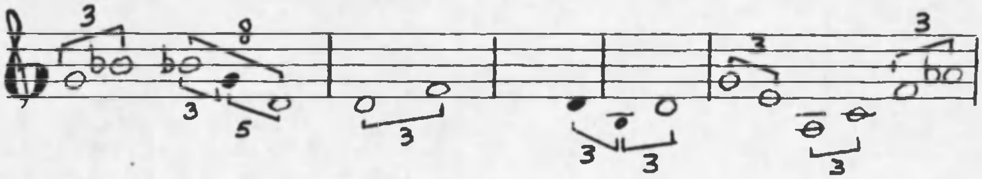


Figure 53. Sixth Quartet-Burletta. Thematic Material Showing Fibonacci Values.

Further Study

During the course of this study, numerous avenues of inquiry appeared which could not possibly be dealt with in the body of this paper. In each movement of the First and Sixth Quartets, the GS levels were determined and the harmonic structures analyzed. One possible topic which would entail further research concerns the expansion and contraction of pitch patterns and how they pertain to golden section proportion. If one were to trace this possibility, it might be discovered that the size between pitches in a structure bears some relation to the GS level. For example, as the levels descend from the golden mean, the intervallic size may become smaller.

Considering pitch patterns in connection with the golden section, another possible facet of further study could be the relationship of pitches to the axis-system. Possibly the pitches in a particular vertical structure may be the very same pitches found in the subdominant axis. This may have a relationship with another vertical structure appearing at a climactic episode whose pitches fall into the tonic axis-system thereby creating a release in tension in moving from the subdominant to the tonic axis-system.

In the same line of thought, analysis of the pitch patterns and harmonic structures may or may not show symmetrical characteristics. This type of study could be a branch from Colin Mason's article concerning symmetry in Bartok's Fourth Quartet. In fact, some of the harmonic structures did show symmetry in which the tone or tones of symmetry had relationships to the axis-system.

An obvious continuation of this same study could apply to the remaining four string quartets. Would the methods of analysis used in this study be applicable to the remainder of the string quartets? All Six Quartets could be analyzed according to these types of proportional and harmonic analysis. A large scale comparison could be made on proportion and harmonic structures as separate entities and then combined. The progressing complexity or evolution of harmonic structures could be traced from 1909 through 1939.

Tables

The following tables summarize the entire project and show a graphic representation of proportion units, one complete table for each unit of proportion analysis for each movement of the First and Sixth Quartets. To accomplish a visual model which would express harmonic structures appearing at various GS levels, the author has designed a standard form. Utilizing a horizontal line and dividing the line into golden section proportion, the golden mean and the subsequent lower levels can be plotted accordingly. To label each golden proportion, every level beginning with the golden mean is numbered from 1 to 9. The symbol used to make reference to the tables when discussing a specific level is the G.S.L. (Golden Section Level) followed by the appropriate numerical value.

Those proportions whose G.S.L. value does not reach up to G.S.L. 9, the final G.S.L. is so indicated on the table showing the final level of proportion within a particular movement. The tables showing Fibonacci relationships based on the number of measures is also constructed on golden proportion.

On the left of each table is a constant sequence of harmonic structures used in the body of this paper as the basis for harmonic analysis. They are abbreviated on each table. The detailed abbreviations are as follows:

Classification	Abbreviation
Four-Note Chords	
Complete	C
Altered	A
Mistuned	M
Incomplete	I
Fourth Chords	F.C.
Seventh Chords	
Minor Seventh Structures	m7
Other Seventh Structures	07
Triad Structures	T
Fibonacci Structures (containing Fibonacci Series)	F.S.
Fibonacci Structure Variants (includes beta, gamma, delta, epsilon, alpha)	F.S.V.
Other	O

Each specific harmonic structure is identified by an "x" at the proper proportion level. Those harmonic structures which do not fall into a classification previously established will be indicated by an "x" in the "Other" classification.

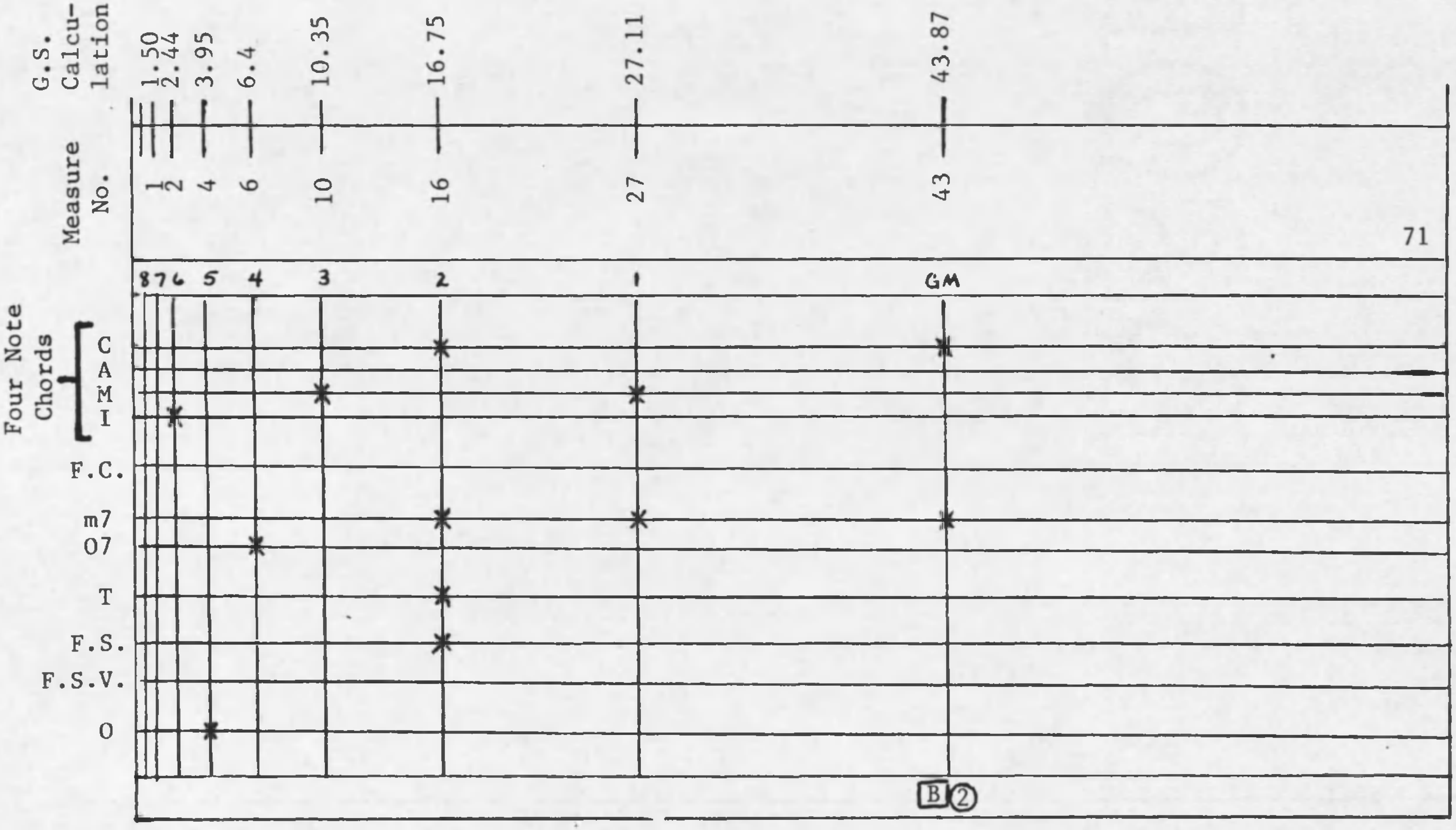


Figure 54. First Quartet-First Movement.
Proportions Based on Measures.

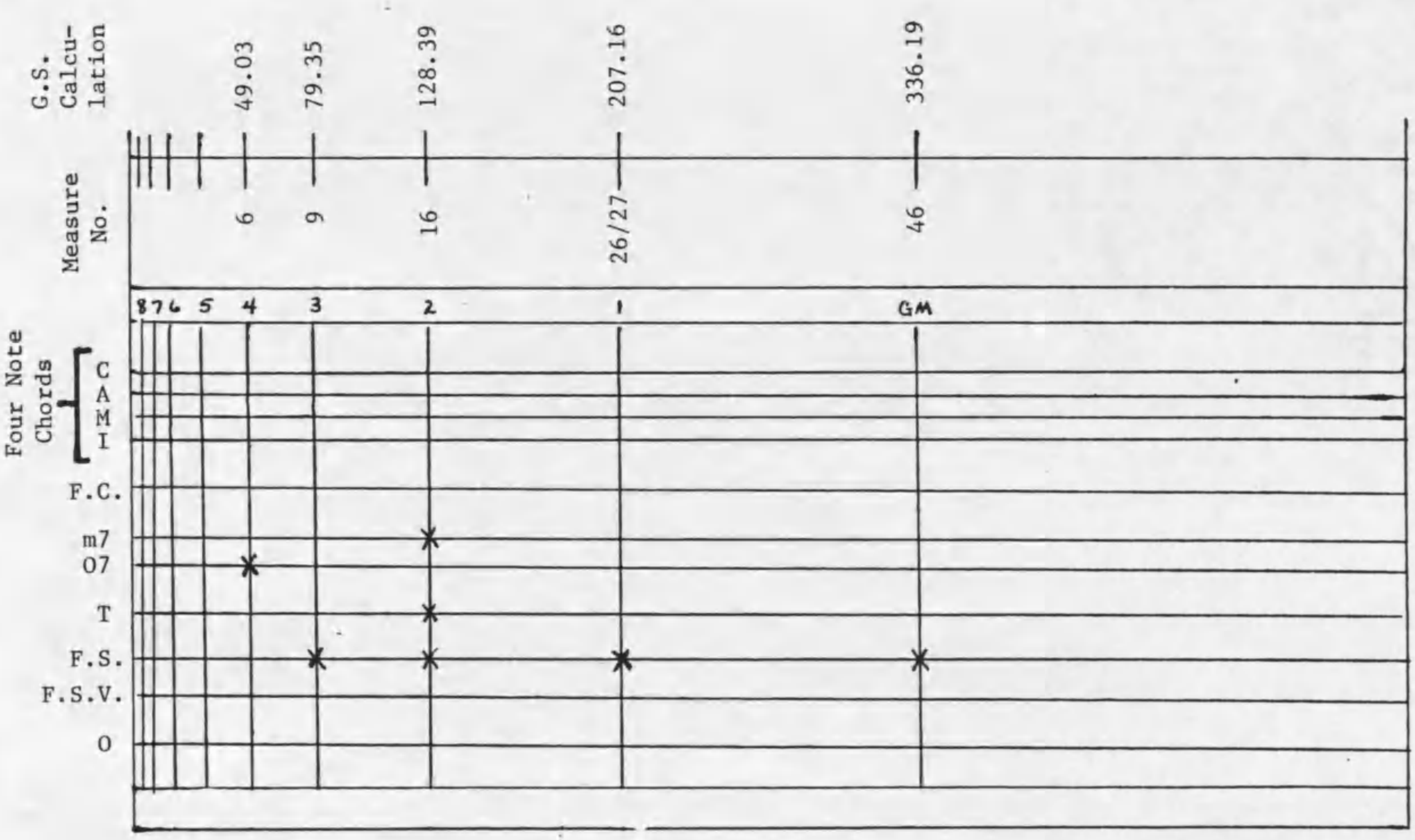


Figure 55. First Quartet-First Movement.
Proportions Based on Seconds.

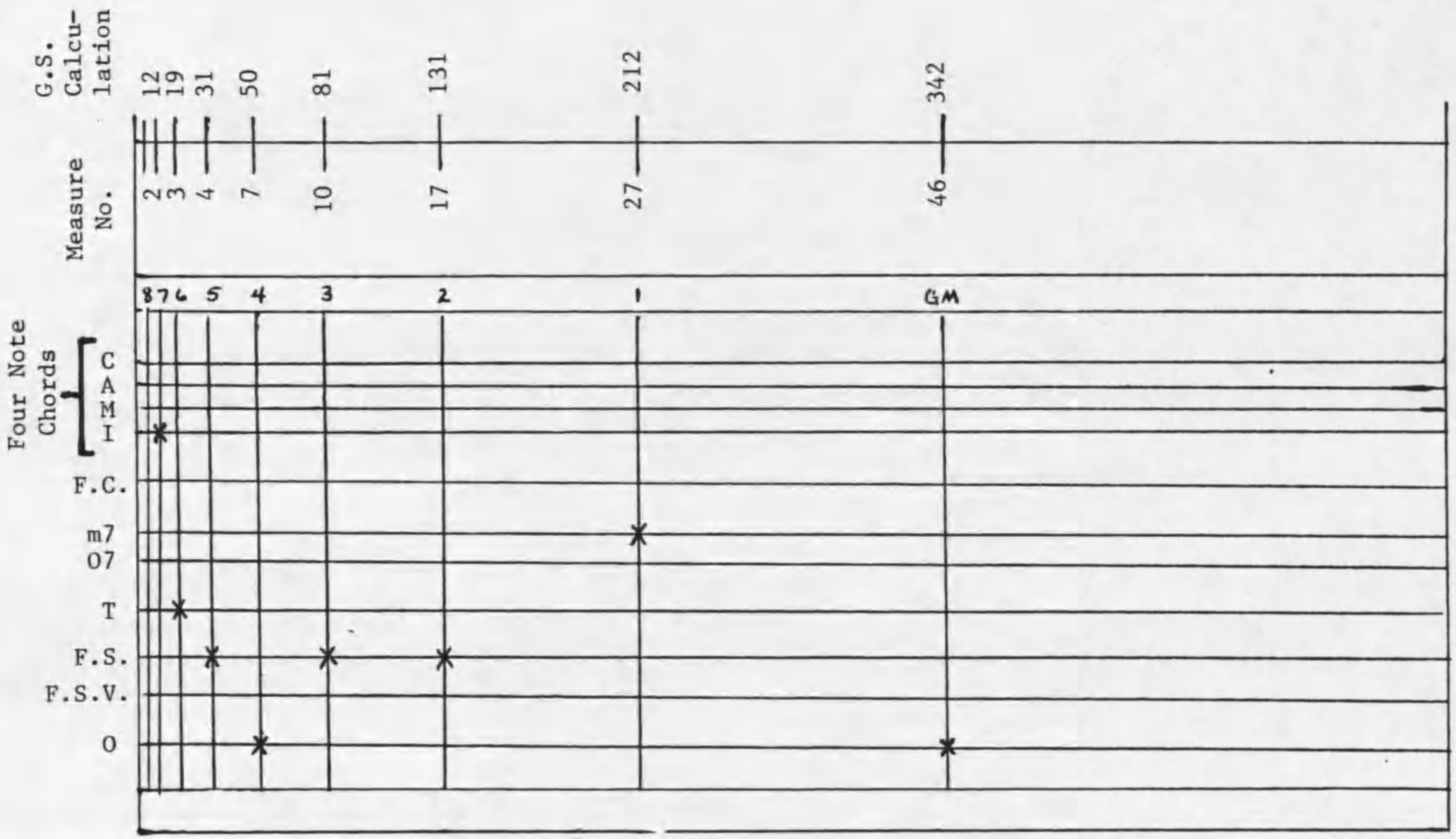


Figure 56. First Quartet-First Movement.
Proportions Based on Eighth-Notes.

