Nov. 18, 1969 E. A. REED ET AL 3,478,637

AUDIO-TO-VISUAL PATTERN CONVERTING APPARATUS

Filed March 30, 1966

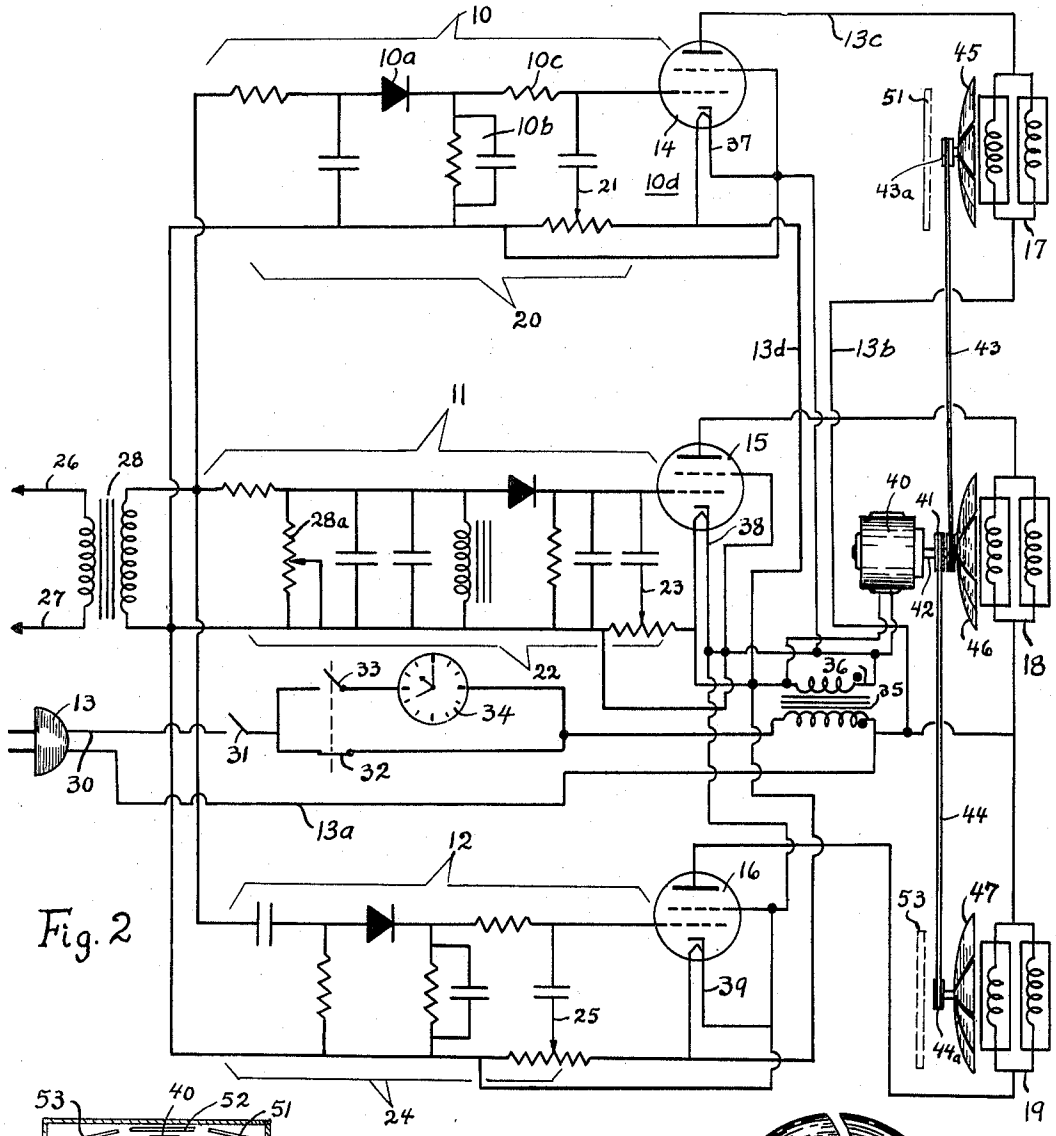


Fig. 2

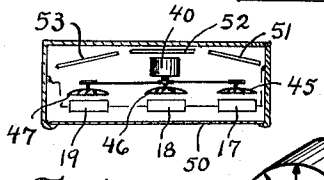


Fig. 4

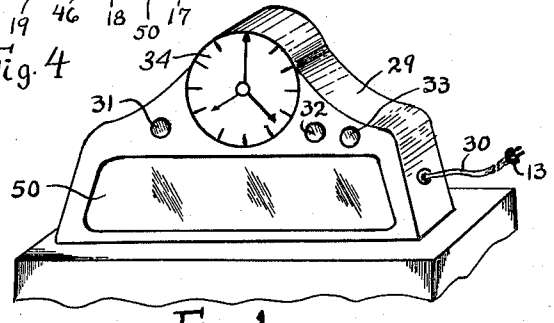


Fig. 1

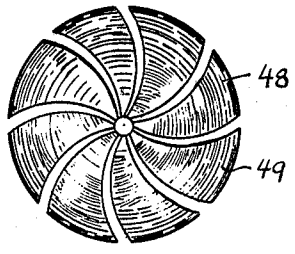


Fig. 3

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AUDIO-TO-VISUAL PATTERN CONVERTING APPARATUS

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U.S. Cl. 84—464 5 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for generating a pattern of changing colored lights on a screen as a function of the frequency variations of an audible signal. A plurality of channels are provided, one for each frequency band, each channel providing changes from dim light with soft sounds to very bright light with loud sounds. Means are provided to set the bias of each channel to adjust the sensitivity thereof and for varying this sensitivity over a wide range.

The present invention relates generally to apparatus for the visual interpretation of acoustic effects and more particularly to an apparatus to convert audio signals into a visual display of colors variable in accordance with change of frequencies of said audio signals.

It is well known in the art of color motion pictures accompanied by music that certain psychological moods or soothing effects can be produced in the observer and listener, by blending the harmony of music with lighting effects. To produce such effects in the home from articulate sound and music of radio, phonograph, and television, many types of light-controlled devices have been devised, but thus far they have not been successful in harmonious rendition of audio signals into visual representations. This difficulty may be contributed to the lack of sufficient sensitivity obtainable from earlier apparatus, because such equipments have been designed to control the illumination rather than the color tone of the visual display. Accordingly, it is one of the principal objects of this invention to provide a color effect intimately synchronized with variations in the volume and quality of sound produced by electrically-operated musical instruments, such as radio, television, phonograph, and like instruments.

A further object of the invention is to produce an audio-responsive apparatus which responds to all frequencies in the audible range and produces a variable visual display of color in correspondence with the varying audio-frequencies.

