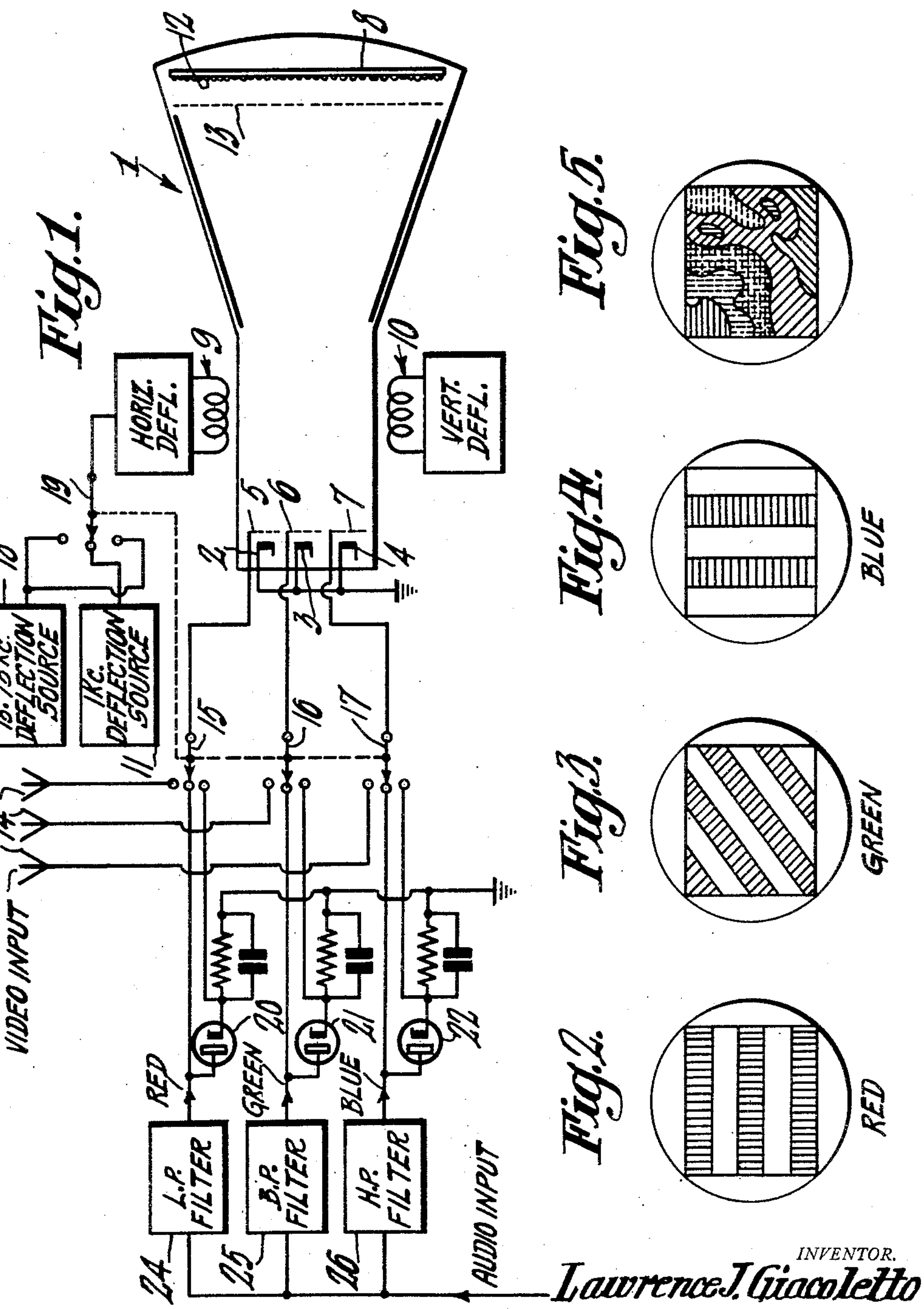
Aug. 27, 1957 L. J. GIACOLETTO 2,804,500

COLOR INTERPRETATION SYSTEM

Filed Oct. 1, 1953 2 Sheets-Sheet 1



INVENTOR.
Lawrence J. Giacoletto

BY [signature]