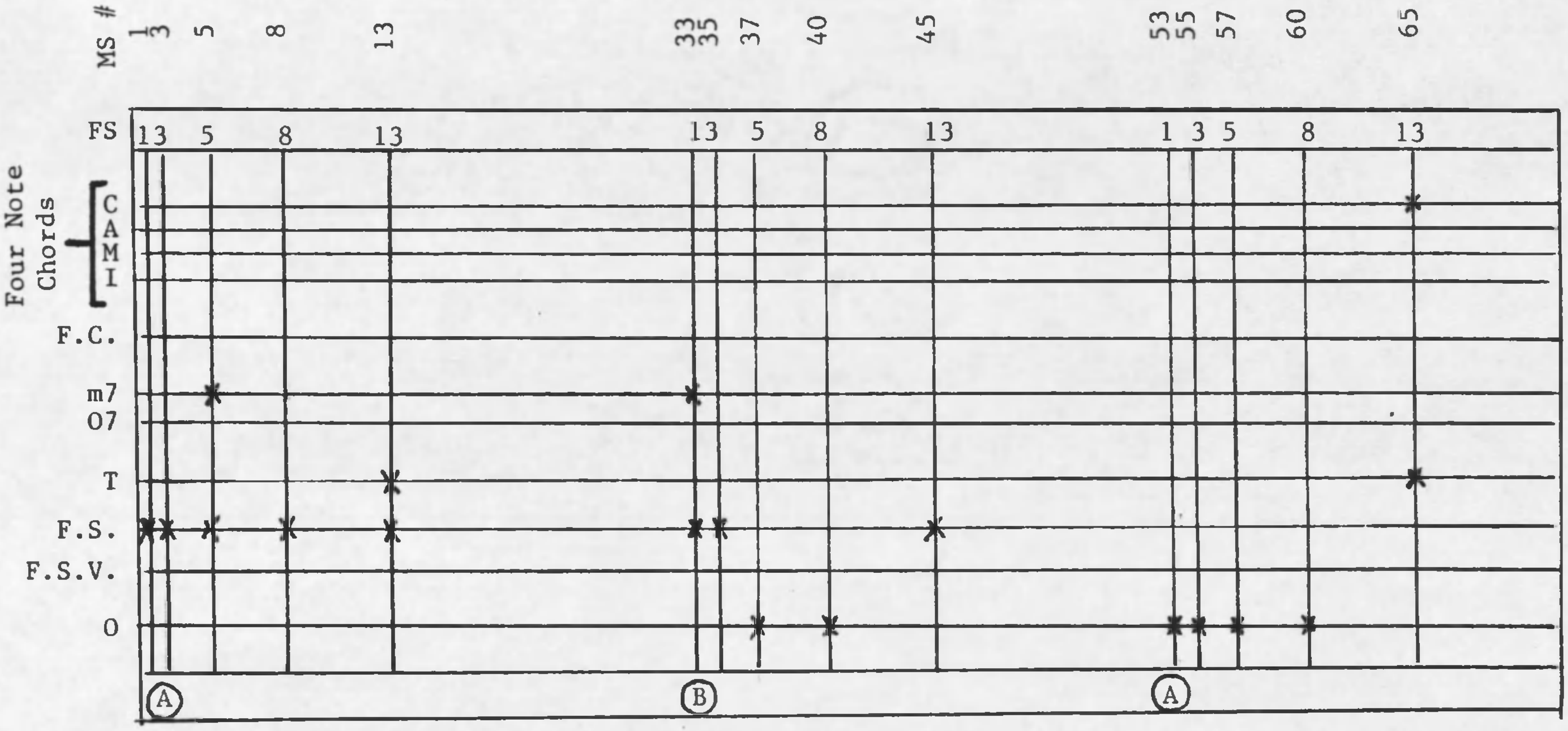


Figure 57. First Quaret-First Movement.
Proportions Based on the Fibonacci Series.

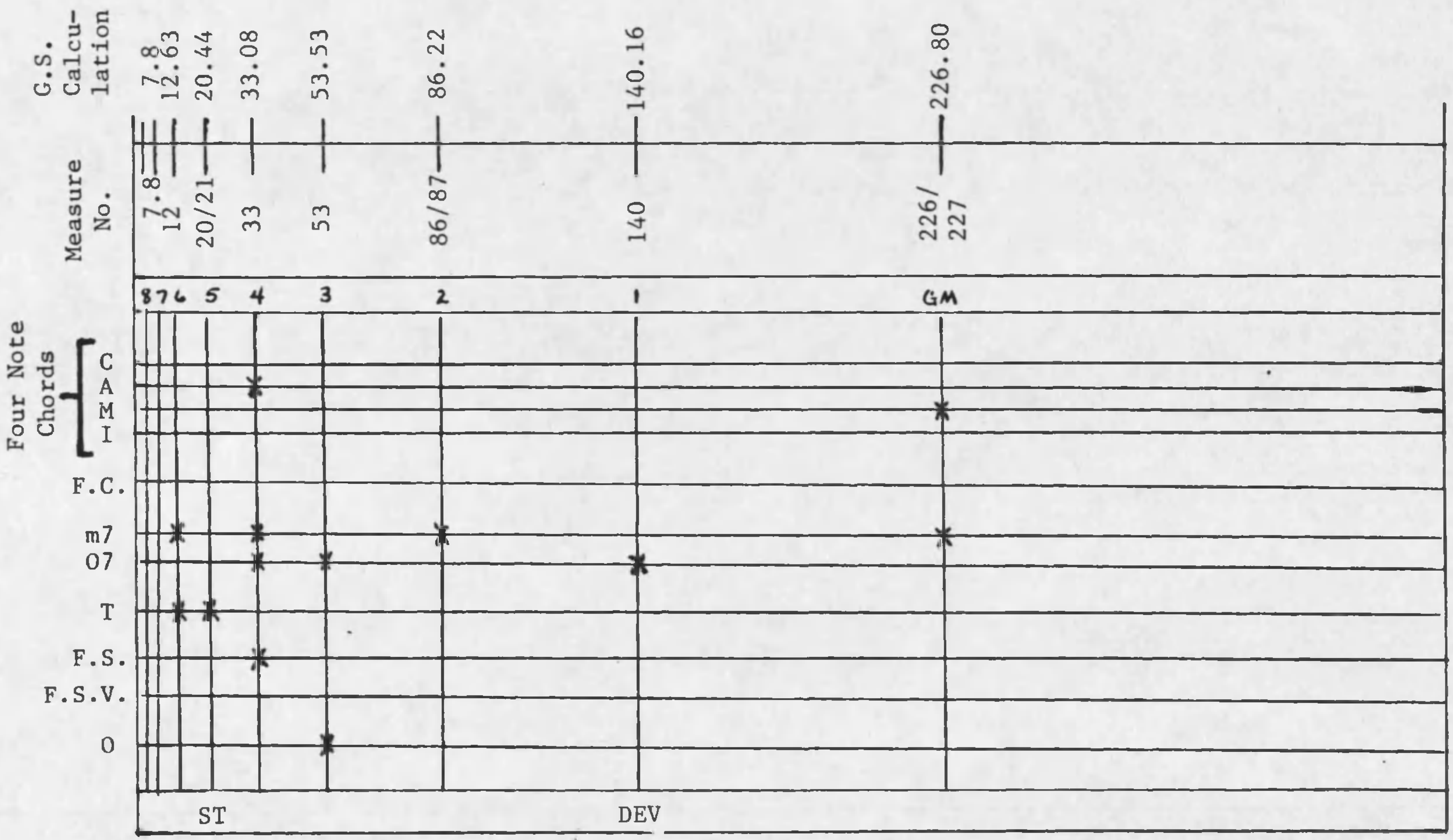


Figure 58. First Quartet-Second Movement.
Proportions Based on Measures.

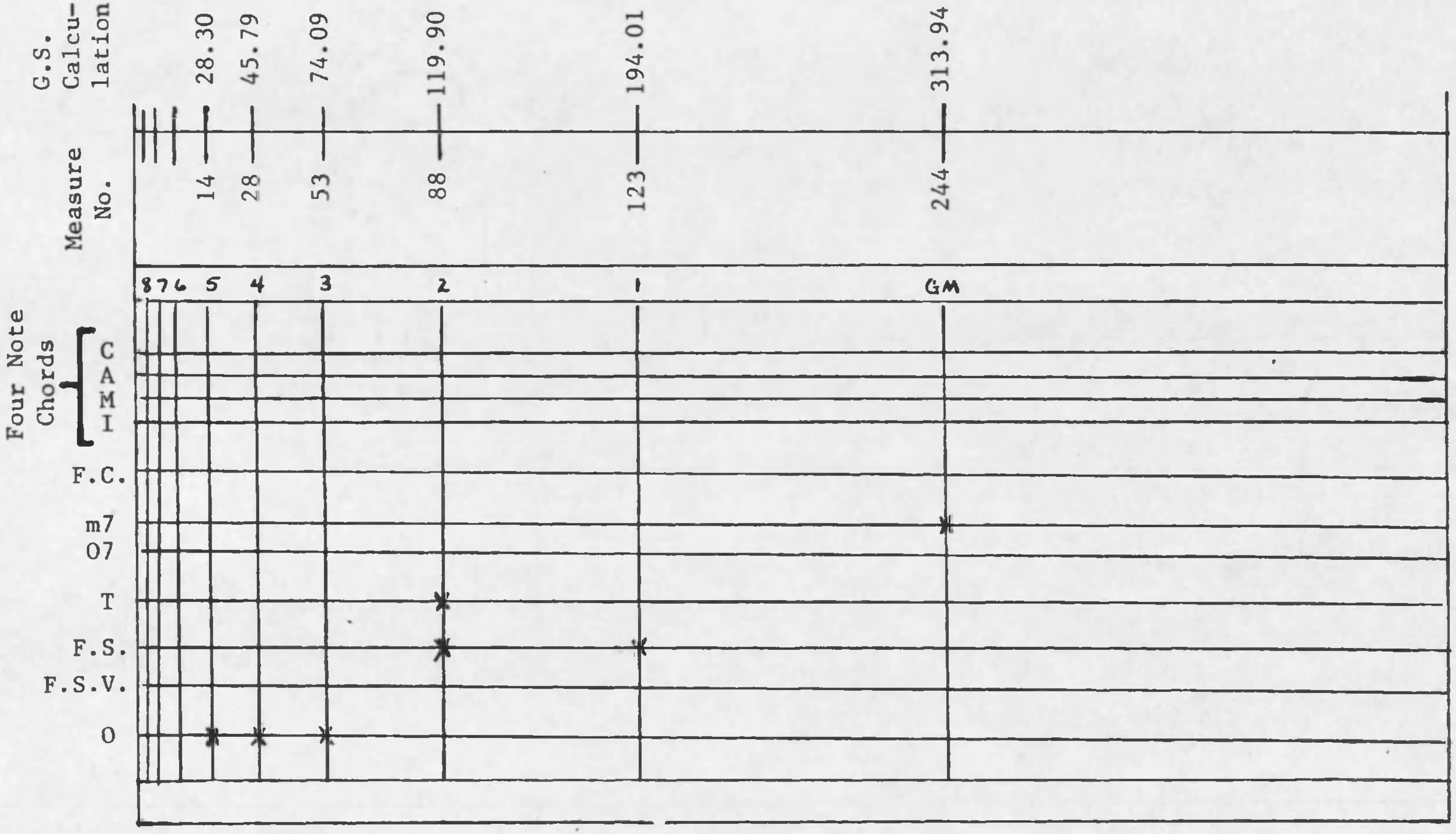


Figure 59. First Quartet-Second Movement.
Proportions Based on Seconds.

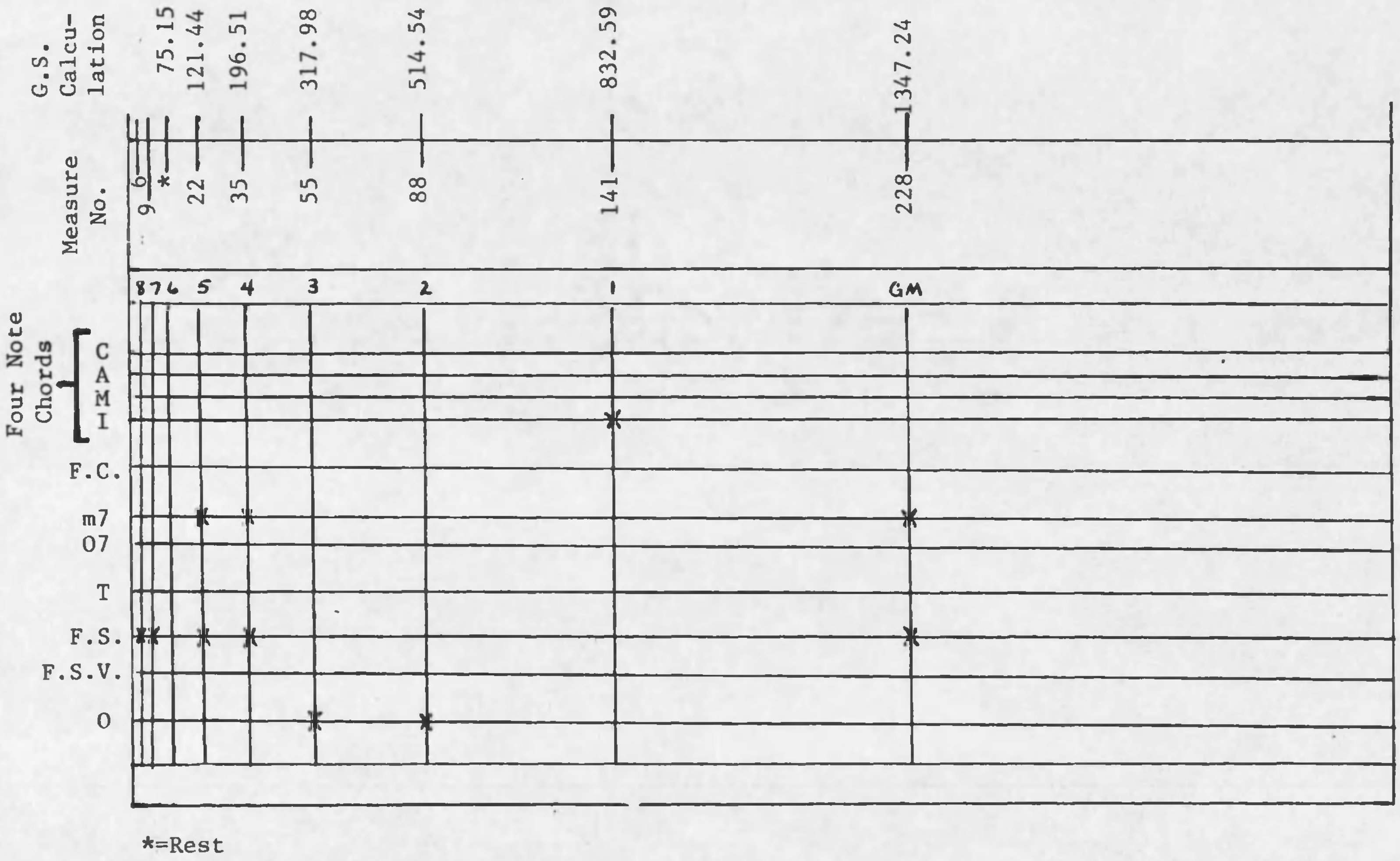
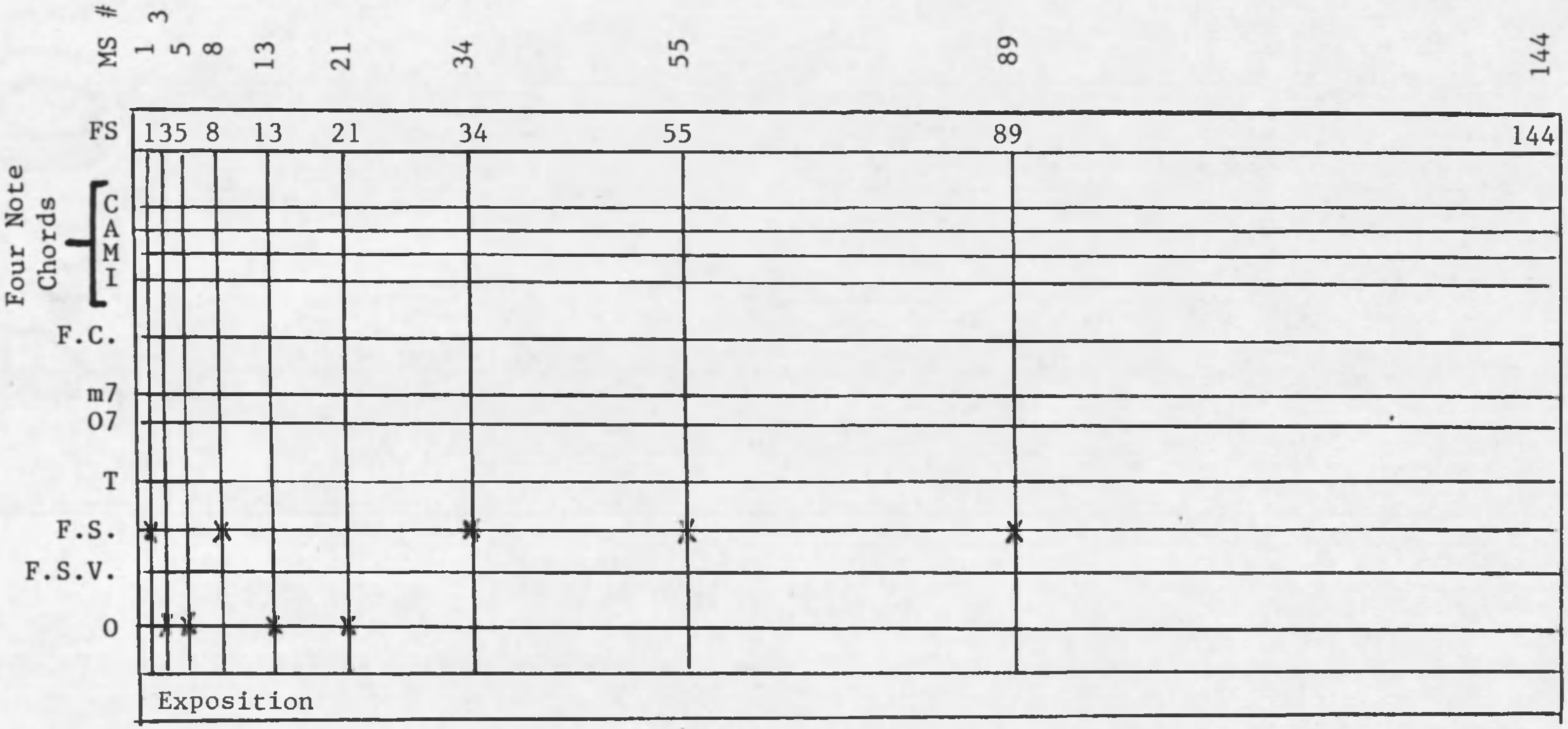


