United States Patent

Barra

[15] **3,698,277**

[45] **Oct. 17, 1972**

[54] **ANALOG SYSTEM OF MUSIC NOTATION**

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[22] Filed: **May 23, 1967**

[21] Appl. No.: **640,700**

[52] **U.S. Cl.** **84/483,** 84/484, 283/47

[51] **Int. Cl.**.....**G10b 15/00**

[58] **Field of Search** ...84/483, 470, 484, 485; 283/47

[56] **References Cited**

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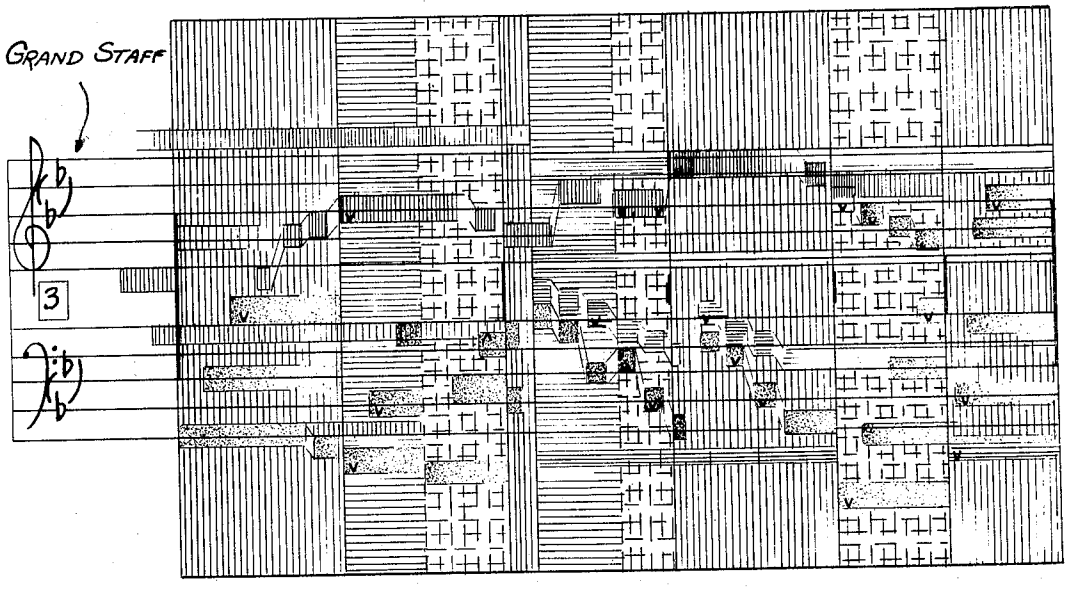
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Assistant Examiner—John F. Gonzales
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[57] **ABSTRACT**

A system of musical notation in which the sound pattern constituting a musical composition is recorded essentially in visual forms which represent the duration, pitch, intensity and other significant characteristics of organized sound.

1 Claim, 11 Drawing Figures



ANALOG NOTATION

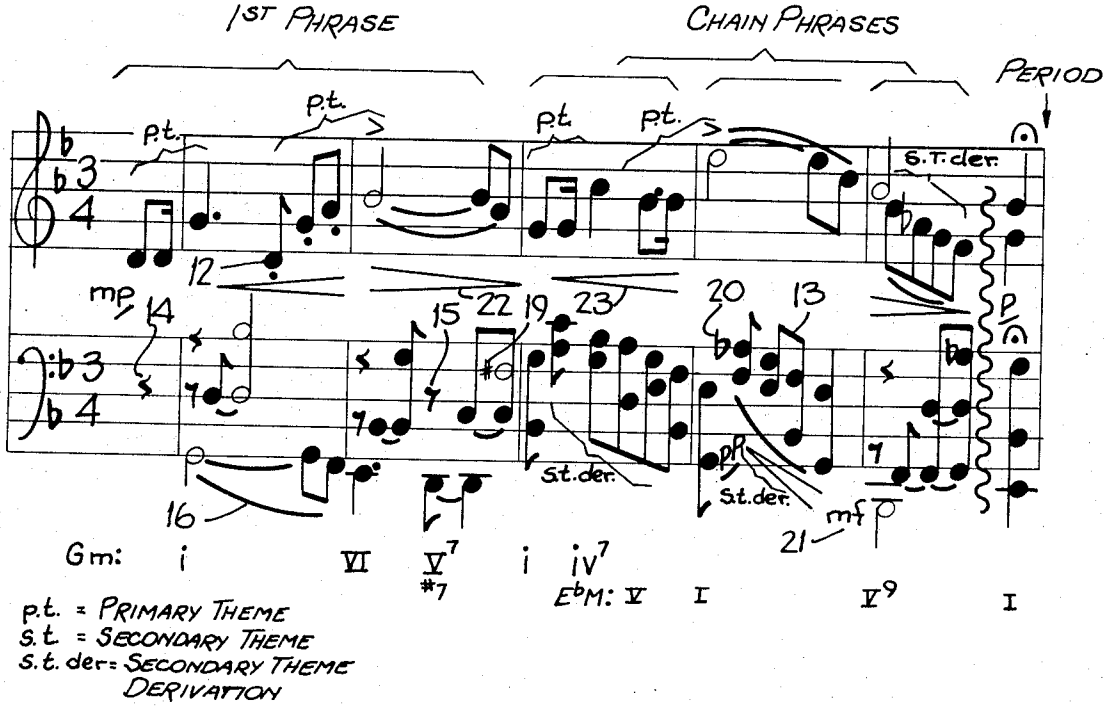
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SHEET 1 OF 5

Fig. 1.