ATTORNEY

Aug. 27, 1957 L. J. GIACOLETTO 2,804,500

COLOR INTERPRETATION SYSTEM

Filed Oct. 1, 1953 2 Sheets-Sheet 2

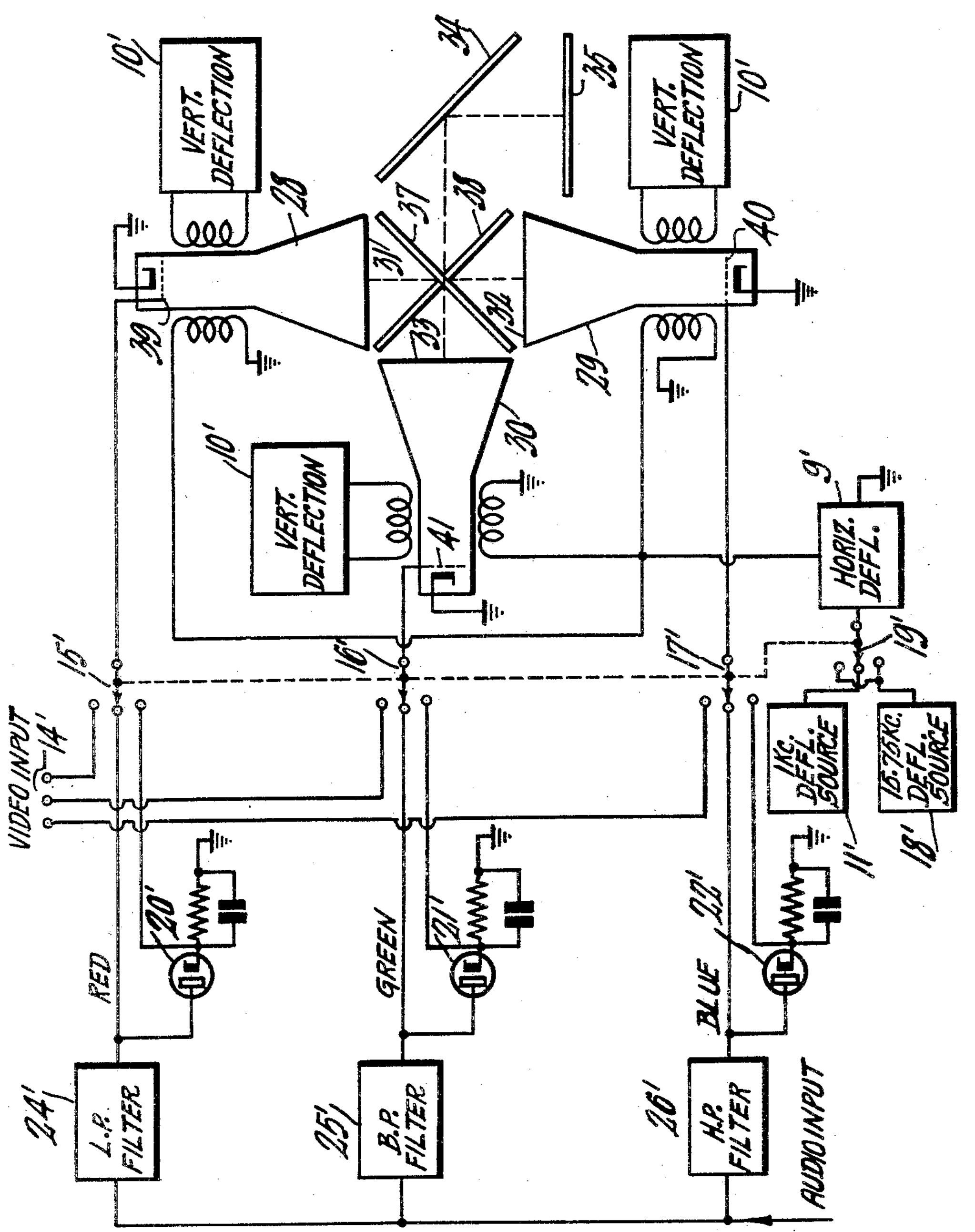


Fig. 6.