Figure 60. First Quartet-Second Movement.
Proportions Based on Eighth-Notes.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1 3 5 8 13 21 34 55 89 144
FS
1 3 5 8 13 21 34 55 89 144
Four Note Chords
C
A
M
I
F.C.
m7
O7
T
F.S.
F.S.V.
O
Exposition

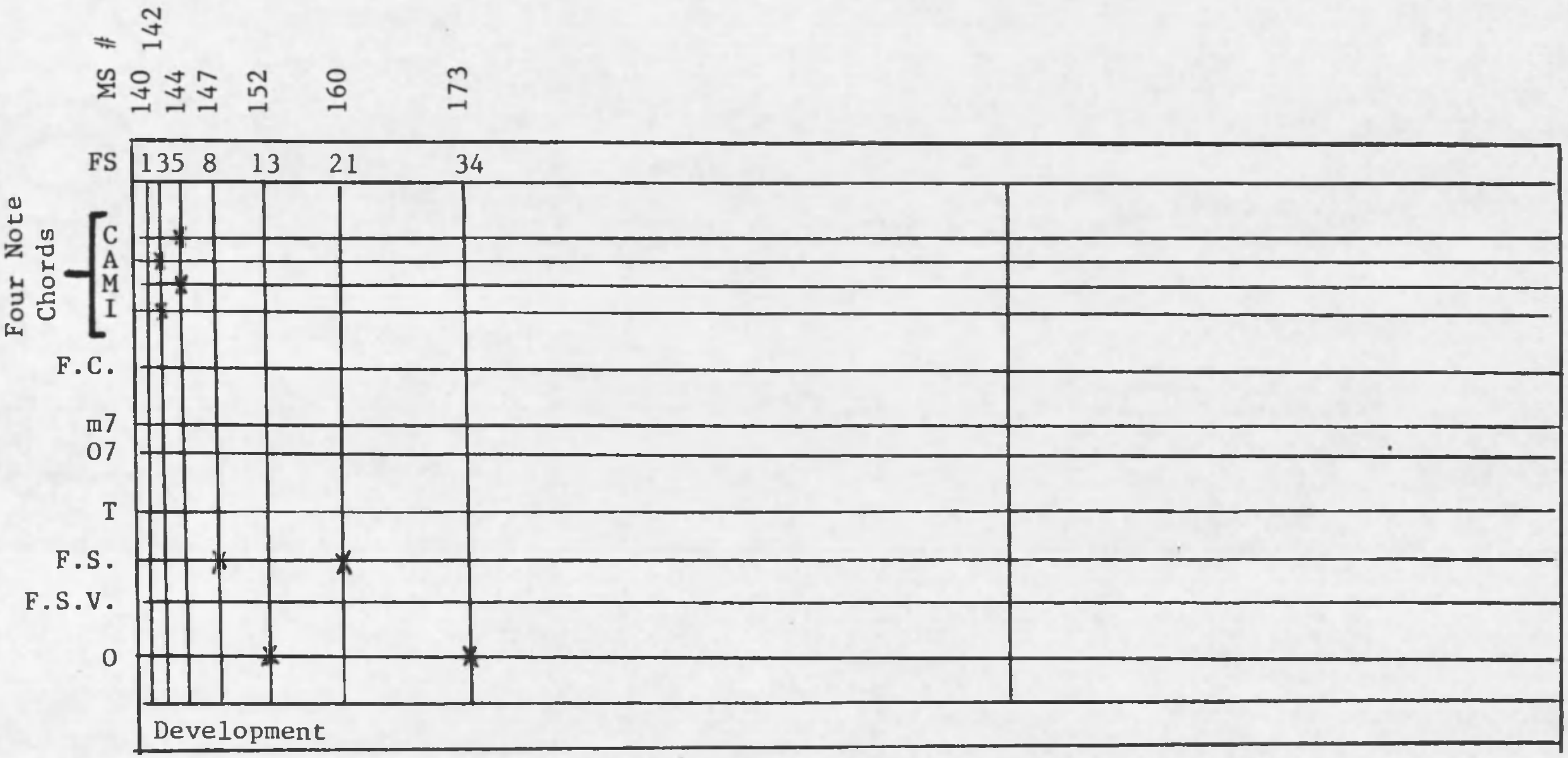


Figure 61. First Quartet-Second Movement.
Proportions Based on the Fibonacci Series.

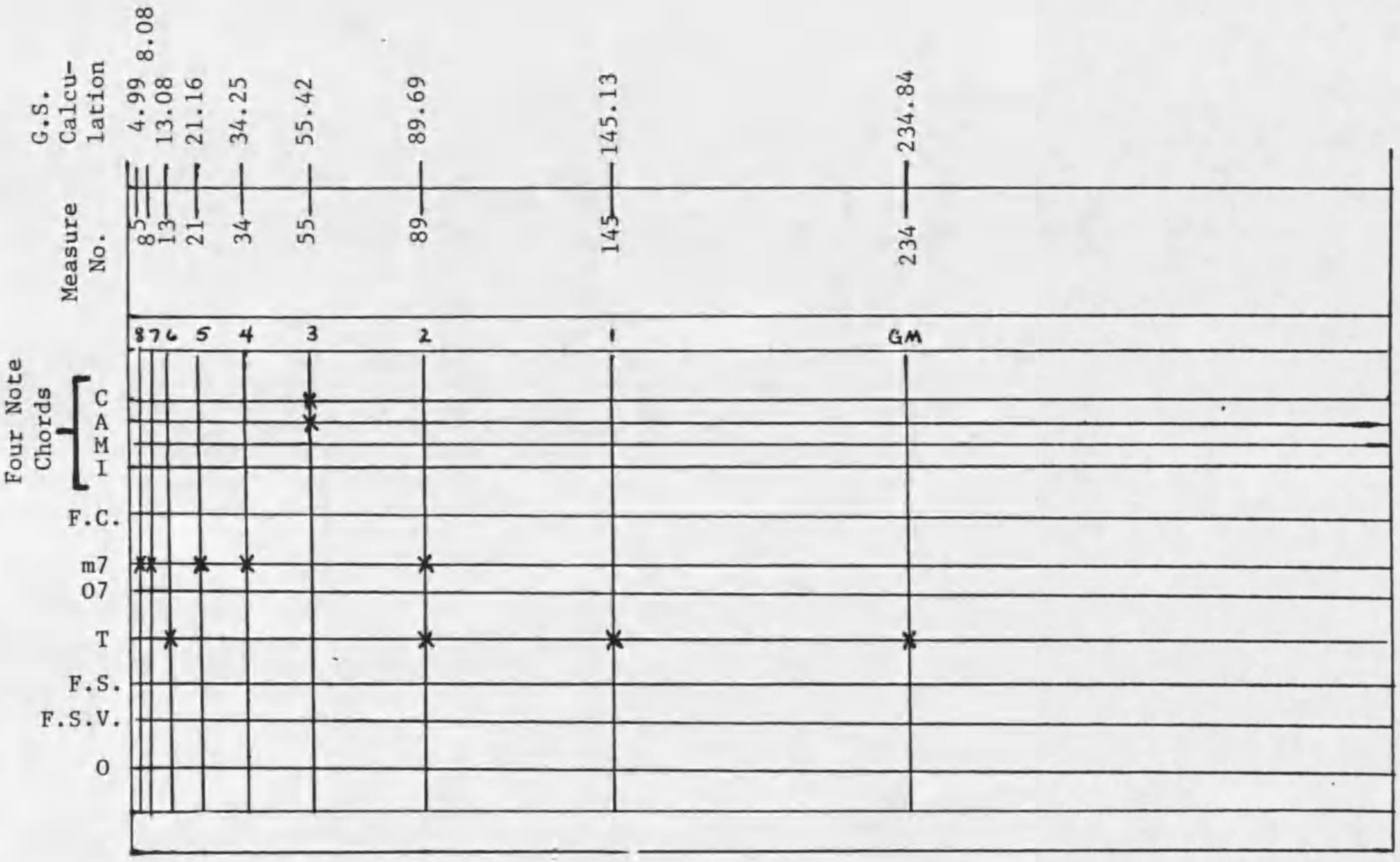


Figure 62. First Quartet-Third Movement.
Proportions Based on Measures.

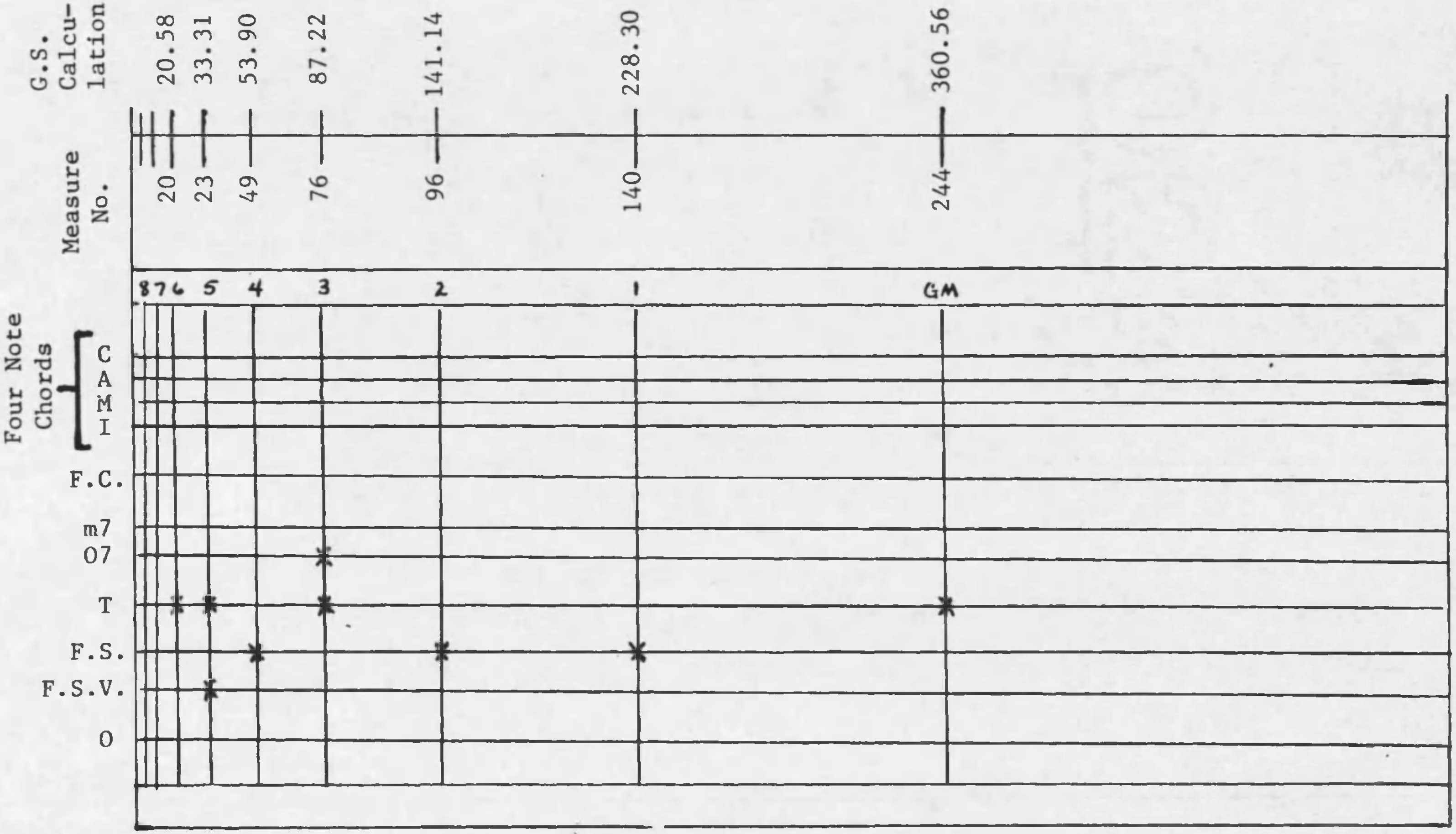


Figure 63. First Quartet-Third Movement.
Proportions Based on Seconds.