(TRADITIONAL NOTATION)



p.t. = PRIMARY THEME
S.t. = SECONDARY THEME
S.t. der = SECONDARY THEME DERIVATION

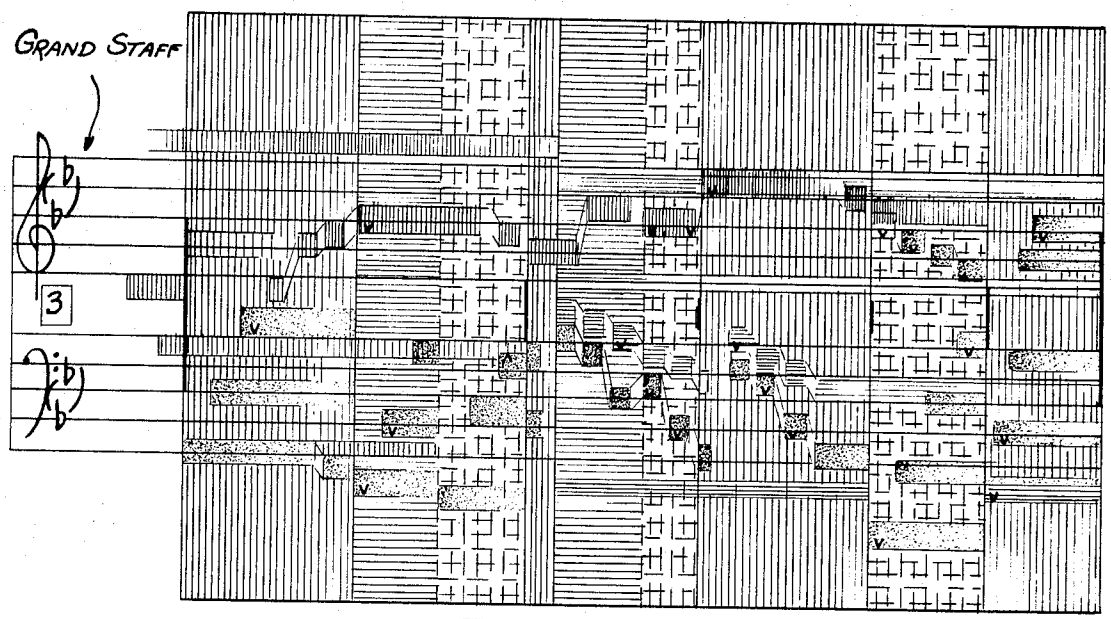


Fig. 2.

ANALOG NOTATION

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Fig. 3.

TRADITIONAL NOTATION FOR NOTE DURATION, PITCH AND METER
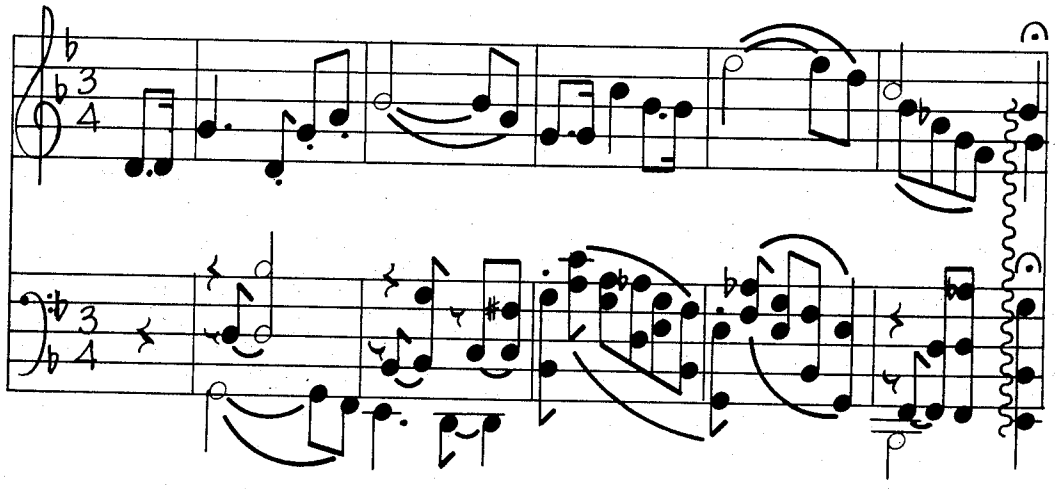


Fig. 4.