INVENTOR.
Lawrence J. Giacoletto

BY [signature]

ATTORNEY

United States Patent Office

2,804,500

Patented Aug. 27, 1957

1

2,804,500

COLOR INTERPRETATION SYSTEM

Lawrence J. Giacoletto, Princeton Junction, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application October 1, 1953, Serial No. 383,480

11 Claims. (Cl. 179—1)

My invention relates to a system for the visual portrayal and interpretation of sound and in particular to a system for converting music into colored geometric patterns.

Systems have been devised for interpreting sound, especially music in terms of color. The development of such systems has been a natural result of a long standing recognition that sounds are peculiarly susceptible to portrayal and interpretation by the many known shades and tones of color. Thus, for example, footlights and spotlights consisting of multifarious colors have been used in dramatic and musical productions for many years. This fact, of course, is a recognition that the artistic effect of such productions is considerably enhanced by the changing color compositions of the scenes. As a result of this recognition, systems have been proposed to coordinate the two effects into an audible and visual unit, the two effects combined serving to complement and augment each other producing a unified response which is superior and more effective than either effect alone.

The systems proposed in the past for correlating light and sound usually resolve themselves into devices whereby the sounds of a phonograph or any other sound reproducer are coordinated with a bank of many colored lights. The lamps are usually selected and controlled in accordance with either the frequency or amplitude characteristics of the sound energy from the reproducer, or both. Thus different colored lights may be selected in accordance with the sound frequency and the intensity of those selected may be varied in accordance with the sound intensity.

Such a system is disclosed and claimed in a patent to E. B. Patterson, No. 1,977,997. In accordance with the Patterson invention, sound from any suitable source is converted into an electric current which is amplified and then separated into distinct bands of frequency by a series of electrical frequency selective filters. The filtered currents are used to control the intensity of a plurality of banks of colored lights, each bank being of a different color.

Heretofore, when it was desired to change the geometric pattern of any illuminated area, it has been the practice to use revolving masks or diffusing crystals placed between the illuminated area and the light source. A very pleasing effect may be obtained if the color pattern is directly related to the audio content of the source, and wherein the patterns produced follow, in rapid sequence, the changes in the sound.

It is, therefore, an object of my invention to provide means for interpreting sound, and more particularly, music, in terms of a rapidly changing color pattern whose geometrical form and content are intimately related to the sound input.

Also, it is an aim of my invention to provide means, in a system for visually interpreting sound, whereby a color pattern is directly related to the audio content of the source and in which the pattern produced will follow the rapid changes in audio content.

2

A further purpose of my invention is to provide an improved system of the general type described in which moving mechanical parts are eliminated.

A still further object of my invention is to provide a novel system of the type under consideration which may be incorporated easily into a standard color television set.

In accordance with my invention means are provided whereby electric currents representing sound waves, are divided into frequency bands by means of suitable filtering devices. The currents representative of each band of frequencies are fed into separate paths and individually applied to the control electrodes of separate color cathode ray tubes or the different control electrodes of a single tri-color tube. Switching means are provided to change the input, which may be either video, audio, or rectified audio, to the various control electrodes in accordance with the wishes of the observer. In this manner, for programs consisting of both sound and pictures, where the picture may not be of interest, the viewer can switch from picture reception to a changing color portrayal or interpretation of the sound.

The above, and other objects, aims, and purposes of my invention are accomplished by the structures and arrangements set forth in the following detailed description of my invention when taken in connection with the accompanying drawings, in which:

Fig. 1 is a schematic representation of one embodiment of my invention;

Figs. 2, 3 and 4 are approximate representations of the picture on the face of the kinescope as used with the arrangement of Fig. 1 for different input sound conditions;

Fig. 5 is an approximate representation of the picture on the face of the kinescope or on an image screen for a condition wherein the geometric pattern is present; and

Fig. 6 is a schematic representation of another embodiment of my invention.