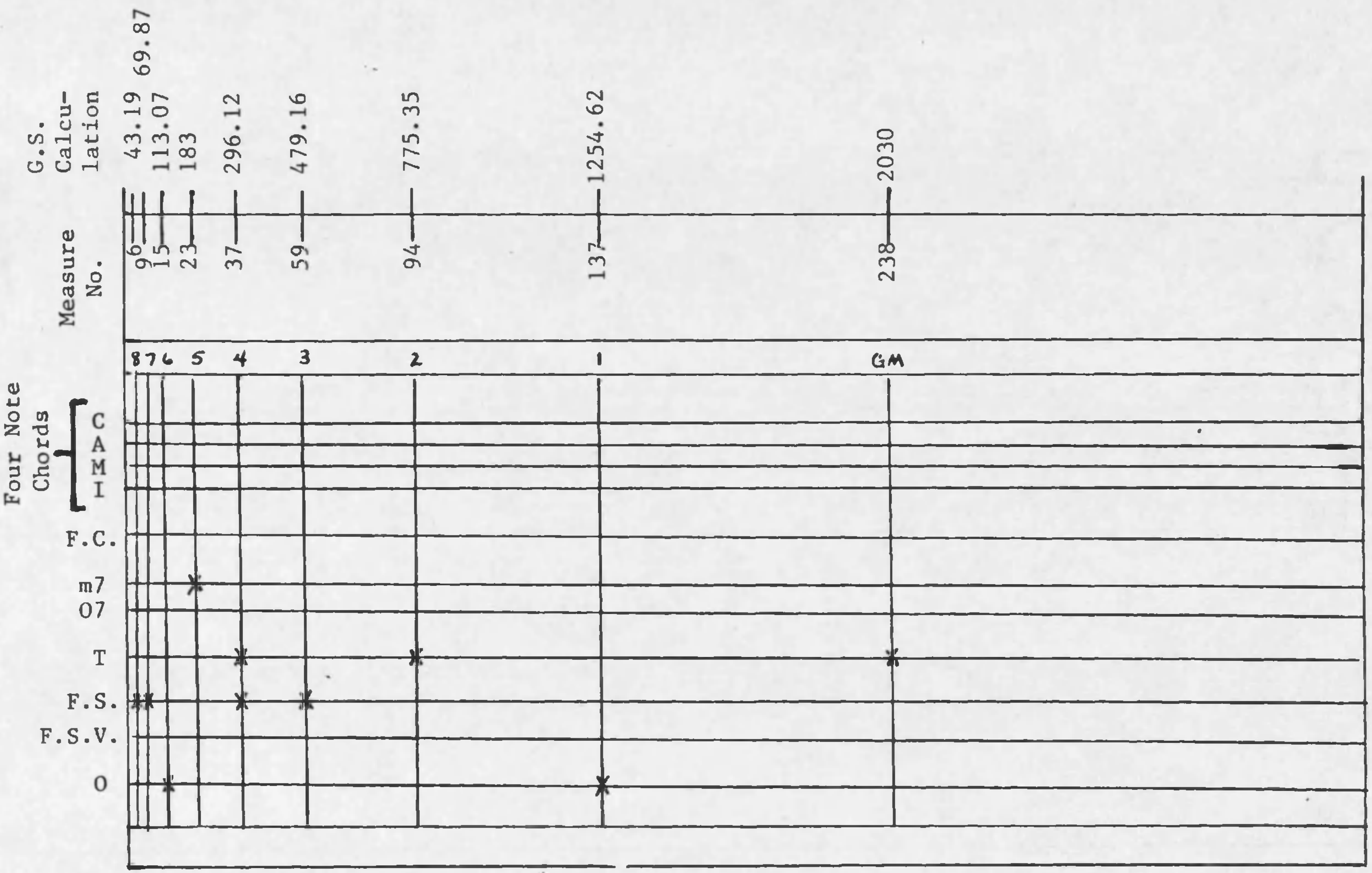
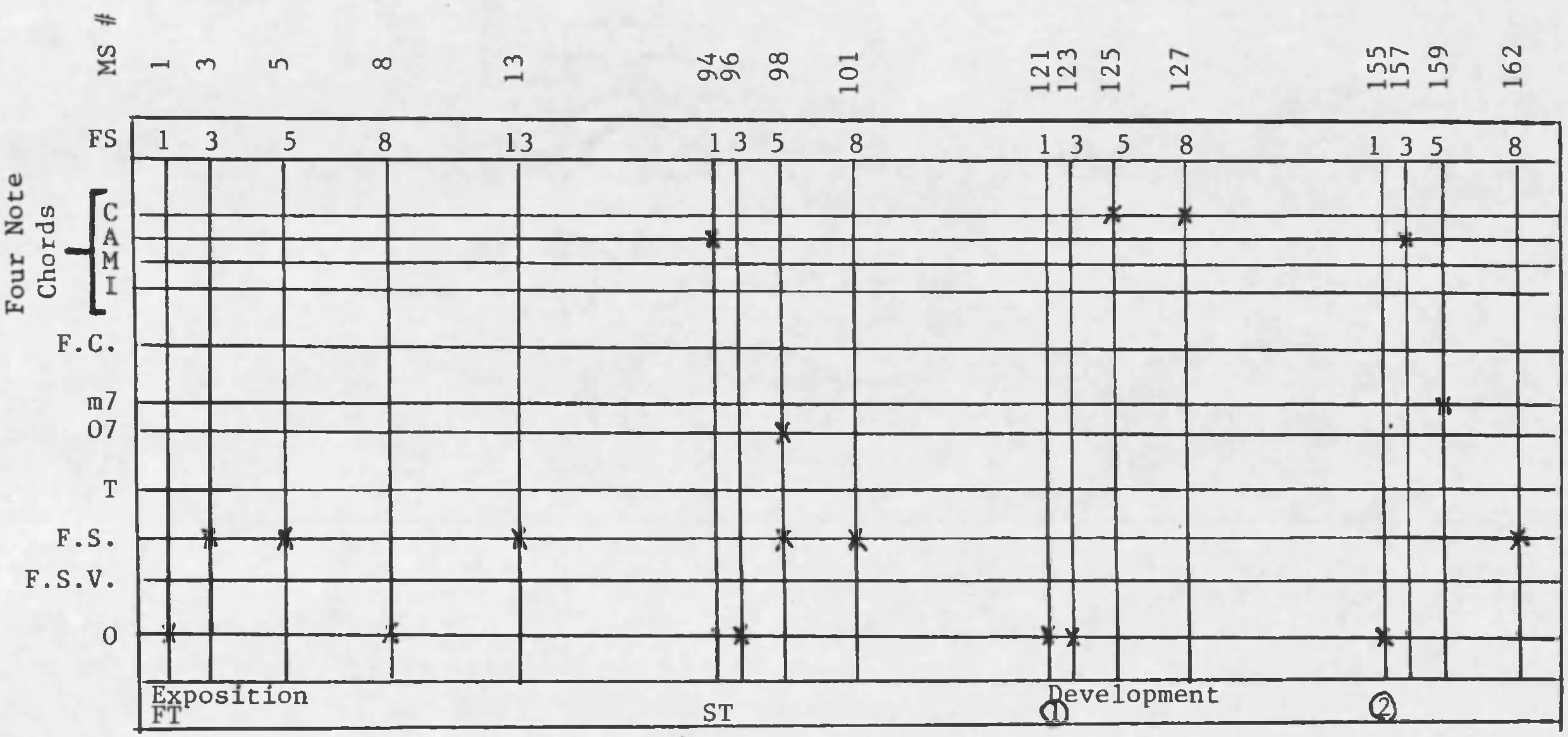


Figure 64. First Quartet-Third Movement.
Proportions Based on Eighth-Notes.


MS #
1 3 5 8 13 94 96 98 101 121 123 125 127 155 157 159 162
FS
1 3 5 8 13 1 3 5 8 1 3 5 8 1 3 5 8
Four Note Chords
C
A
M
I
F.C.
m7
O7
T
F.S.
F.S.V.
O
Exposition
FT
ST
Development
①
②

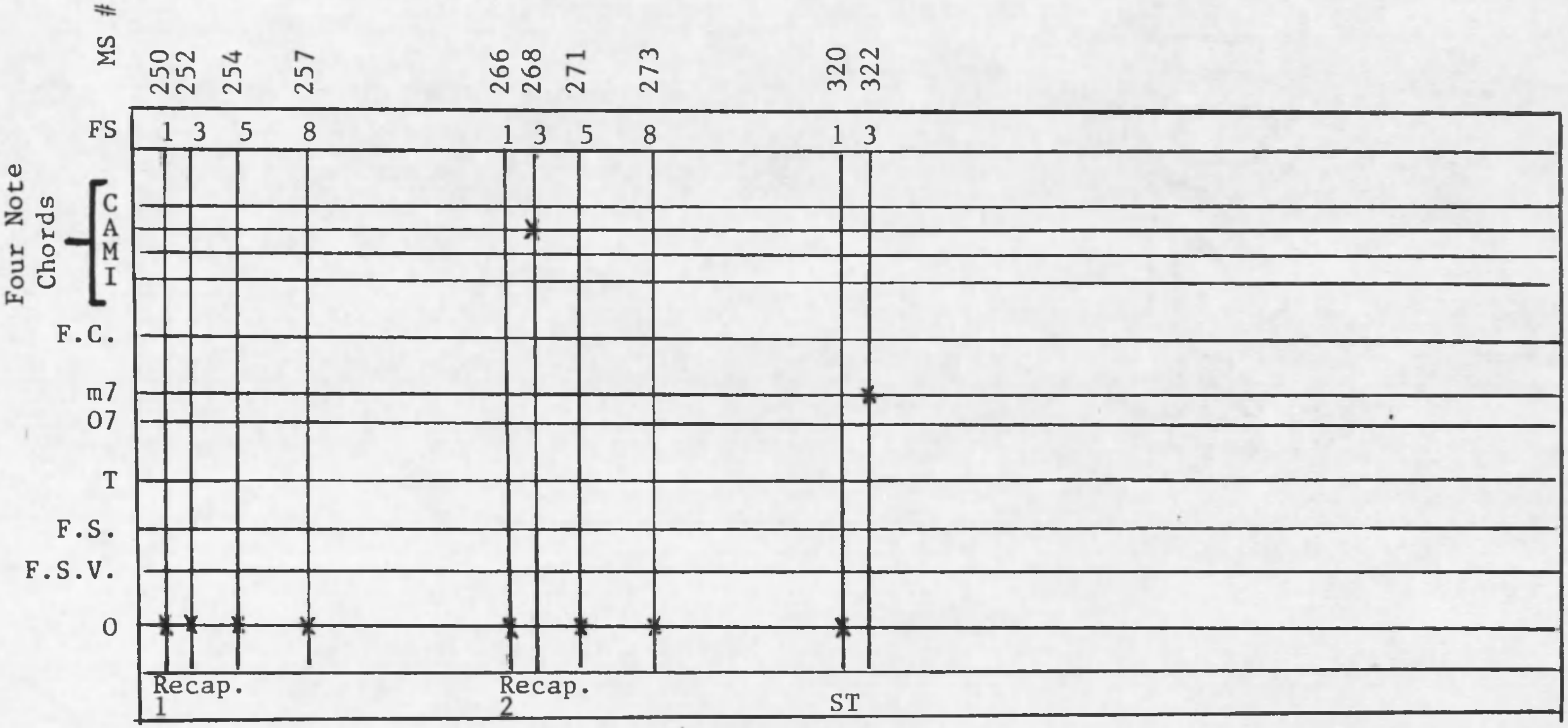


Figure 65. First Quartet-Third Movement.
Proportions Based on the Fibonacci Series.

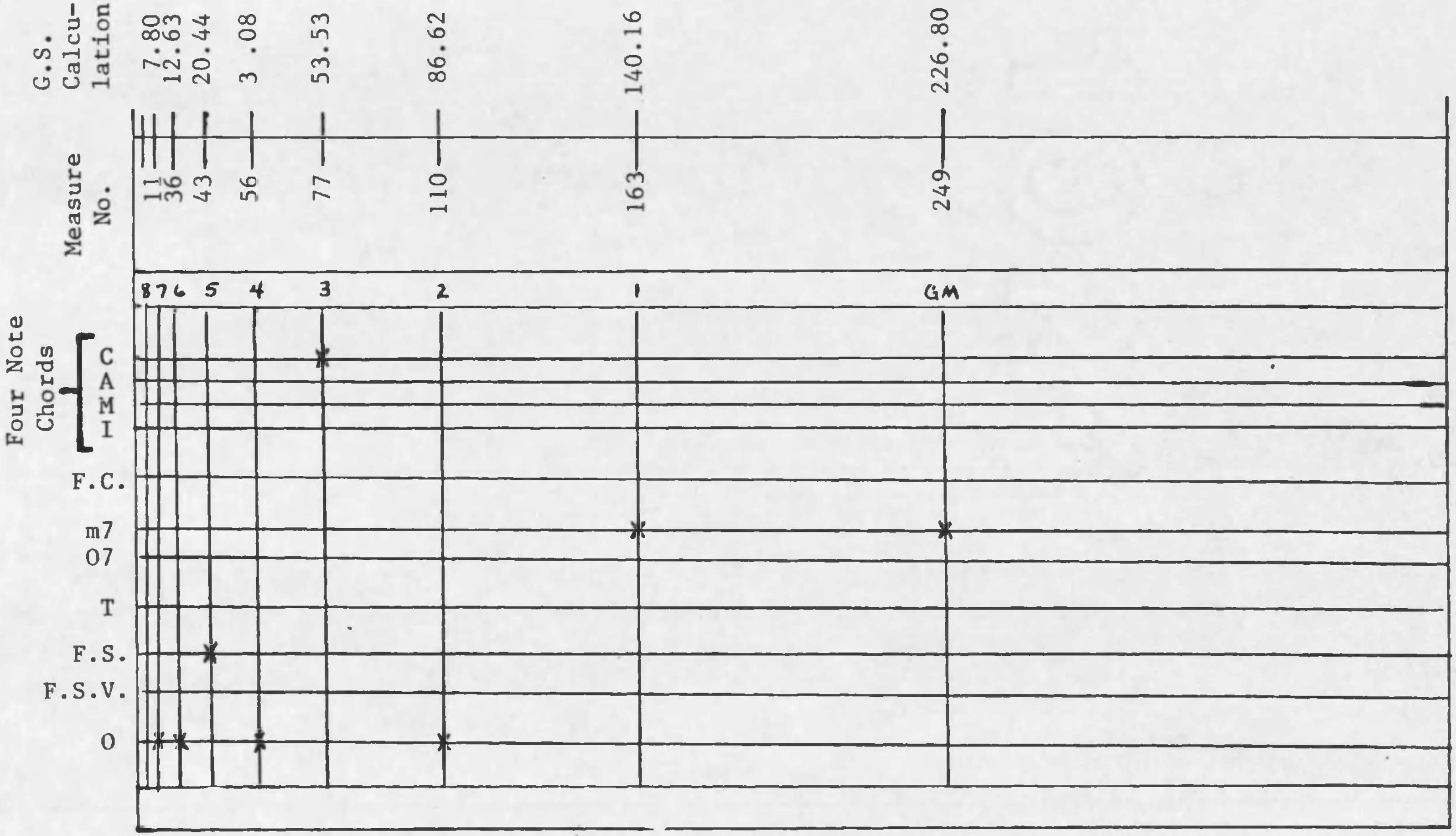


Figure 66. Sixth Quartet-First Movement.
Proportions Based on Measures.

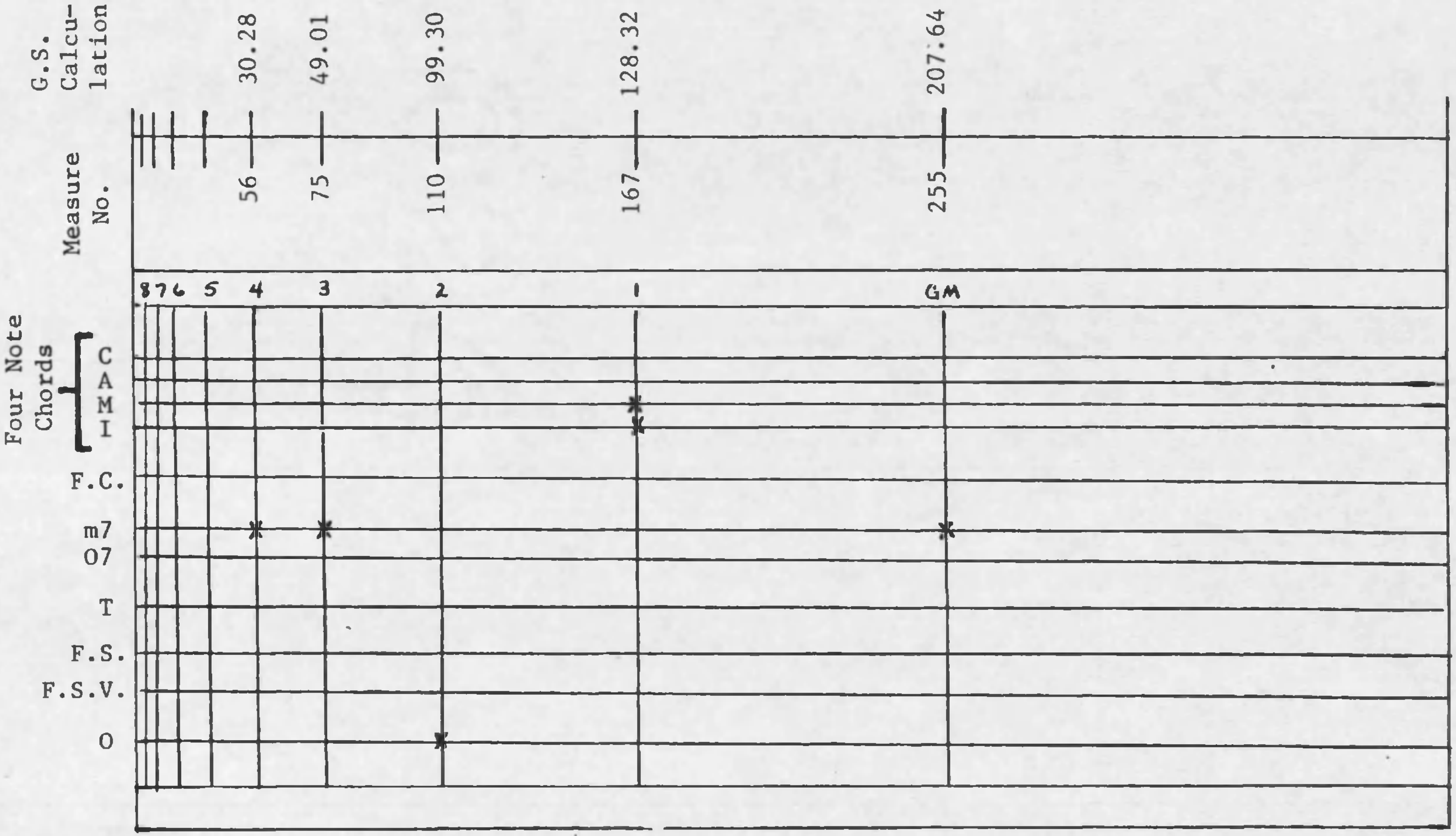


Figure 67. Sixth Quartet-First Movement.
Proportions Based on Seconds.