ANALOG NOTATION

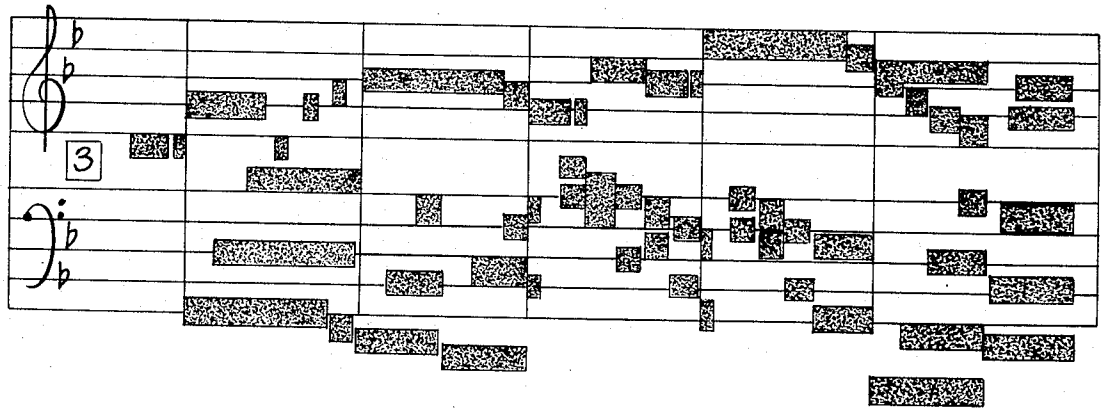
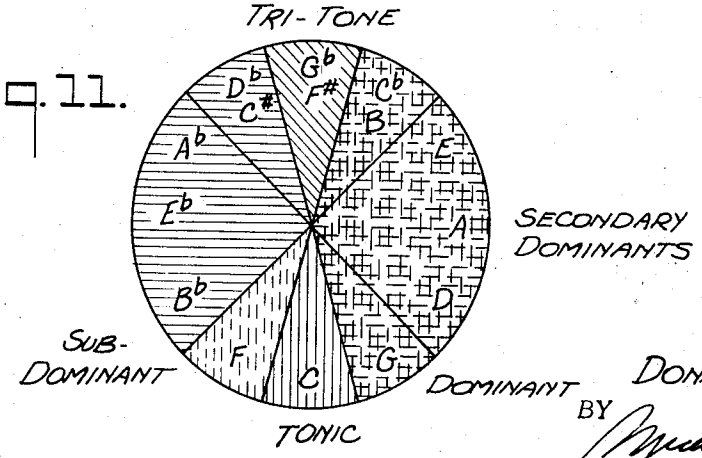


Fig. 11.



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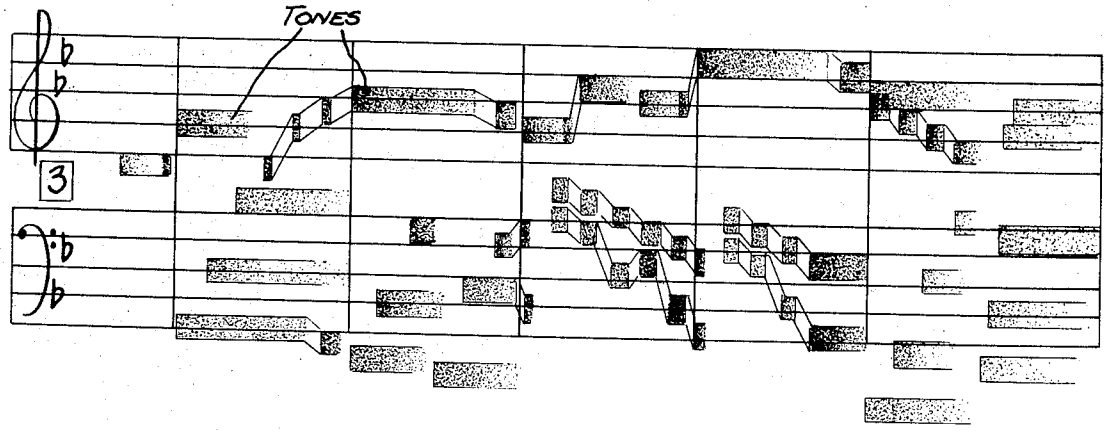
Fig. 5.

TRADITIONAL NOTATION FOR NOTE DURATION, PITCH AND METER
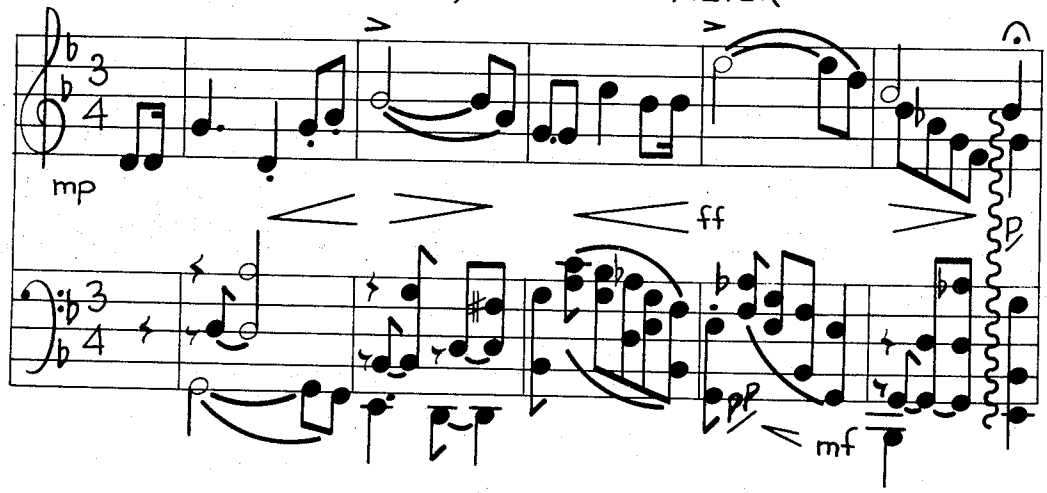


Fig. 6.