Referring in detail to the drawings, and in particular to Fig. 1, a simplified representation of one type of tricolor kinescope is indicated by the numeral **1**. A tricolor kinescope **1** suitable for employment in the practice of this invention has been well shown and described in an article entitled "A three-gun shadow-mask color kinescope" appearing in Part II of the RCA Review for September 1951 at page 466, et seq. The kinescope **1** has three cathodes **2**, **3** and **4** and three corresponding control electrodes **5**, **6** and **7**. The electrodes **2**, **3** and **4** control the intensity of the three electron beams produced by the respective cathodes and the electron gun structures. As the potential on these control electrodes **2**, **3** and **4** becomes more negative, fewer electrons will be drawn from the space charge adjacent to the cathodes.

The beams are deflected by any known method such as electrostatic or magnetic means. In Figure 1 a set of magnetic deflecting coils **9** and **10** is illustrated. The coils **9** and **10** exert a magnetic force on the electron beams so that when they emerge from the magnetic field, they have been deflected from their original direction. Each of the three electron beams may have its intensity controlled in accordance with signals from a transducer which converts the intensity of a particular color into corresponding voltage variations.

For the purposes of this invention, any colors may be used but red, blue and green will be chosen as examples. Thus, in Figure 1, the cathode corresponding to the red beam is indicated by the numeral **2**, the cathode for the green beam by the numeral **3** and the cathode for the blue beam by the numeral **4** The beams strike a cathodoluminescent phosphor screen **12** composed of a regular array of red, green and blue emitting phosphor dots or strips which are placed on the interior surface of the transparent plate **8** of the kinescope **1**.

If the dot form of target or screen is employed, the dots on the glass plate **8** are closely spaced in groups of three so that the center of a dot of each of the three colors is located at each apex or corner of an equilateral triangle. A perforated metal sheet **13** commonly known as a "shadow mask" is located in front of the phosphor screen **12** for partially masking the electron beams. The shadow mask **13** is so spaced with respect to the gun and the phosphor dots, and has such geometrical properties that the electron beam corresponding to the red components strikes only those phosphor dots which are red emitting. The shadow mask **13** also insures that the electron beams for green and blue strike only green and blue phosphors respectively. Thus the shadow mask in fact provides means whereby each electron beam has access only to one of three separate areas of a particular type of phosphor, these areas being physically interlaced to permit the production of a line raster by an electron beam which produces an area of illumination when it strikes the target. The line raster is therefore made up of a plurality of adjacent elemental areas of illumination in effect controllable as to color and intensity. Since each of the beams is capable of exciting only one of the primary colors, appropriate modulation of the beams with color intelligence will reproduce a picture in full color on the face of the kinescope **1**. It should be understood that the details of the kinescope **1** in themselves form no part of my invention, and are given by way of explanation only.

Switch arms **15, 16** and **17** are provided for changing the signals which are applied to the control grids **5, 6** and **7** of the kinescope **1**. A three position switch **19** is also provided to change the frequency of the horizontal deflection voltage.

Since the switch arms **15, 16** and **17** are gang-connected, all switches will be in the upper, middle or lower position at the same time. These switches are also ganged to the switch arm **19** which is associated with the horizontal deflection circuit. Thus, as the input to the control grids **5, 6** and **7** of the kinescope **1** is changed from video to audio or to a rectified audio, by moving the switch arms **15, 16** and **17** respectively to the upper, middle and lower positions the horizontal deflection switch arm **19** will simultaneously be moved to change the frequency of the horizontal deflection voltage. The source of horizontal frequency, it should be understood, may be a single source which can be varied within the desired limits.

The video signal applied at **14** is passed to the control grids **5, 6** and **7** when switch arms **15, 16** and **17** are in the upper position. In this position of the switch contacts the tri-colored kinescope tube is operating normally, i. e., in the presence of a video signal the electron beams will be modulated in accordance with colored picture information, and a design in full color will be reproduced on the plate **8** of the kinescope. Also, in this switch position the horizontal deflecting frequency supplied from source **18** will be the television horizontal deflection frequency standard of 15.75 kilocycles per second. The vertical deflecting frequency is maintained approximately at the television vertical deflection standard of 60 cycles per second.