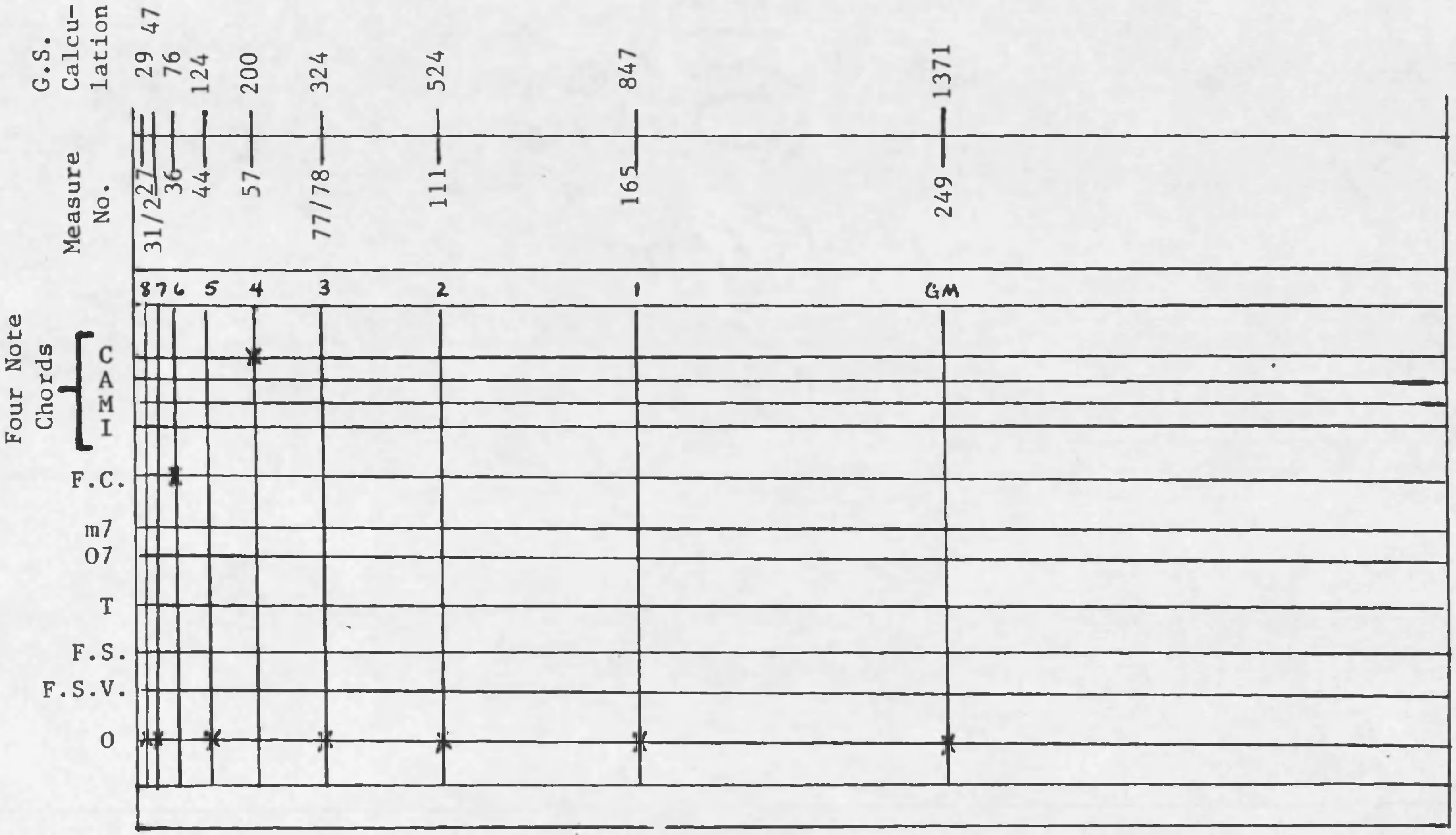
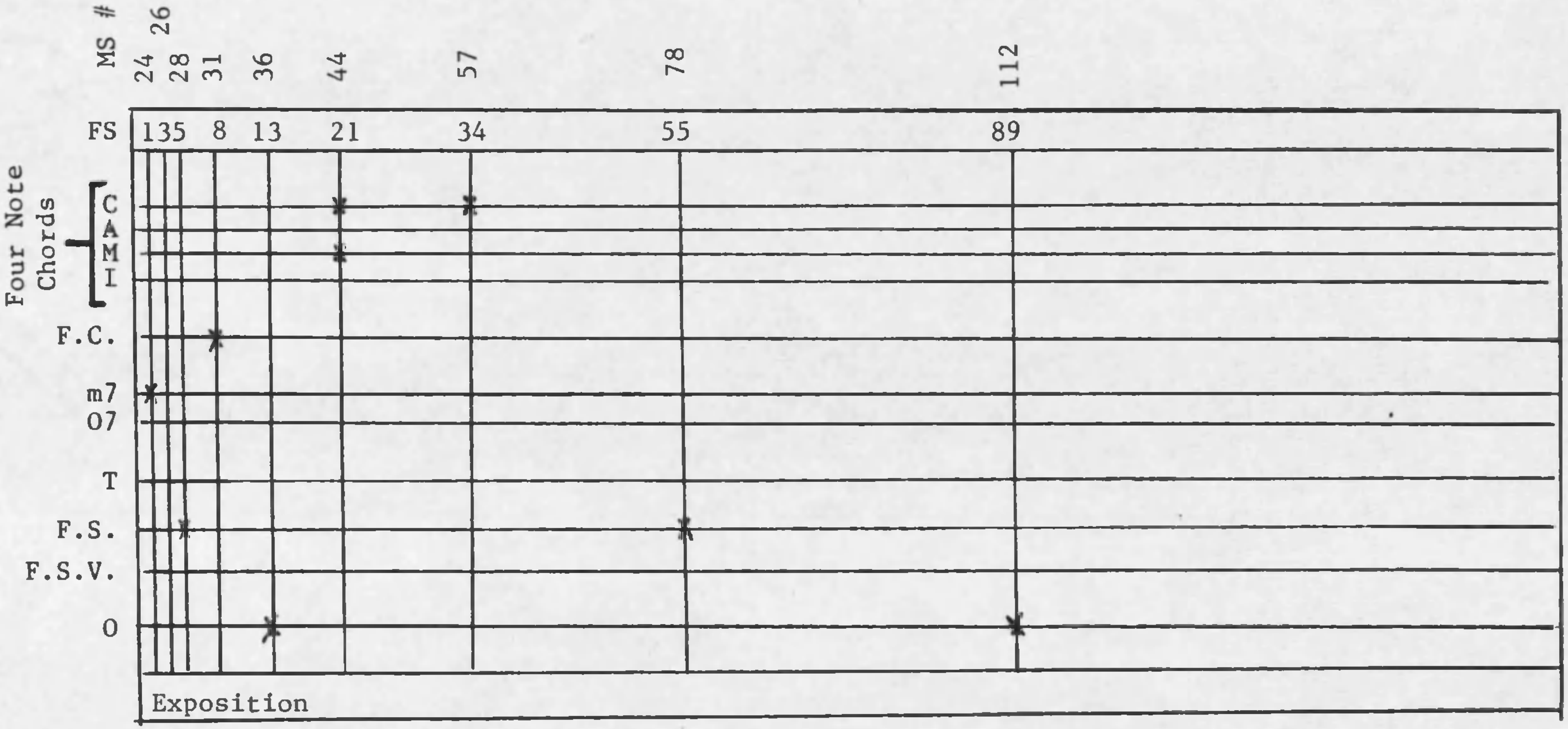


Figure 68. Sixth Quartet-First Movement.
Proportions Based on Eighth-Notes.


MS #
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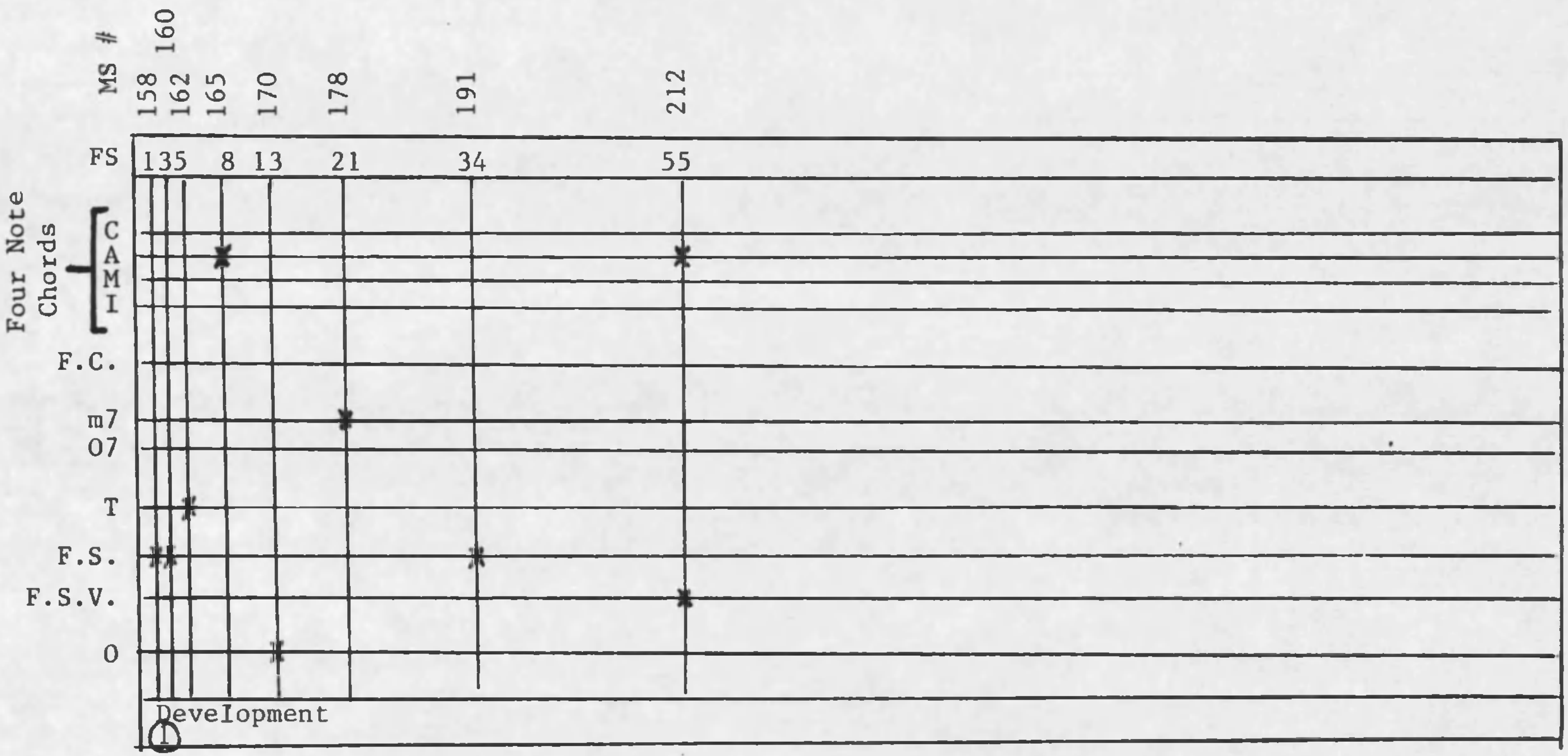
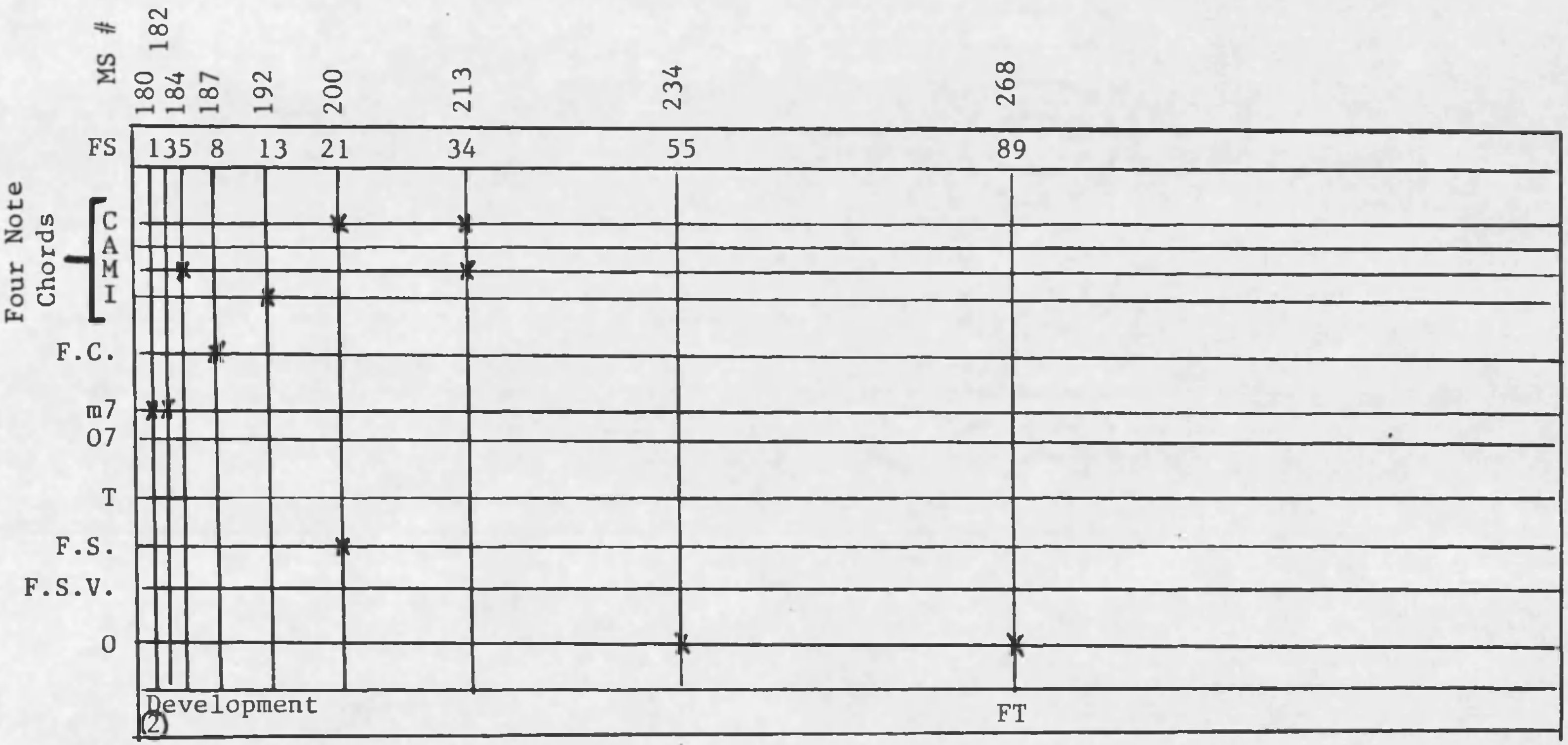
FS
1 3 5 8 13 21 34 55 89
Four Note Chords
C
A
M
I
F.C.
m7
O7
T
F.S.
F.S.V.
O
Exposition



MS #
158 160 162 165 170 178 191 212
FS
1 3 5 8 13 21 34 55
Four Note Chords
C
A
M
I
F.C.
m7
O7
T
F.S.
F.S.V.
O
Development
1


MS #
180 182 184 187 192 200 213 234 268
FS
1 3 5 8 13 21 34 55 89
Four Note Chords
C
A
M
I
F.C.
m7
O7
T
F.S.
F.S.V.
O
Development
(2)
FT