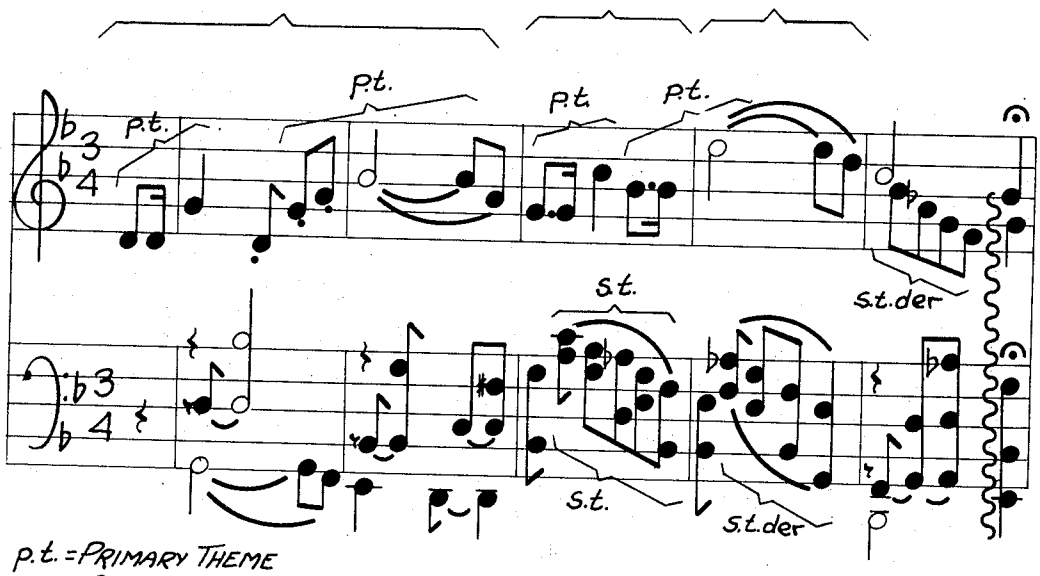
ANALOG NOTATION FOR DYNAMICS



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Fig. 7.

TRADITION NOTATION FOR ANALYSIS



p.t. = PRIMARY THEME
s.t. = SECONDARY THEME
S.T. der. = SECONDARY THEME DERIVATION

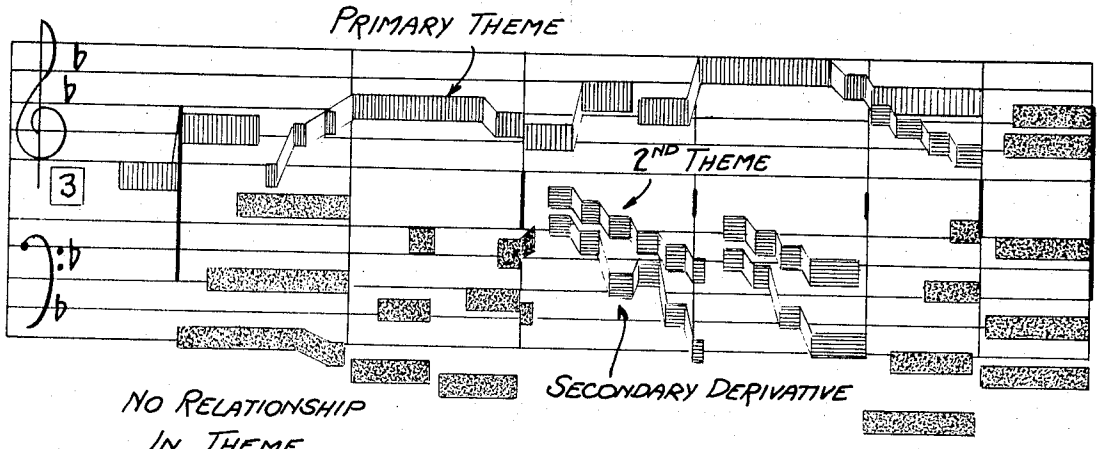


Fig. 8.