When the switch arms **15, 16** and **17** are in the middle position as shown in Fig. 1, the switch arm **19** will also be in the middle position. In this setting the control grids **5, 6** and **7** of the kinescope **1** are connected to receive the audio input signal. At the movement of the switch to the middle position the horizontal deflection frequency may be lowered. By way of example, in the illustration shown and for the switch position indicated on the drawing, the horizontal deflection frequency from source **11** may be at a value approximating 1000 cycles per second.

In general, the audio signal will be taken from the audio circuit of any commercially available television set. It should be understood, however, that an audio signal from any source, such as a phonograph reproducer, may be used. For normal operation the audio signal will be present at the same time the changing colored pattern appears on the face of the tube. By tapping off the audio signal at some point in the system in advance of the place where the volume control unit of the audio stage of the set is located, the heard audio signal may be switched on and off in accordance with the wishes of the observer so that the changing colored pattern may be present without the sound.

The audio or music spectrum will be filtered into appropriate frequency bands by filters **24, 25** and **26**, and the output from the low-pass filter will be approximately in the range of frequencies from 30 to 500 cycles per second, the bandpass filter **25** will reject all frequencies except those in the 500 to 2500 cycles per second band, and those frequencies in the 2500 to 15,000 per second band will be passed by the high pass filter **26**. When the switch arm **19** is moved to its lower position, the arm **15, 16** and **17** will be simultaneously moved to their lower position. In this position the audio input will pass through the diode rectifiers **20, 21** and **22** and thence to the control grids **5, 6** and **7** of the kinescope. The horizontal deflection frequency will be 15.75 kc., the same as for video input conditions. It should be understood that although typical frequency values for horizontal scanning have been indicated they should not be considered unique, and the system will be operative for many different values of horizontal scanning frequency.

The music or audio spectrum is first divided into three bands by means of filters **24, 25** and **26** which may be any of the well known types. By way of example filter **24**, may pass frequencies in the 30 to 500 cycle range and reject all others. In the same manner filter **25** may pass frequencies in a band extending from 500 to 2500 cycles per second, and filter **26** may reject all frequencies except those falling within the 2500 to 15,000 cycles per second. These values are typical when the three primary colors are used in the kinescope. It is obvious, of course, that the filters may be changed according to either the selected colors or the wishes of the individual, and the values given by way of example, therefore, are not the only possibilities.

The output currents from the low-pass filter **24**, the bandpass filter **25** and the high-pass filter **26** are impressed respectively on the inputs of the diode rectifiers **20, 21** and **22** which may be of any conventional type. The direct currents in the outputs of the rectifiers will be representative of the audio input to each both in its amplitude and in the rate at which it fluctuates in amplitude. In this manner the envelopes of the filtered outputs are obtained. The rectified currents are then used to drive the control grids **5, 6** and **7** of the kinescope. Since the envelope of the filtered and rectified input energy changes relatively slowly with respect to time the picture on the face of the kinescope will be somewhat similar in appearance and effect to that obtained by the other systems using a bank of colored lights. The face of the tube at any given moment, under these conditions, will substantially be one color which will cover almost the entire plate **8** of the kinescope, and the multi-colored geometric pattern effect on the face of the kinescope will be absent. However, since the scanning process takes a finite amount of time, the picture will not be entirely one color. The circuit operation for the lower switch position is approximately the same, therefore, as the systems heretofore in use. In contrast to the previous systems, however, a fast changing colored light is available on the kinescope face which has practically no time lag. The fast changing character of the pattern is kaleidoscopic in nature and is due to the random relation of the sound signals to the relatively fixed horizontal and vertical deflection frequencies.

Referring to Figure 2, the picture on the plate **8** of the kinescope is illustrated for a low frequency condition, i. e., in the approximate range between 30 and 500 cycles per second. Under these conditions low frequencies will produce horizontal bands of red when the three primary colors, red, blue and green, are used. The number of bands will increase as the frequency of the signal is increased within the low frequency range. Thus for a particular choice of low frequency audio input to the grid **5** of the tube, a picture containing a series of red horizontal bands will appear on the face of the kinescope as indicated in Figure 2.