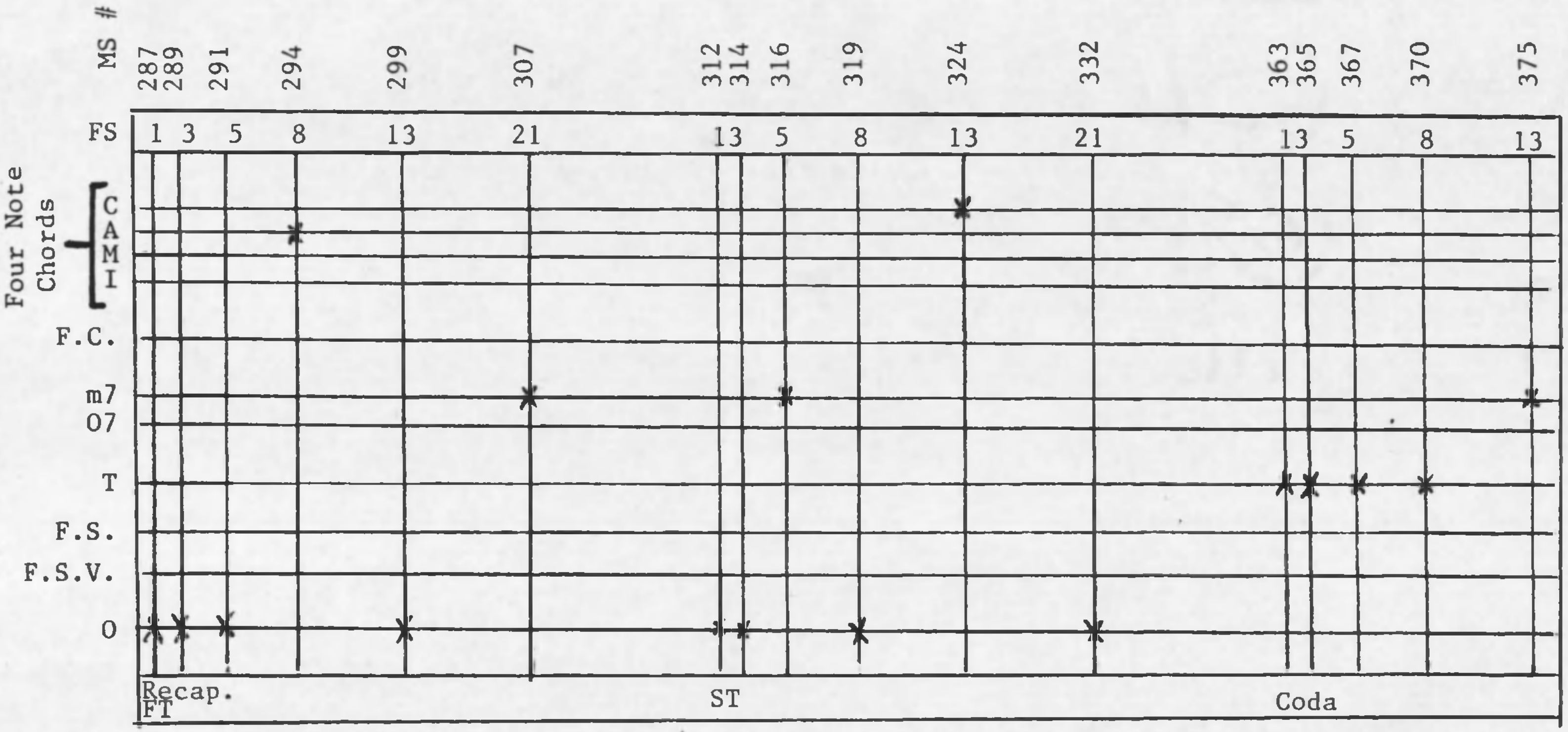


Figure 69. Sixth Quartet-First Movement.
Proportions Based on the Fibonacci Series.

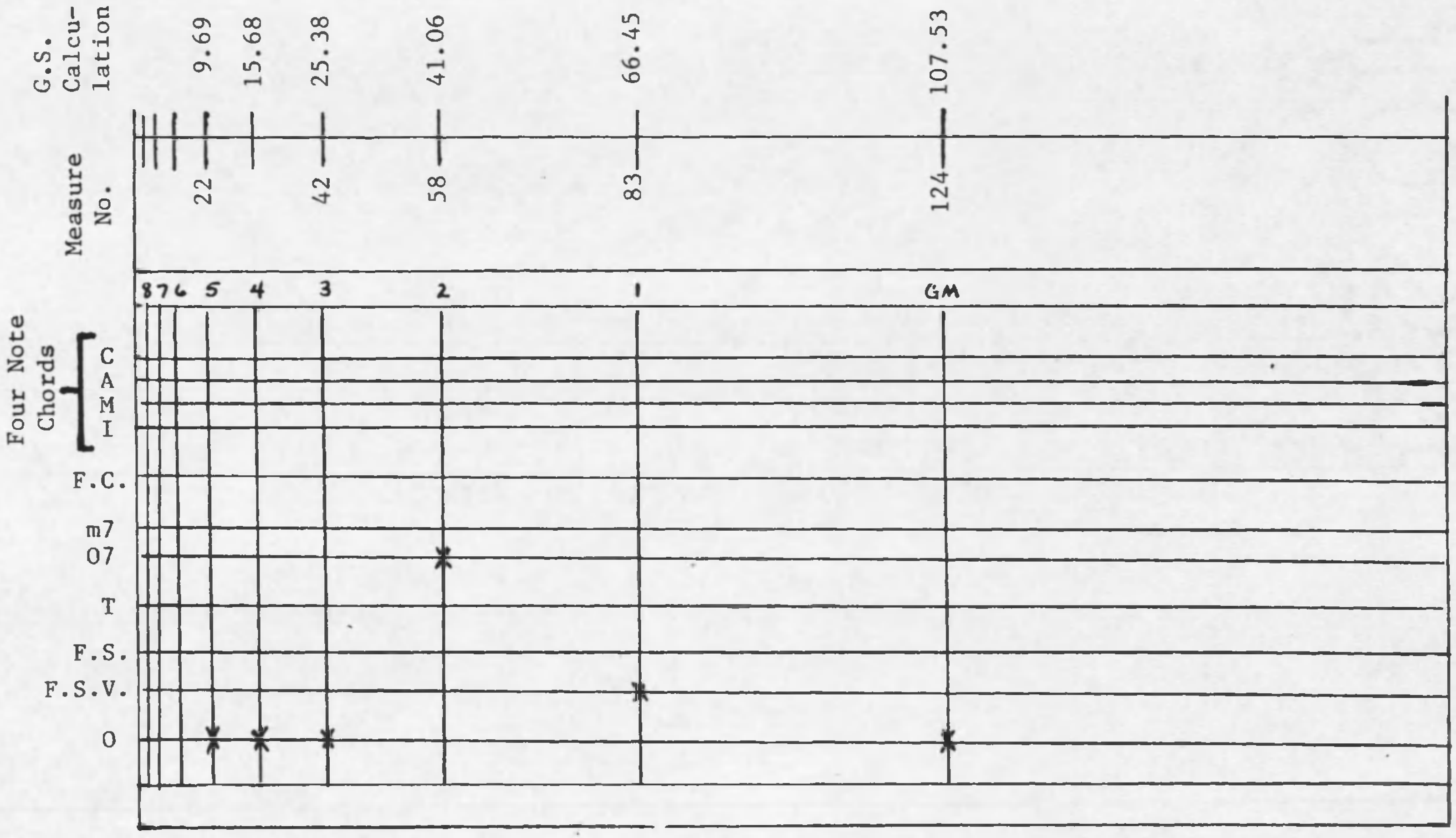


Figure 70. Sixth Quartet-Second Movement.
Proportions Based on Measures.

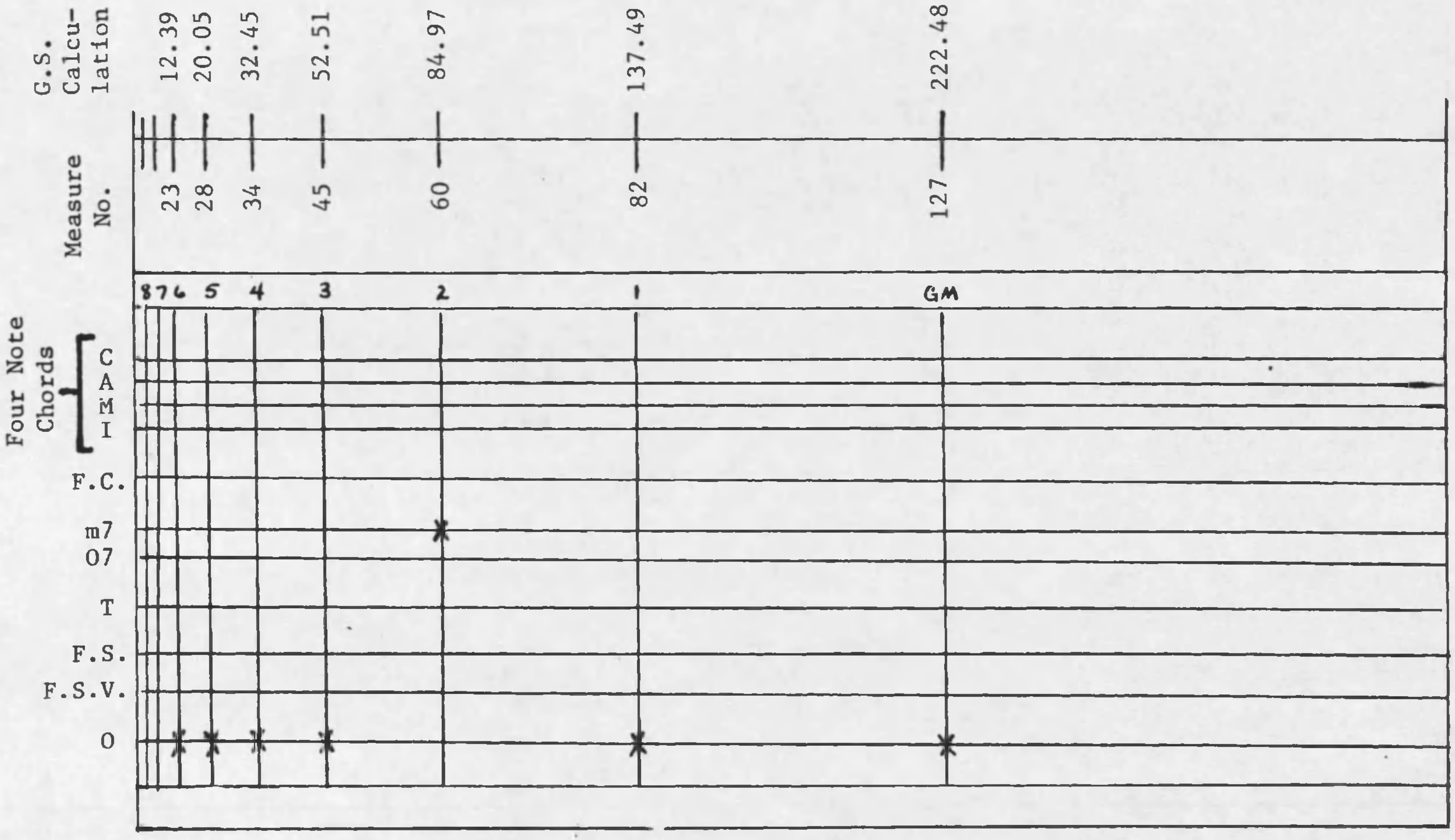


Figure 71. Sixth Quartet-Second Movement.
Proportions Based on Seconds.

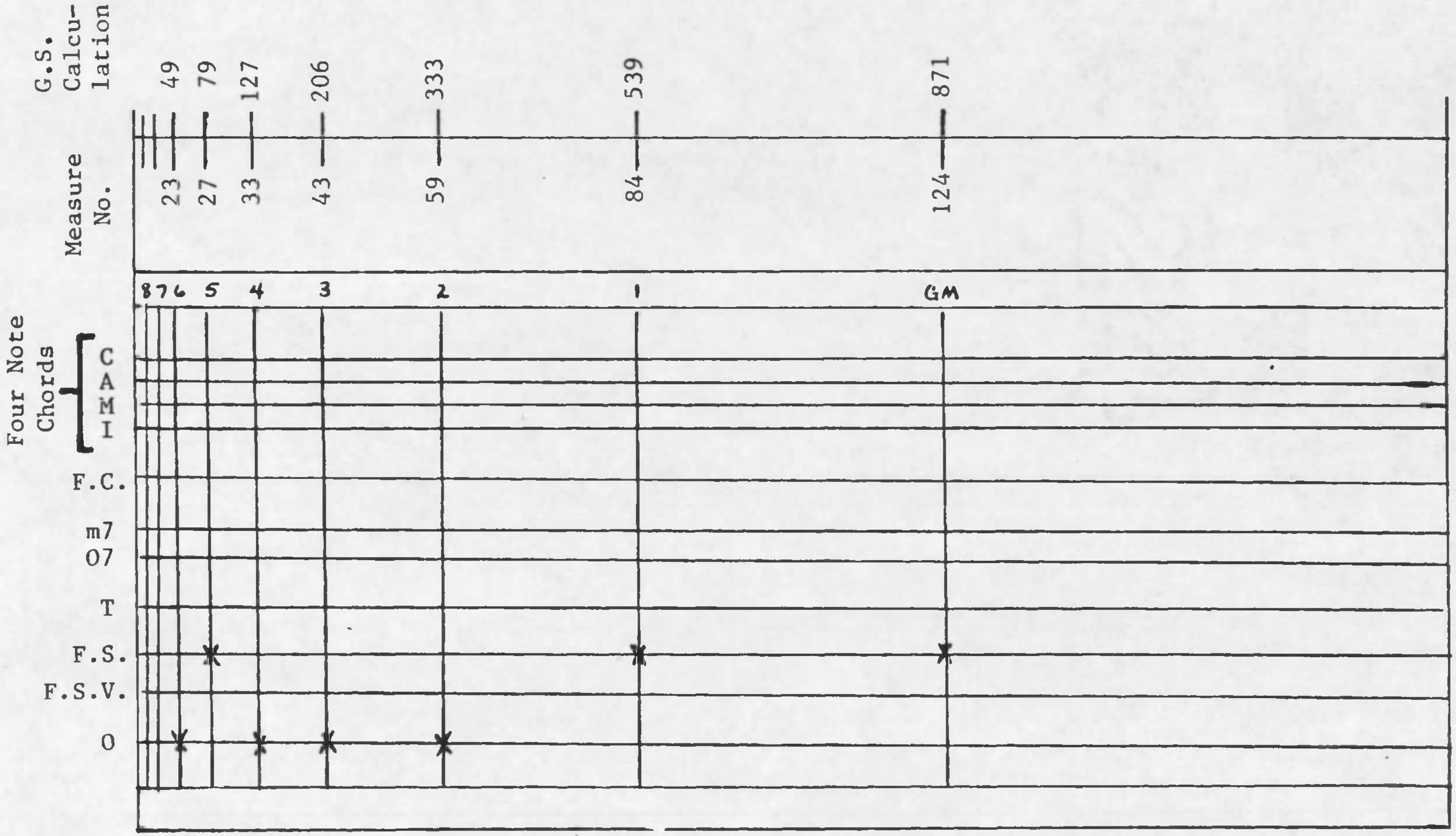


Figure 72. Sixth Quartet-Second Movement.
Proportions Based on Eighth-Notes.