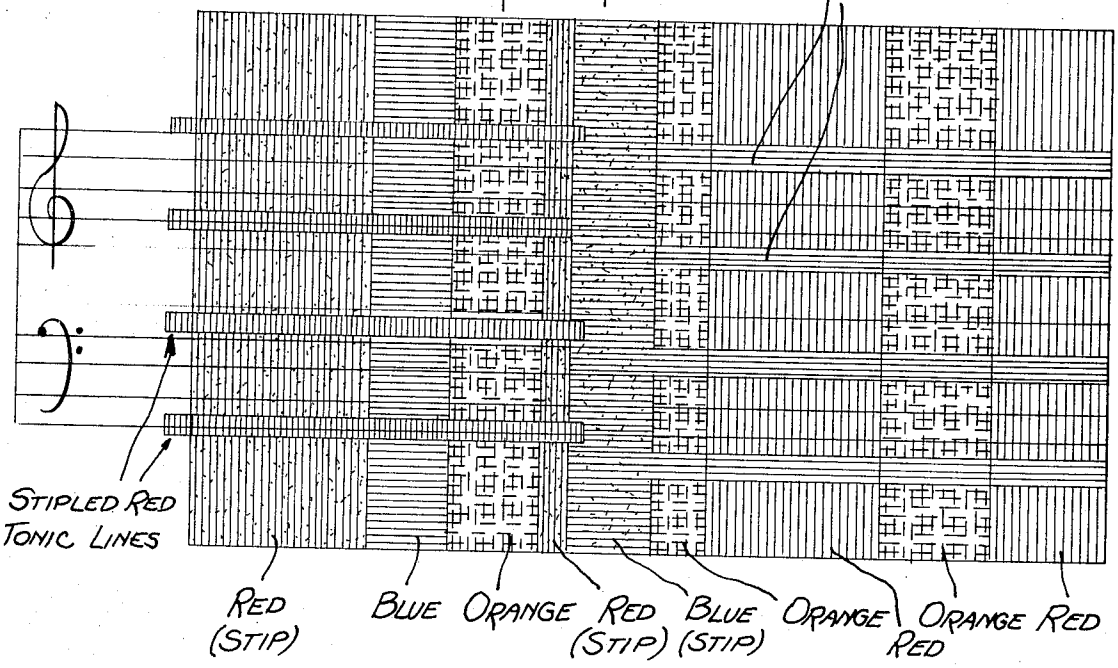
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Fig. 9.

TRADITIONAL NOTATION FOR HARMONY AND TONALITY
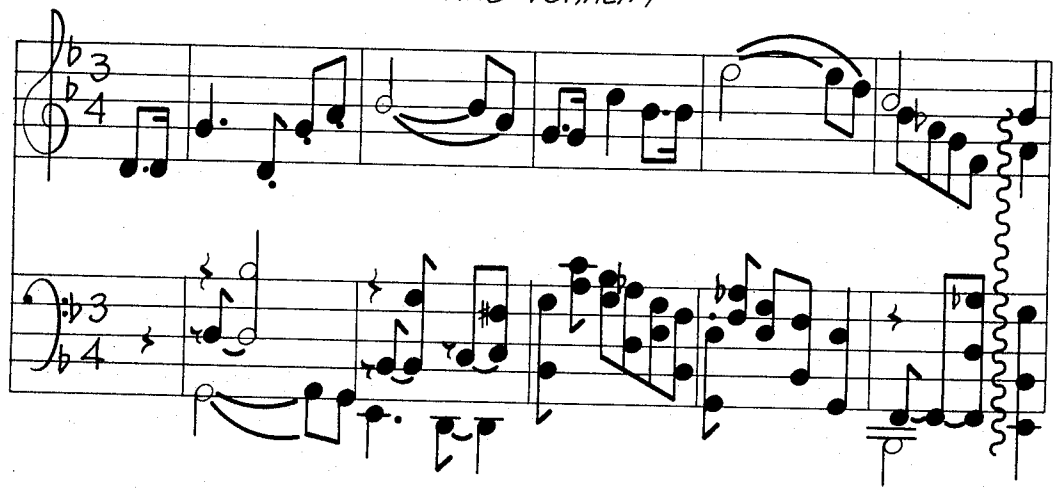


Fig. 10.



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ANALOG SYSTEM OF MUSIC NOTATION

This invention relates generally to musical notation and more particularly to an analog or graphical system of notation in which a sound pattern is essentially recorded by analog visual values which represent the various characteristics of organized sound.

Music is a pattern of sounds of varying frequency organized in time. In order to record and communicate musical compositions, various systems of notation have been devised in which the sounds constituting the pattern are represented in code form or by symbols. These symbols serve to designate the four principal characteristics of musical tones: namely; duration, pitch, intensity and quality. The existing symbolic system of notation is essentially a code or language wherein for example a tone of one duration is identified by a given symbol and a tone of longer duration by a distinctly different symbol.

Attempts have been made to improve the traditional system of notation, but these have in all instances also involved the use of symbols. Thus in U.S. Pat. Nos. 1,551,819, 1,483,380 and 1,539,308 conventional symbols have been replaced or simplified by other symbols to facilitate sight reading or for other purposes.

The language of musical symbols can be understood only by those who have carefully acquired the skill to do so. Paradoxically, this language is both complex and inexact, for a simple musical phrase might contain as many as fifty different symbols without however precisely communicating the composer's intention. Tonality, modulation and harmony are difficult even for a highly skilled musician to analyze from an orchestral score. A non-musician, lacking training in musical notation, however responsive he may be to musical sounds, is altogether incapable of reading a score in traditional symbolic notation or of comprehending the shape and character of the composition.

One reason for this difficulty is that a notation system based on symbols involves a translation process for which the reader must be thoroughly trained. The facility to read complex musical scores takes years to acquire. This difficulty can best be appreciated by cybernetic analysis.