Medium frequencies, on the other hand, will produce either many horizontal bands of green or a few vertical bands of green depending upon the exact frequency of the signal. In Fig. 3 the particular frequency of the signal applied to grid **6** is somewhere between the two extremes, i. e., horizontal bands and vertical bands. The result is a series of diagonal bands of green. The particular pattern will, of course, be dependent on the exact frequency, and will vary in accordance with the frequency of the incoming signal.

Fig. 4 indicates the picture on the face of the kinescope for a single particular high frequency condition. It has been observed that high frequency input in the 2.5 to 15 kilocycles per second band produces vertical bands of blue on the phosphor screen. In a manner similar to low frequency conditions, the bands will increase in number as the frequency increases. Thus for a given choice of high frequency audio input to the grid **7** of the kinescope, a picture containing a series of blue vertical bands will appear on the face of the kinescopes as indicated in Fig. 4.

With a complex signal such as music in the audio input to the grids of the kinescope, the bands will not be seen as such, but a complex, changing, geometrical pattern will be produced on the plate **8** of the tube as illustrated in Fig. 5 of the drawing. The resulting picture somewhat resembles that of a kaleidoscope, except of course, that the geometry of the pattern is determined by the music. Fig. 5 then represents a typical tube picture for a general audio input with the geometric pattern and color content of the pattern shifting instantaneously in response to the audio content of the complex signal.

Referring now to Fig. 6, a schematic representation of another embodiment of my invention is shown. In the example illustrated three kinescopes **28**, **29** and **30** are employed and the images on faceplates **31**, **32** and **33** respectively, are reflected by means of a suitable optical system and superimposed on an image screen **35**. For purposes of illustration, the kinescope **28** is shown as the red kinescope, the kinescope **29** as the blue kinescope, and the kinescope **30** as the green kinescope. Viewed as a complete unit, the optical system for projecting the images on the faceplates of kinescopes **28**, **29** and **30** to the image screen **35** consists of a pair of crossed dichroic selective reflectors **37** and **38**, and a 45 degree plane mirror **34**. The relative positions of the optical components in the entire assembly are illustrated in Fig. 6. Other optical systems such as the one illustrated in a patent to D. W. Epstein, No. 2,590,240 may alternatively be used.

Light appearing on the faceplates **31** and **32** of the red and blue kinescopes **28** and **29** is reflected by means of the dichroic reflectors **38** and **37** respectively on screen **35** by means of plane mirror **34**. Light from faceplate **33** of kinescope **30** passes through reflectors **37** and **38** and is reflected by mirror **34** on screen **35** so that a single, registered, multi-colored configuration is produced.

The remaining portions of the circuitry as illustrated in Figure 6 are similar to that used and illustrated in Figure 1 and heretofore explained. The switching arrangement for connecting control grids **39**, **40** and **41** of the kinescopes **28**, **29** and **30** to a video signal, an audio input, or a rectified audio input, is similar to that shown in the embodiment of the invention illustrated in Figure 1. Thus, the horizontal deflection switch arm **19'** is gang connected to input switch arms **15'**, **16'** and **17'**. By moving these switches to any one of the three positions illustrated, similar results are obtained as for the case when a single kinescope is employed. In this manner the images appearing on the faces **31**, **32** and **33** of kinescopes **28**, **29** and **30** for the intermediate switch position will appear approximately as shown in Figs. 2, 3 and 4 respectively. Thus the image superimposed by means of reflectors **37** and **38**, and plane mirror **34**, on the image screen **35**, will be similar to the pattern illustrated in Fig. 5 of the drawings.

As illustrated also in Fig. 6 of the drawings three filters **24'**, **25'** and **26'** having low pass, bandpass and high pass characteristics, respectively, are serially connected to the control grids **39**, **41** and **40** of the kinescopes. It should be understood that these filters have characteristics similar to their counter-parts as shown in Fig. 1 and described above. Similarly the diode rectifiers **20'**, **21'** and **22'** are similar to the three input rectifiers as shown in Fig. 1, and are incorporated in the circuitry for identical reasons. Thus it is apparent that with the exception of the use of three kinescopes and an optical system for superimposing the images appearing on the kinescope faces, the embodiment of my invention as illustrated in Fig. 6 is identical to the embodiment illustrated in Fig. 1 and the numbers of corresponding elements are primed.