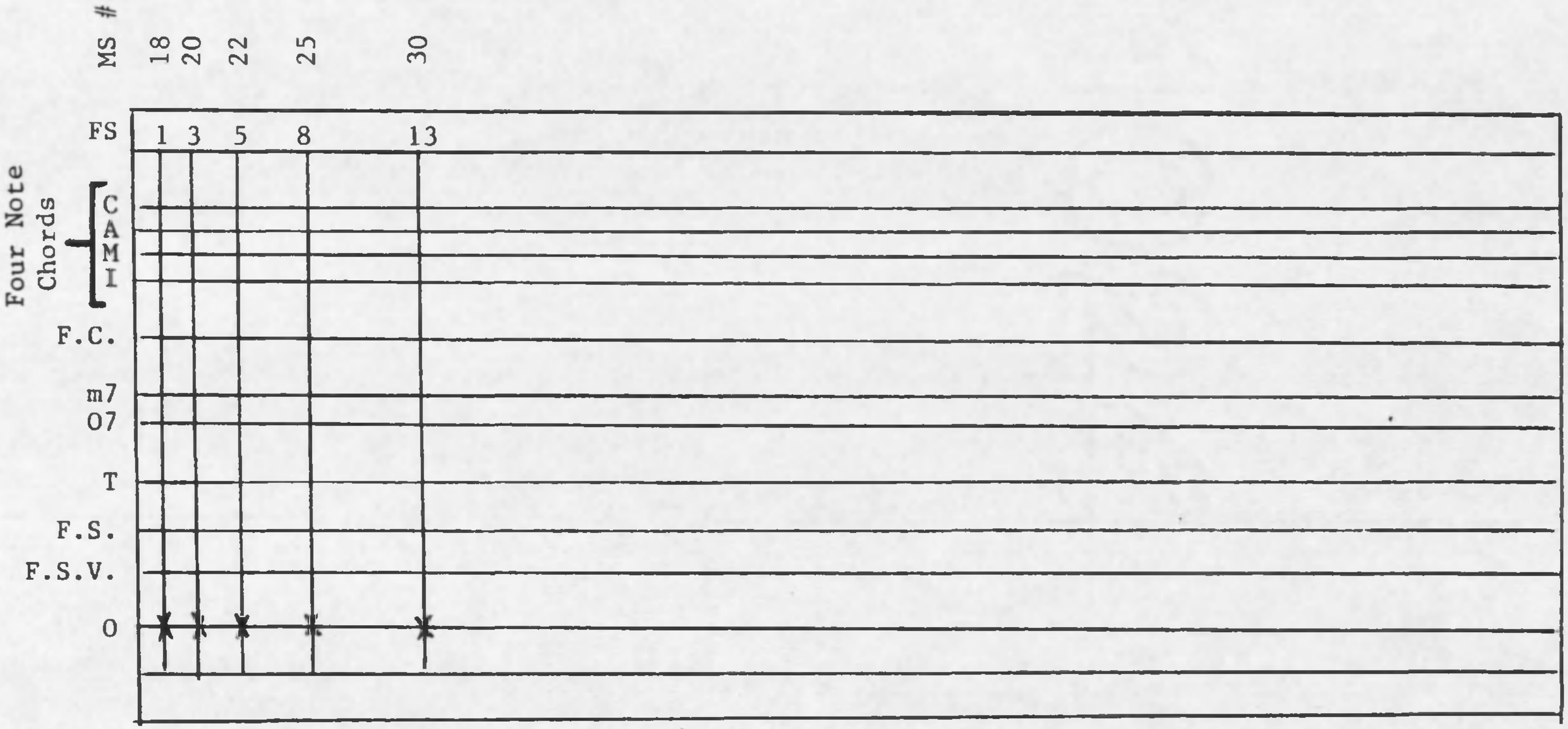


Figure 73. Sixth Quartet-Second Movement.
Proportions Based on the Fibonacci Series.

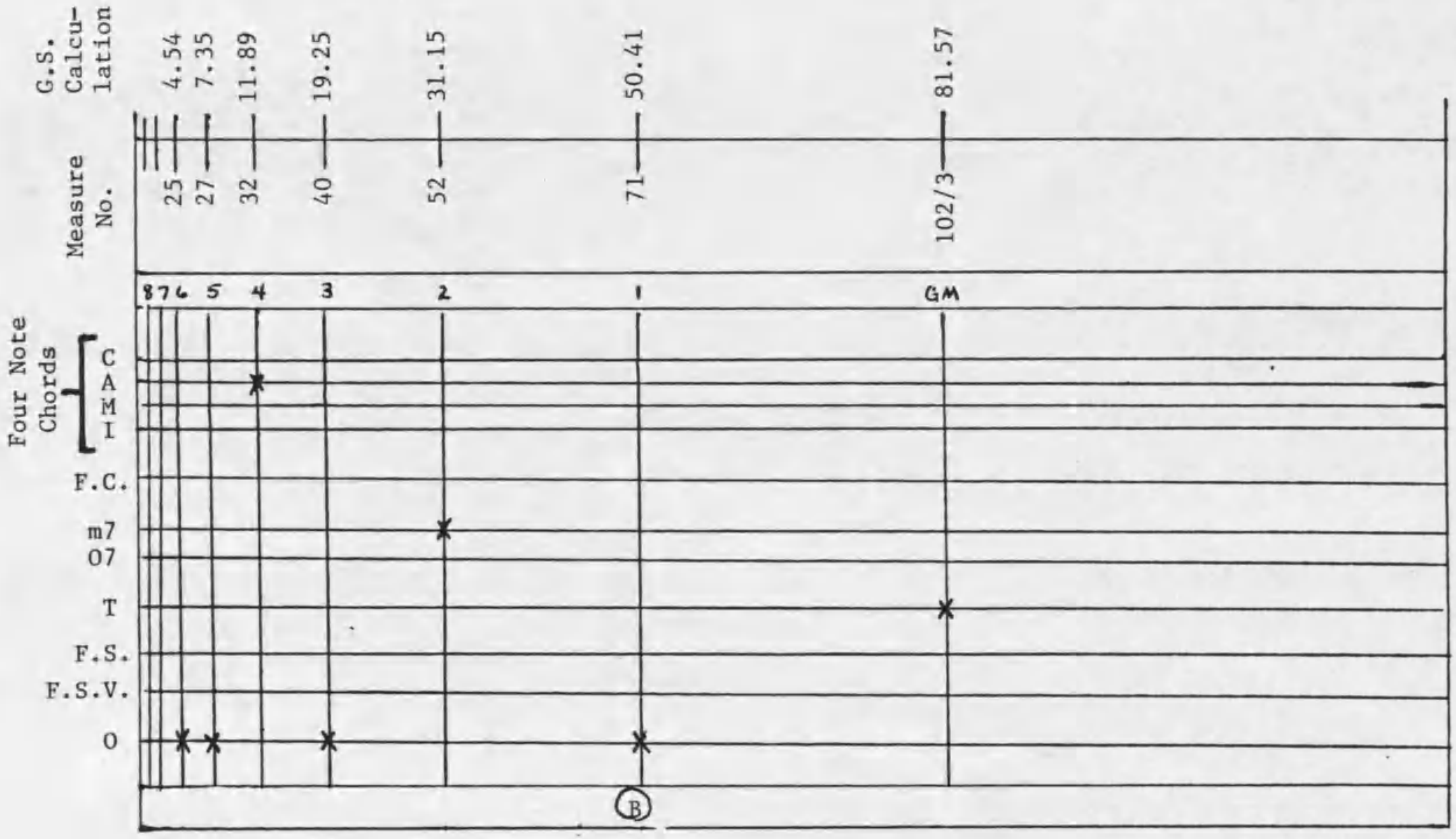


Figure 74. Sixth Quartet-Third Movement.
Proportions Based on Measures.

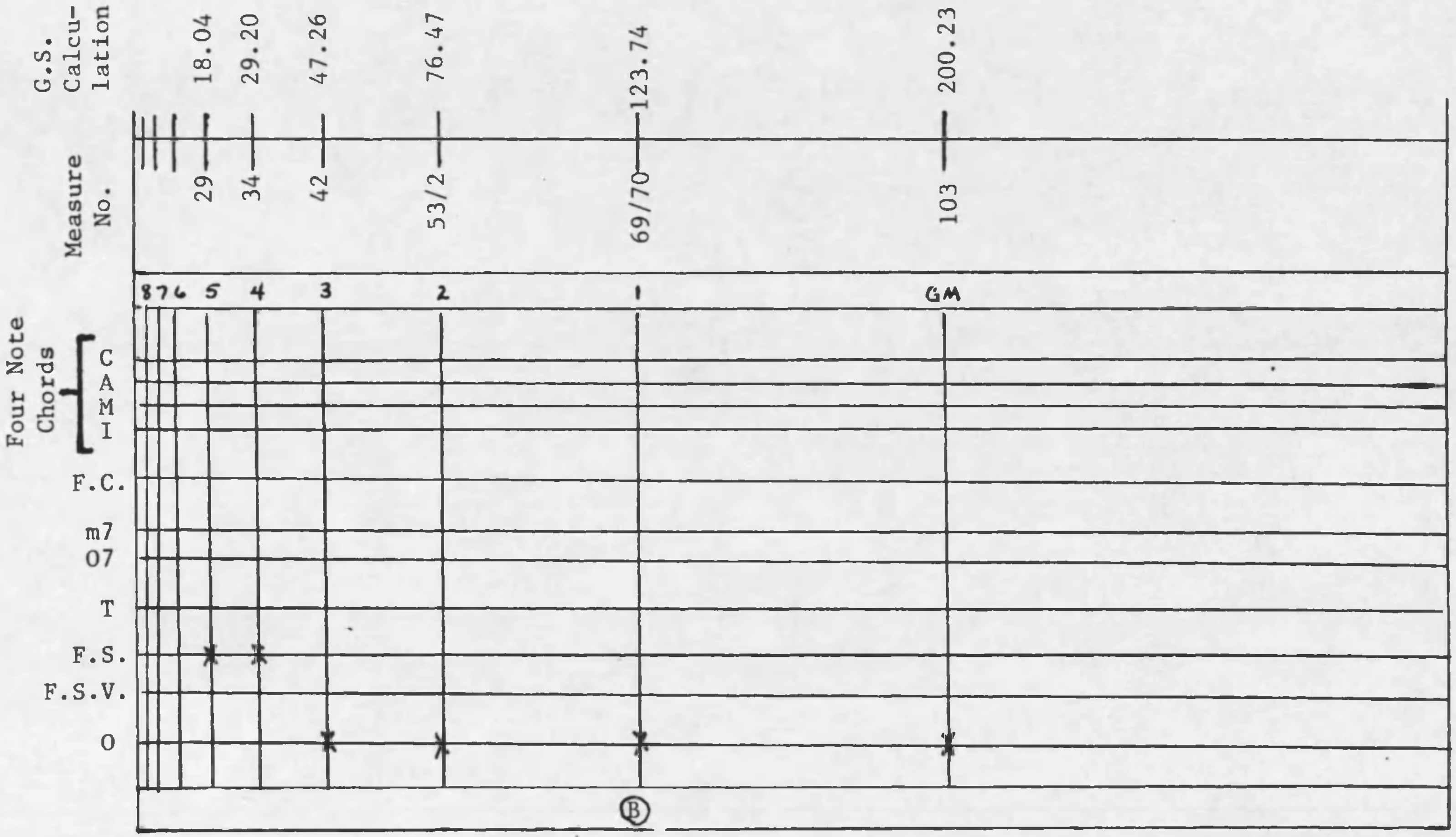


Figure 75. Sixth Quartet-Third Movement.
Proportions Based on Seconds.

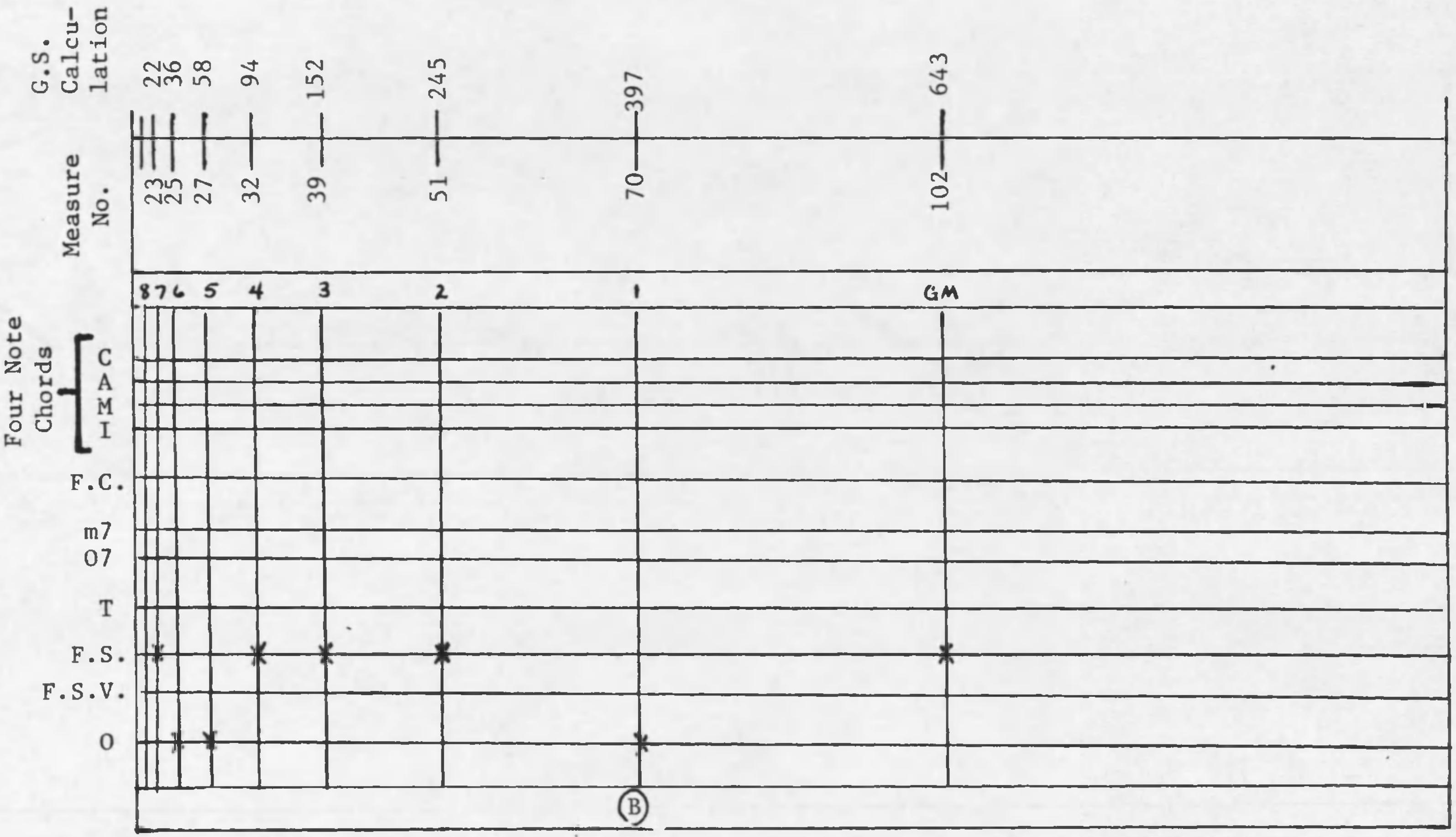


Figure 76. Sixth Quartet-Third Movement.
Proportions Based on Eighth-Notes.

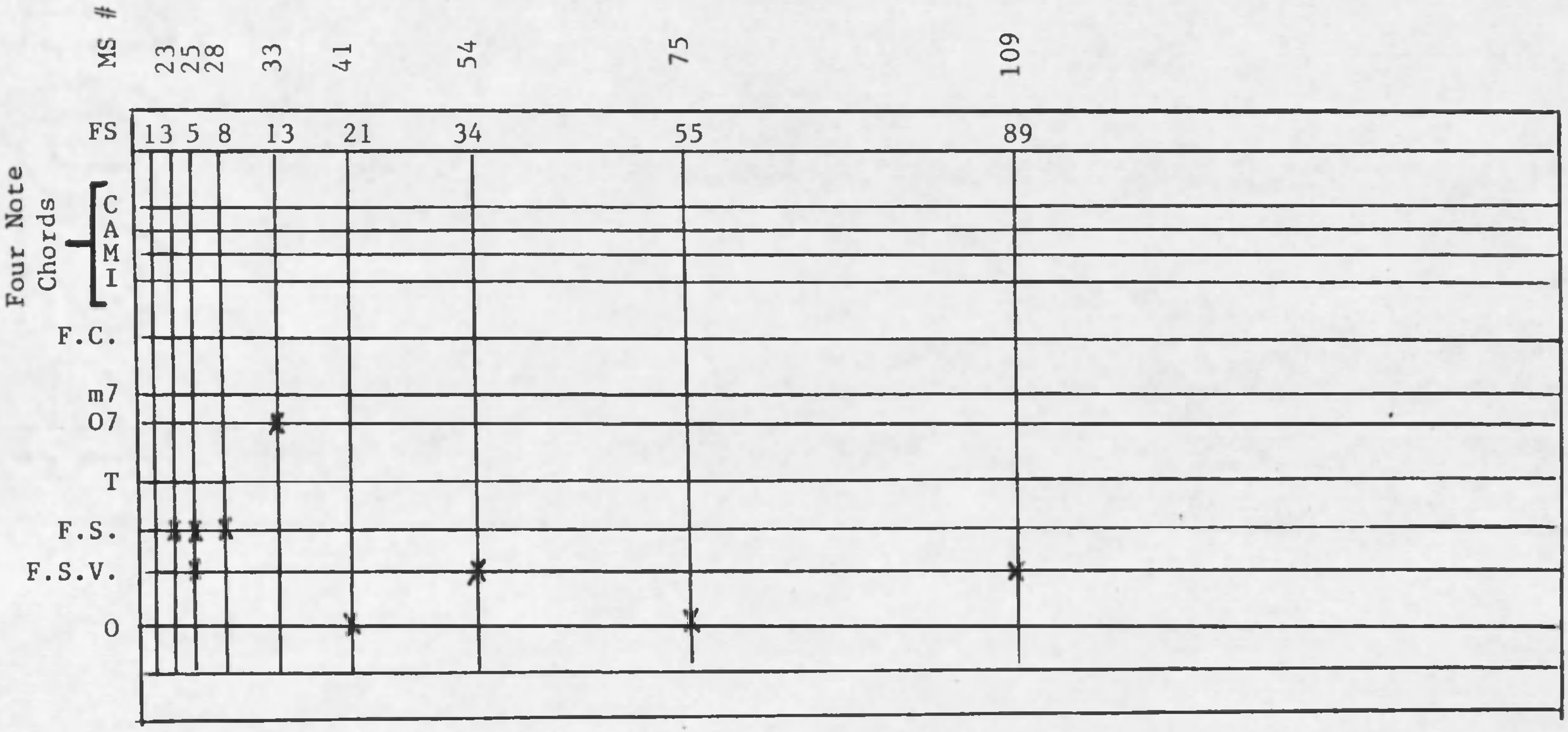


Figure 77. Sixth Quartet-Third Movement.
Proportions Based on the Fibonacci Series.