Cybernetics is a science based on a comparison of the human nervous system and brain with automatic electromechanical systems or computers. Computers fall into two broad operating classes, the digital and the analog. In the digital computer, the information fed into the system is converted into a code formed by symbols. Thus if the computer is being used to analyze a changing phenomenon such as a varying temperature, different levels of temperature will be converted into discrete binary values formed by plus and minus signs.

In an analog computer, the varying levels of temperature will be converted into a value which is similar or proportional to these levels. For example, if a temperature goes from one level to a level twice as high, in the digital system one binary code number will represent the first level and another binary code number the second, whereas in an analog system, the magnitude of a voltage representing the first level will increase in degree to double its initial value.

The human sensory system is more sensitive physiologically to analog values than to a code or symbols, for to respond to symbols an intellectual decoding process is entailed, whereas the response to analog

values is unconscious and direct. Moreover, a symbolic language is a cultural acquisition, whereas an analog language is universal and independent of cultural conditioning.

For example, to express the concept that an object is big or small, different words or symbols for this purpose have been devised and are employed in various parts of the world. These words can give only a rough rather than a precise impression of quality or dimension. Even when the word "big" is further qualified as being "very big" or "not so big", its meaning remains imprecise. But if the size of an object is conveyed by the spacing between a person's hands, that is by an analog, one can by varying this spacing give a much more exact impression. This visual analog can be understood by all peoples, regardless of differences in language.

Thus dynamic changes in magnitude or degree may be expressed and more readily understood by a person in terms of changes in light intensity or in color rather than by words or symbols, for the analog meaning of the former is universally and directly sensed in terms of visual images whereas the meaning of symbols must be decoded, and even when understood they provide impressions which are indefinite. The existing system of musical notation, which is essentially symbolic in nature, suffers from this very drawback, and while useful for trained musicians, it constitutes a barrier to musical knowledge in the path of the non-musician.

Accordingly, it is the main object of this invention to provide a novel system of musical notation, which is based on analog representations for the characteristics of sound.

More specifically it is an object of the invention to provide an analog system in which the elements of a musical pattern such as form, harmony, tonality and modulation, are represented graphically, whereby the reader is readily able to read and analyze compositions.

A significant advantage of the invention is that it not only provides composers and musicians with a more exact form of notation and thereby expresses the composer's quantitative and qualitative intentions in more definite terms, but it also affords non-musicians as well as musicians with a vivid sound picture or structural diagram of the composition rather than with abstract symbols whose analysis entails a high order of skill.

Briefly stated, in an analog system of musical notation in accordance with the invention, the traditional grand staff is retained, but the treble and bass staffs are divided by only two spaces with middle C directly between them. Tones are represented by solid bands whose width is such that each band occupies the width of one staff space. The tone band is placed in the staff at a level depending on its pitch and it is given a length proportional to its duration. The loudness or aural intensity of a tone is reflected by the visual intensity or color temperature of the band.

To aid in melodic identification, themes are indicated in different tone colors, whereas the formal element of a composition, such as phrases and double periods, are delineated by vertical lines of different length parallel to the bar lines. Harmony is represented by background colors, the various harmonic functions being indicated by differently colored backgrounds. Tonic lines are drawn over the staff lines to identify tonic pitch, minor keys being shown by lines having a

stipled texture, modulations being also represented by the use of color.

Thus the notation system makes of record a musical pattern in terms of visual analogs expressed in dimension, color and intensity, rather than by symbols, so that one reading a score while listening to a composition can at the same time follow the shape and character of the music. The reader can watch each musical element separately as well as in interaction, and observe the elements in visual terms as the sounds complement or conflict with one another. He is thereby able to visualize the tonal relationships which constitute the essence of music.

In this way professional musicians as well as amateurs and those studying music appreciation can quickly learn to read and analyze compositions, including sophisticated modern orchestral works. Students can in a sense actively participate in a performance and recognize when the performer's execution deviates from the composers intensions. The analog system of notation not only is of great value in writing music in more exact terms, but it opens up for students and non-musicians new doors of understanding to the essential nature of musicial composition.

For a better understanding of the invention as well as other objects and further features thereof, reference is made to the following detailed description wherein:

FIG. 1 is a musical score using the traditional system of symbolic notation;

FIG. 2 shows the same score recorded by the analog system in accordance with the invention;

FIG. 3 shows a traditional score wherein the symbolic notes represent the duration, pitch and meter of the tones;

FIG. 4 shows the corresponding score using the invention;

FIG. 5 shows a traditional score using symbols for thematic analysis, structural divisions and phrasing;

FIG. 6 shows the corresponding score using the invention;

FIG. 7 shows the traditional score using symbols for dynamics;

FIG. 8 shows the corresponding score using the invention,

FIG. 9 shows a traditional score with symbols for harmony and tonality;

FIG. 10 shows the corresponding score using the invention; and

FIG. 11 is color chart or wheel explanatory of the color principles underlying the invention.

Referring now to FIG. 1, there is shown a small section of a musical composition represented by the standard system of notation. In music, we react to four principal characteristics of tones, their duration, pitch, intensity and quality. While these will now be analyzed individually, in practice they are strongly interdependent.