In this manner, the viewer may switch from the video input to the audio input if he becomes tired or bored with the picture. The particular utility of my invention will perhaps be realized to its best advantage for musical programs where the picture is of little interest, or in those situations where the viewer prefers not to concentrate on the picture and is interested in obtaining a soothing and attractive colored picture which changes with the musical content and is intimately related thereto. By means of my invention this result is achieved in a simple manner and the two effects, music and color, are combined into an effective unitary interpretation.

Although the invention has been described in terms of an audio input to the filters, it is evident that any signals, video or even random, may alternatively be applied.

It should be understood that my invention, as disclosed, is not confined to any particular television system, being equally adaptable to any one desired.

It is to be noted that other systems for combining optically the separate images appearing on the faceplate of each kinescope may alternatively be used without departing from the essence of this invention.

What I claim and desire to secure by Letters Patent is:

1. A system for displaying colored configurations representative of sound which has been converted into corresponding electrical variations comprising in combination, a low pass filter, a high pass filter and a bandpass filter, said filters adapted to receive and separate said variations into a plurality of different frequency bands, means coupled to said filters for detecting the envelopes of said frequency bands, a tri-color kinescope having a plurality of input circuits, switching means having a plurality of contact settings coupled to said plurality of input circuits, said switching means being adapted to apply each of said filtered frequency bands to each of said input circuits respectively in one contact setting, said switching means adapted to apply the detected envelopes of each of said filtered frequency bands to each of said input circuits respectively in another of said contact settings, and means coupled to said kinescope for controlling the horizontal deflection frequency thereof, said last-named means being coupled to said switching means so as to provide a different horizontal deflection rate when said switching means applies said detected envelopes to said input circuits than when said switching means applies said filtered frequency bands to said input circuits.

2. The invention according to claim 1 wherein said means for controlling the horizontal deflection frequency provides a slower rate when said switching means applies

said detected envelopes to said input circuits than when said switching means applies said filtered frequency bands to said input circuits.

3. The invention according to claim 2 wherein the slower horizontal deflection frequency is approximately 1000 cycles per second when said switching means applies said detected envelopes to said input circuits.

4. The invention according to claim 2 wherein said slower horizontal deflection frequency is approximately 1000 cycles per second and wherein the horizontal deflection rate when said filtered frequency bands are applied to said input circuits is 15.75 kc.

5. A system for displaying colored configurations representative of sound which has been converted into corresponding electrical variations comprising in combination, a low pass filter, a high pass filter and a band-pass filter, said filters adapted to receive and separate said variations into a plurality of different frequency bands, a plurality of means each of which is coupled to one of said filters for detecting the envelopes of each of said frequency bands respectively, first, second and third kinescopes each having means for controlling the intensity of the electron beam therein, switching means having a plurality of contact settings coupled to each of said controlling means, said switching means being adapted in one of said contact positions to apply each of said filtered frequency bands to one of said controlling means respectively, said switching means further adapted in another of said contact settings to apply the detected envelopes of each of said filtered frequency bands to each of said controlling means respectively, means coupled to each of said kinescopes for controlling the frequency of the horizontal deflection thereof, said last-named means also being coupled to said switching means so as to provide a different horizontal deflection rate when said switching means applies said detected envelopes to said controlling means than when said switching means applies said filtered frequency bands to said controlling means.

6. The invention as described in claim 5 wherein the horizontal deflection rate is slower when said switching means applies said detected envelopes to said controlling means than when said switching means applies said filtered frequency bands to said control means.

7. The invention as described in claim 5 characterized by another contact setting for said switching means, said switching means adapted to apply video signals to said controlling means in said last-mentioned contact setting, said means for controlling the horizontal deflection frequency being adapted to provide a horizontal deflection rate of 15.75 mc. when said video signals are applied to said controlling means.