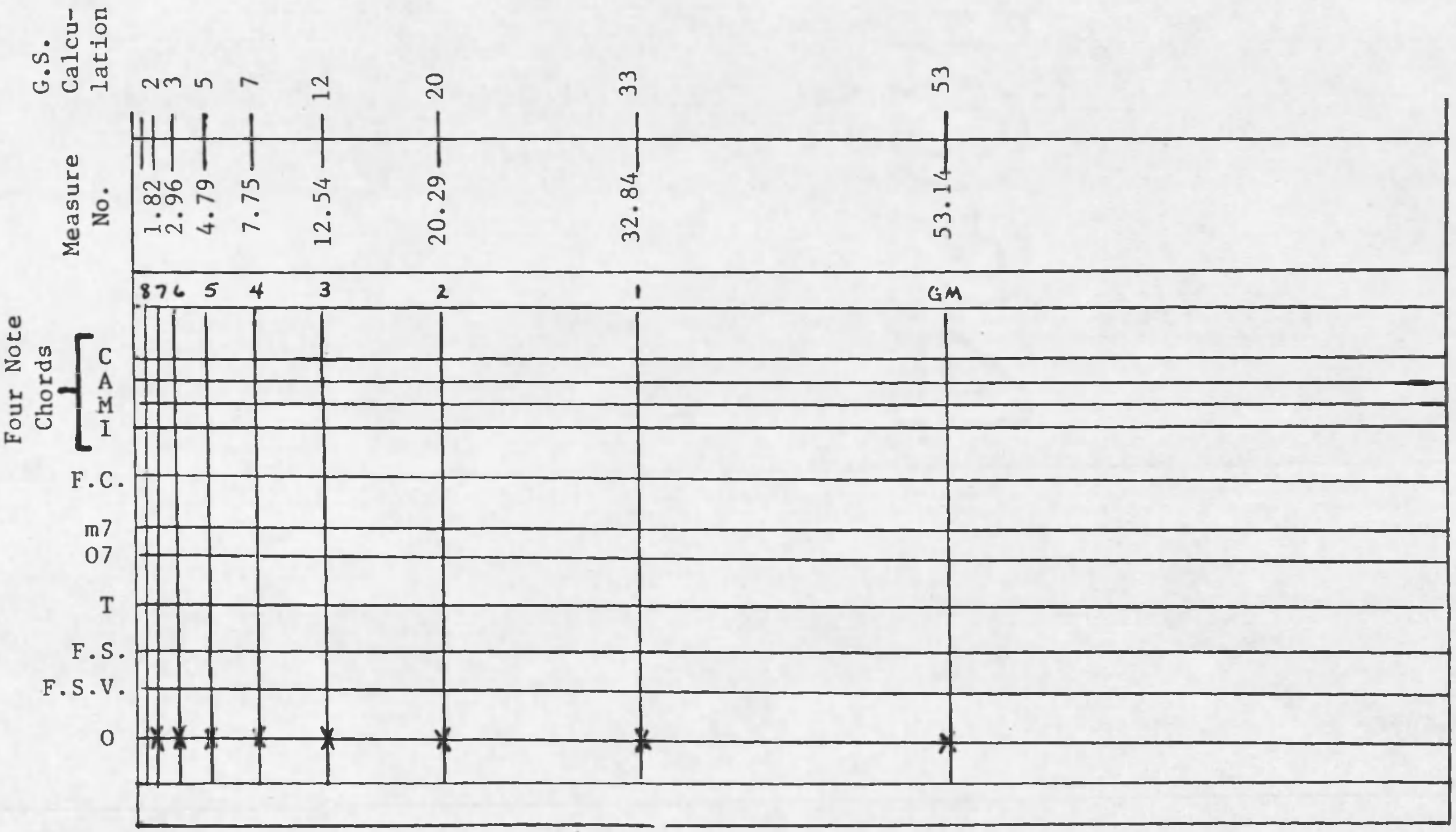


Figure 78. Sixth Quartet-Fourth Movement.
Proportions Based on Measures.

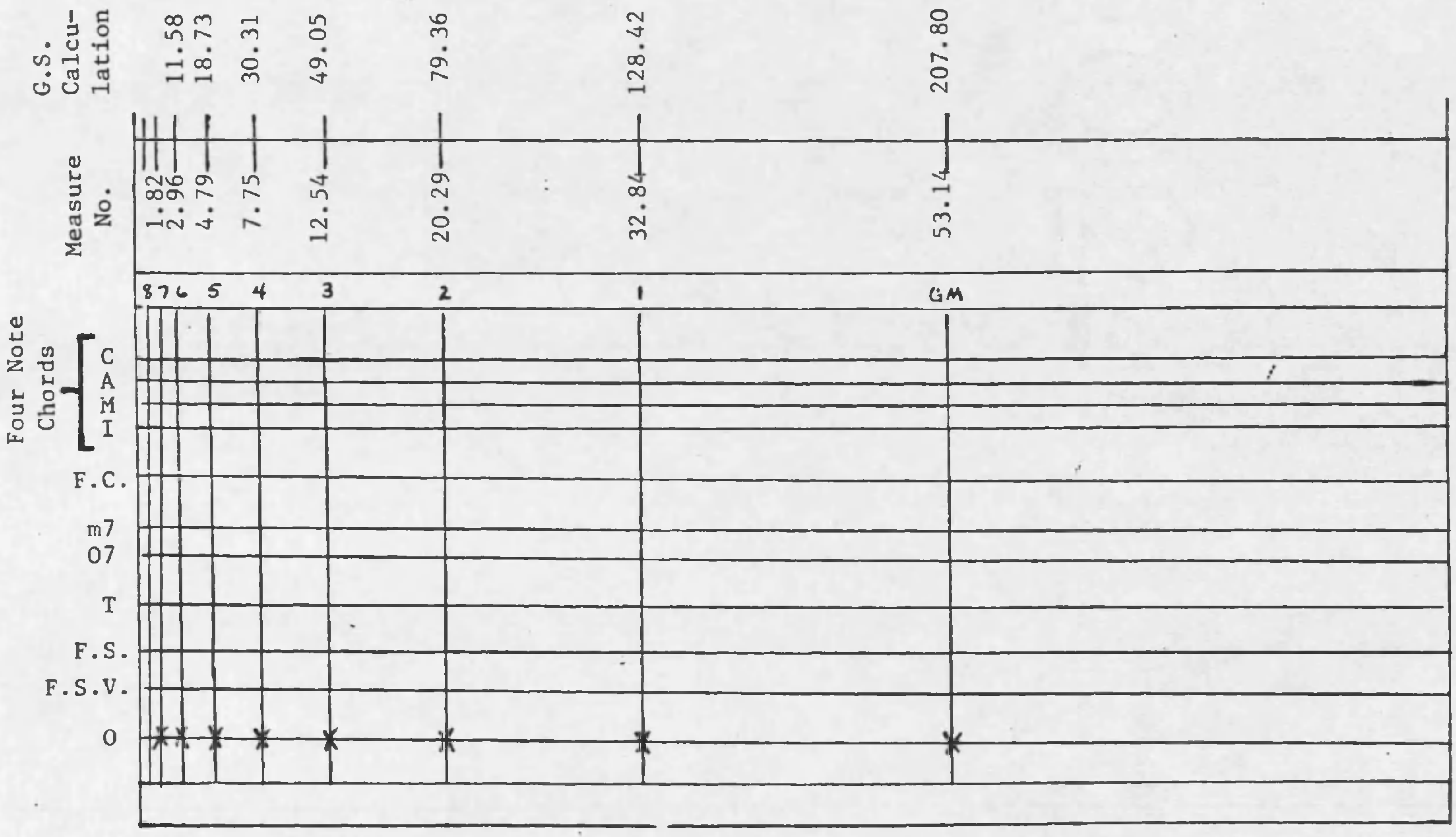


Figure 79. Sixth Quartet-Fourth Movement. Proportions Based on Seconds.

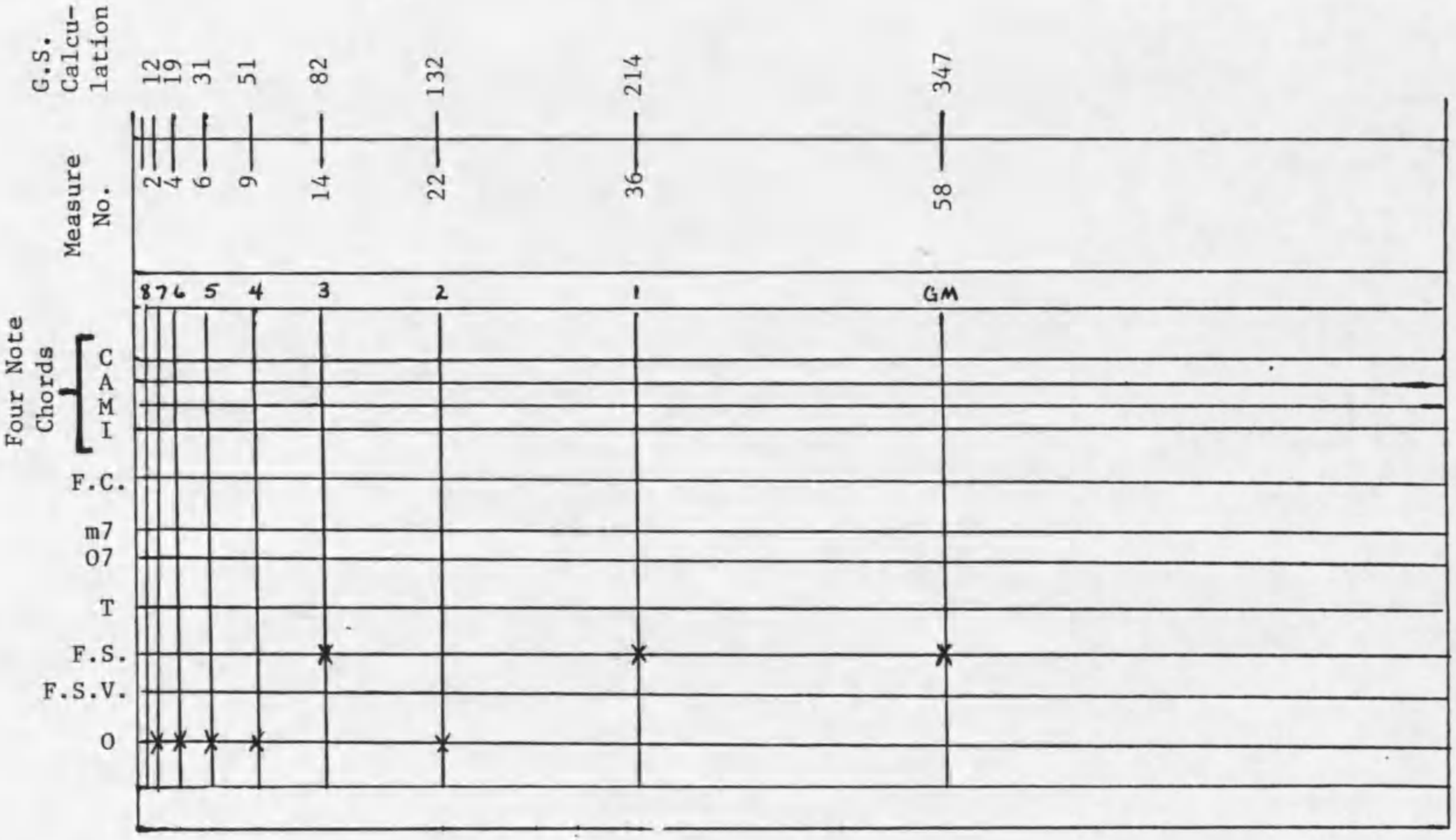


Figure 80. Sixth Quartet-Fourth Movement.
Proportions Based on Eighth-Notes.

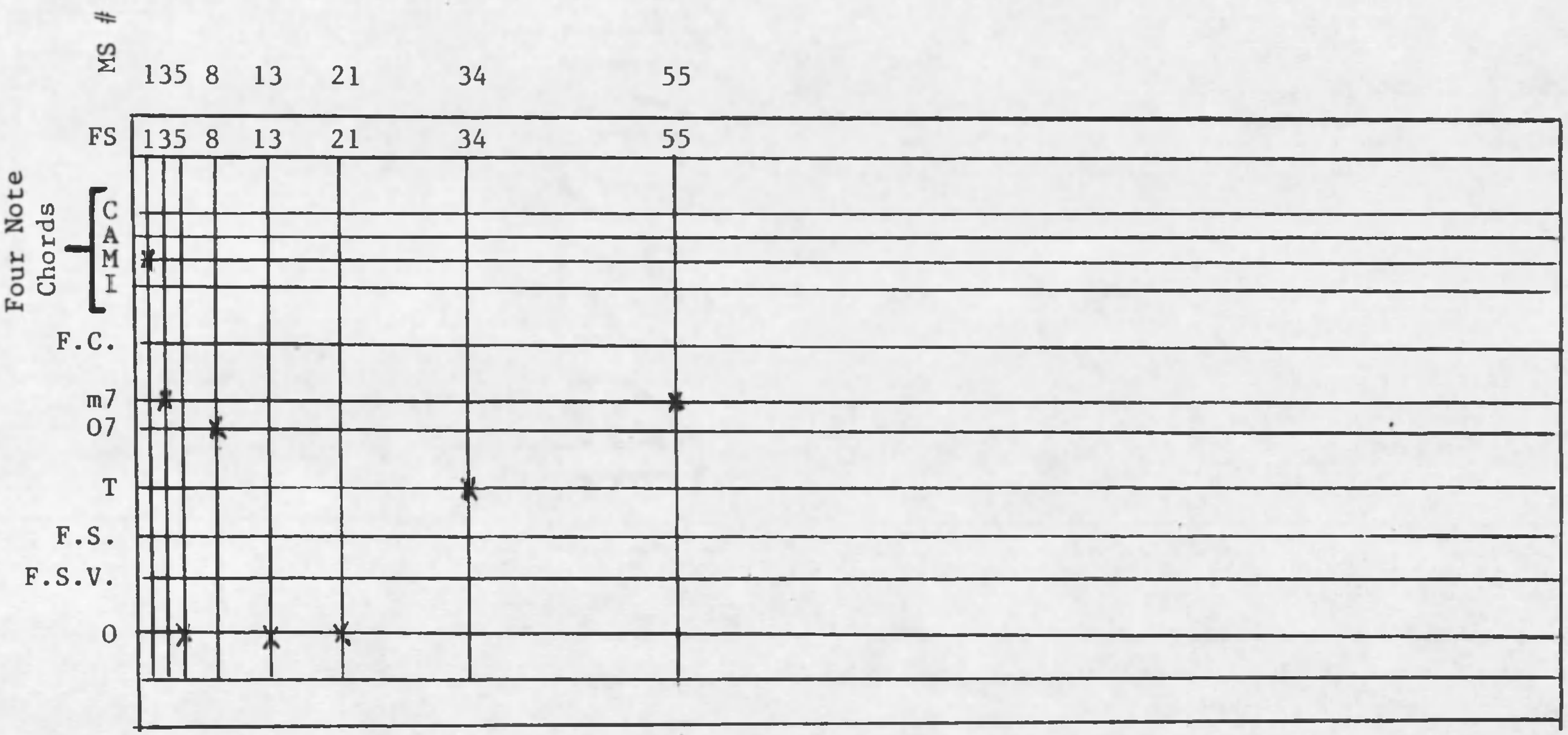


Figure 81. Sixth Quartet-Fourth Movement.
Proportions Based on the Fibonacci Series.

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