The duration of a tone is the time the sound lasts. Traditional notation signifies the relative duration of tones by a system of symbols, usually employing the ratio 1:2. Thus in FIG. 1, symbol **10** is a half-note, symbol **11** a quarter-note and symbol **12** a sixteenth-note. Notes of shorter value are often joined together as shown at **13**. Notes can be prolonged by adding a dot thereafter. Symbols for silence, called rests, follow the same ratio system as notes. Thus we have a symbol for a quarter rest, as shown at **14**, and an eighth rest as shown at **15**.

The legato style of performance in which tones are so closely connected that no audible interruption occurs is indicated by a curved line or slur, as shown at **16**.

Pitch is sometimes inaccurately referred to as the highness or lowness of a note, but actually it represents its frequency of vibration. Music employs fundamental frequencies of about 16 to 4,186 vibrations per second. The A sounded by an oboe for the preliminary tuning of an orchestra has a frequency of 440 vibrations per second. The pitch difference of an octave results from sounding two tones whose frequencies are in a 1 to 2 ratio.

Pitch is conventionally indicated by the position of notes on a set of five lines called the staff, notes being placed either on the line or in the spaces therebetween. Definite pitches will be presented only by these notes when a clef or key is placed at the head of the staff; the most common being a bass clef, as shown by **17**, and a treble clef as shown by **18**. A note can be raised a half tone by a symbol called a sharp (note **19**) and lowered to the same degree by a flat (note **20**).

The intensity of a musical tone produces the sensation of loudness, the varying degrees of which are responsible for the dynamics of music. Symbolically this is represented in traditional notation by *f* for forte or loud and *p* piano or soft. Gradations are indicated by *ff* for very loud, *fff* for extremely loud and *mf* for moderately loud (note **21**). In the soft range we correspondingly have *pp*, *ppp* and *mp*. An increase in loudness or a crescendo is indicated symbolically by symbol **22** and a decrease or descrescendo by symbol **23**.

Two fundamental concepts of music arise from the successive arrangement of tones; rymthm and melody. A third concept is based on harmony which is a pattern resulting from simultaneously produced tones. Rhythm is concerned with the accent given a tone, and this may be produced by a change in intensity or a change in texture and tonality. But meter deals solely with patterns of duration or time. Metric groups known as measures are indicated by vertical bars. The upper figure in a time signature indicates the number of pulses in a measure, whereas the lower figure gives the relative time value of the unit of notation. Thus the time signature 3/4 indicates a triple meter. The tempo of music is the rate of the musical pulse, and this is indicated by descriptive words, such as Adagio for slow and Allegro for fast.

A melody is an organized succession of single tones. The pitch relationship existing between the tones of a melody are summarized by chains of successive tones called scales. The labeling of a scale depends on the name of the tone on which it is based and its internal construction: i.e. the number and position of its half-steps. Thus we have a major scale with half steps between the third, fourth, seventh, eighth scale degrees and a minor scale where the half steps have a different internal structure. The major and minor scales are known as diatonic scales composed of a series of whole steps and salient half steps. But other divisions of the octave are possible, to produce for example a chromatic scale.

Tonality is the relationship between the tones of a melody as summarized by its scale and as determined by its basic note to which the melody returns. This focal term is called the tonic. Change in tonality is identified as modulation. Two or more melodies played simultaneously give rise to polyphony.

In the foregoing we have not exhausted all of the elements of musical composition. It will be apparent however that regardless of the musical pattern, it is composed of tones whose pitch, duration, intensity and quality and the relationship therebetween in time determine the nature of the composition. These relationships can be highly complex or very simple, and the problem of notation is to provide a language which accurately reflects the intention of the composer over the prior ones which merely gives a rough idea thereof.

FIG. 2 shows the traditional notation of FIG. 1 converted into corresponding analog notation according to the invention. It will be seen that while the grand staff, along with its clef and bar lines has been retained, the treble and bass staffs are separated only two spaces, with middle C placed directly between them. Traditional symbols for notes are absent and instead the notes are graphically represented in conjunction with a color which in the drawings are indicated by cross hatching. Thus hundreds of arbitrary symbols are avoided and any score can be reduced to one grand scale.

In order to demonstrate the analog technique as applied to duration, pitch and meter, apart from all other considerations, we will not at this stage refer to FIG. 2 which includes all musical characteristics, but to FIGS. 3 & 4 which are confined to the characteristics of interest, FIG. 3 showing the traditional notation and FIG. 4 the new technique.

It will be seen in FIG. 4 that each musical tone is represented by a solid tonal band having the width of a staff space. Duration is represented by the proportional length of the tonal band. Thus in 4/4 time, a whole note is held for a full measure and would be represented by **0** in traditional notation. This symbol must be translated by the reader into duration, whereas in the present technique a whole note is represented visually by a tonal band extend-the entire length of a measure, that is from bar line to bar line.

Fractions of a whole note are represented by lengths, directly proportioned thereto, not in incremental terms by symbols for half-notes, eight-notes, etc. In symbolic notation, it is not possible exactly to represent the desired duration, and when a note is to be held for a longer interval, a dot is used. But with an analog system, the precise fraction of a whole tone can be represented graphically whether or not it is in a 1:2 ratio. Rests are represented not by symbols but merely by the spaces between successive tone bands.