8. An entertainment device for the aesthetic interpretation of sound in continuously varying kaleidoscopic patterns of light changing in color, shape and design as a function of changes in the amplitude of sound energy falling in predetermined ranges of the sound frequency spectrum, comprising in combination: a source of electrical sound signal; means for dividing said sound signal into at least first, second and third frequency ranges to produce respective first, second and third control signals; means for producing an optical light raster comprised of a predetermined number of spaced lines, said line raster being formed by the simultaneous scansion of an element of illumination in both horizontal and vertical directions over the area of said raster at predetermined fixed scansion frequencies randomly related to the frequencies falling in said first, second and third sound signal frequency ranges; signal responsive means operatively associated with said raster producing means and having at least first, second and third control signal input terminals for changing the color and intensity of light emitted by said element of illumination at any given elemental position in said raster; and means coupling said first, second and third control signals to said first, second and third color control signal input terminals for controlling the color and intensity of each element of said line raster as it is formed by the deflection of said element of illumination.

9. In a color television system for producing images in color by an optical line raster comprising a predetermined number of spaced lines formed by the simultaneous scansion of an element of illumination in both horizontal and vertical directions over the area of said raster at predetermined fixed scansion frequencies, the intensity and color of light emitted by said element of illumination being controlled at each elemental position in said line raster, an entertainment system for interpreting sound information in continuously changing kaleidoscopic patterns of color and brightness variations comprising in combination: signal responsive means adapted to receive color control signals for controlling the intensity and color of light emitted by said element of illumination at each elemental position in said line raster; a source of electrical sound signals embracing a predetermined frequency range, all frequency components in said sound signals being randomly related to both said vertical and horizontal scansion frequencies; filter means coupled with said signal source for dividing said sound signals into a plurality of frequency ranges the signals in each range being designated as color control signals; and means coupling said filter means to said color control means to apply said color control signals to said color control means for altering the intensity and color of said element of illumination as it defines said line raster.

10. In a color television receiver a system for the aesthetic interpretation of sound signals comprising in combination: a source of color television video signals; a source of sound signals; means for producing an optical light raster comprised of a predetermined number of spaced lines, said line raster being formed by the simultaneous scansion of an element of illumination in both horizontal and vertical directions over the area of said raster at predetermined fixed scansion frequencies randomly related in frequency to the signal frequencies comprising said sound signals; means coupled with said sound signal source for dividing said sound signal into low, medium and high frequency ranges to produce respective first, second and third color control signals; signal responsive means operatively associated with said raster producing means and having a first, second and third control signal input terminals for changing a respective and different aspect of the color and intensity of light emitted by said element of illumination at any given elemental position in said raster; and switching means connected with said source of color video signals, said dividing means and said signal responsive means for selectively applying either said video signals or said first, second and third control signals to said signal responsive means for controlling the color and intensity of each element of said line raster as it is formed by the deflection of said element of illumination.

11. In a color television system for producing optical images in color on a color kinescope reproducing means capable of producing a cathodoluminescent light image comprised of light from areas of at least a first, second and third type of cathodoluminescent material, each material type emitting a different color of light when excited by an electron beam, said kinescope reproducing means including an electron beam producing means and means continuously deflecting said beam in horizontal and vertical directions at fixed deflection frequencies to form a rectangular raster of lines, an entertainment apparatus for the aesthetic interpretation of sound signals comprising in combination: signals responsive input means for independently controlling the intensity of light emitted by each type of cathodoluminsecent material during deflection; a source of electrical variation representing sound signals, said electrical variations embracing the sound frequency spectrum and randomly related to the horizontal

and vertical cathode ray beam deflection frequencies; color control signal producing means including filter means connected with said source of electrical variations dividing said variations into low, medium and high frequency ranges to produce a first, second and third color control signals respectively corresponding in intensity to the amplitude of electrical variations falling in said low, medium and high frequency ranges; and means coupled with said color control signal producing means and said signal responsive input means for controlling the intensity of light emitted by said first, second and third types of cathodoluminescent materials by said first, second and third color control signals respectively.

References Cited in the file of this patent

UNITED STATES PATENTS

2,335,180	Goldsmith	Nov. 23, 1943
2,481,247	Schott	Sept. 6, 1949
2,501,788	Ross	Mar. 28, 1950
2,593,925	Sheldon	Apr. 22, 1952
2,615,975	Sziklai	Oct. 28, 1952
2,629,778	Potter	Feb. 24, 1953