The pitch of the tones is represented by the staff positions, as in traditional notation, inasmuch as this is already an analog; hence the higher the pitch, the higher the staff position. The staff, clefs and accidentals of traditional notation are used, but in place of a time signature, a number indicating the number of beats per measure is placed between the staves (note number **3** in FIG. 4). A square around this number indicates simple time, while a triangle is used to indicate compound time.

Dynamics are represented analogously by the proportional intensity of the tonal band. For reasons which will be explained later, the tonal bands are colored, hence changes in the intensity will not be in gradation of gray from white to black but in changes in color intensity or temperature, from a light to dark hue. Thus a light tone band indicates a soft sound, and a dark tone band a loud sound, intermediate values being represented by gradations in color intensity.

Dynamic notation in the traditional and new form is shown in FIGS. **5** & **6** respectively. It will be seen in FIG. **6** that in place of the usual symbols, the intensity of the tonal bands are varied. A crescendo is indicated by a darkening tonal band and a diminuendo by a fading tonal band. The climax occurs in measure **4** of FIG. **6** which is darkest.

In FIGS. **7** & **8** there is compared the traditional notation for thematic analysis, structural divisions and phrasings in addition to the elements of duration, pitch and meter. In FIG. **7**, the primary theme is identified by the characters *p.t*, the secondary theme by *s.t.* and the secondary theme derivation by *s.t.der.*

It will be recognized that it is difficult when using the traditional form of symbolic representation to visually separate the themes, but in FIG. **8** different colors are used for thematic material. These colors are represented in figure by different forms of cross hatching.

Thus the primary theme may use red for the tone bands, while blue is used for the secondary theme. Phrases in blue-gray (measures **3**, **4** & **5**) indicate similarity to the secondary theme which in this case is primarily rhythmic in measures **3** and **4** and rhythmic and melodic in measure **5**. Gray tone bands indicate no thematic relationship.

Phrasing is indicated by extending the upper and lower outlines of the tone bands. Phrases are indicated by dark vertical lines parallel to the bar lines. These lines are short when indicating short phrases and progressively longer for periods, sections, etc. Thus the structural divisions of a composition, motive, phrase, chain phrases periods, double periods and so on, are represented in accordance with the analog principle.

The element of harmony and tonality are represented traditionally in FIG. **9** and in the new analog form in FIG. **10**. In FIG. **10**, harmony is represented by a background "wash" and harmonic progression by a succession of colors in the background. Tonic function is indicated by a red background, sub-dominant function by blue and dominant function by orange. A minor chord is indicated by stipling the texture of the color background. The intensity of the color in the background is made to vary in proportion to the degree of harmonic dissonance. Hence by analogy, consonant chords are represented by color of light intensity and progressively dissonant chords by a progressively darker background.

Thus the darkest colors in FIG. **10** are the orange areas representing the most dissonant chords—a dominant **7th** in measure **2** and a dominant **9th** in measure **5**. Tonic lines are drawn lightly through the tonal centers and their color indicates the relationships of modulation.

Other harmonic relationships are also indicated as will now be explained by analogy between the circle of

fifths, and the color wheel, as shown in FIG. 11. In this wheel, C is the principle tonal center and is represented by the color red. C therefore is tonic.

The flat keys are represented on the blue side of the wheel and the brighter sharp keys on the yellow side. As the keys merge into each other, becoming different spellings for the same sound, the colors merge into green. Thus tonal relationships can be seen at a glance by color analogy, closely related colors pointing to closely related keys. Major and minor colors are represented by the primary colors and tri-tone by the exact opposite colors.

Returning now to FIG. 2, all of the analog forms are shown combined in a system of notation which supplants the traditional form. For accidentals, a symbol is added. Raised or lowered tones are indicated by an arrow in the appropriate direction located at the beginning of a tone band. Because of the absence of assorted heads, stems, flags, rests, phrasings, accent marks, dynamic terms and markings, transpositions and other abstract symbols constituting the complex language of traditional notation, one looking at a score in analog notation is able to perceive the internal structure of the music in a visual counterpart which reveals the thematic patterns and the interplay of the harmonic elements and other characteristics of the music.

While there has been shown a preferred technique in accordance with the invention, it will be obvious that many changes may be made therein without departing from the essential spirit of the invention.

Thus even with color absent from the analog system it still provides virtually all of the information presently given by traditional notation. The added use of color communicates to the reader vital musical intelligence far beyond that given by traditional notation. It is intended therefore in the annexed claims to cover the basic analog notation concept as well as the specific forms thereof.

What I claim is:

1. A recording in visual form of a sound pattern whose tones constitute a musical composition having different and concurrent themes, which recording is formed by:

A. converting the sound pattern to produce for each theme, a succession of visible solid tone bands whose lengths are proportional to the duration of the respective tones forming the theme, each band having a visual intensity which along its length is varied in accordance with the aural intensity of the tone indicated thereby,

B. applying the succession of tone bands so produced to a music sheet having a grand staff defined by spaced parallel lines, the bands being placed on the staff at levels depending on their pitch, the width of each band being equal to the space between adjacent lines, and

C. imparting a distinct color to each succession of tone lines whereby the themes may be distinguished from each other.

* * * * *