A still further object of the invention is to provide a plurality of colored lamps representing various colors of the visible spectrum, from blue to red, so arranged that higher audio frequencies will produce correspondingly higher frequency illumination (blue), and lower audio frequencies will produce correspondingly low-frequency light (red), and audio frequencies intermediate to these will produce illumination of light frequencies intermediate to red and blue; that is, yellow and green.

Another object of the invention is to provide a plurality of rotating reflectors with segments positioned, in the posterior aspects of said lamps, in random directions so that light patterns from differently colored lamps will never be duplicated when incident on a screen.

Another object of the invention is to provide a translucent screen disposed anteriorly to the colored lamps so that reflected light from the lamps can be blended with each other to form an over-all diffused color tone on said screen.

Still another object of the invention is to provide a circuit for directly connecting a plurality of colored lamps to a commercial source of 115 volts alternating current for

use of high wattage lamps in order to obtain spectacular displays.

One other object of the invention is to provide a plurality of audio frequency responsive channels of successively varying bands of frequency signals coupled to the corresponding colored lamps.

These objects and other advantages of the invention will become more apparent from the description of the specification taken in conjunction with the accompanying drawing, in which:

FIGURE 1 is a perspective view of a typical design configuration of the invention resting on top of a radio or phonograph console partially shown,

FIGURE 2 is a schematic diagram of the audio-to-visual converting system,

FIGURE 3 is a view in elevation of a typical illumination reflector forming a part of the invention, and

FIGURE 4 illustrates the illumination section viewed downward from top position, showing the arrangement of the colored lamps, reflectors, and mirrors which are positioned posteriorly to the reflectors.

In the signal converting system shown schematically in FIGURE 2, there are three audio frequency channels designated by numerals **10**, **11**, and **12**, receiving 115-volt A.C. operating power through an outlet power plug **13**. This power furnishes filament-heating current and plate voltages to the detectors **14**, **15**, and **16**, and also serves to supply electric energy to a small motor **40** and to the dual lamps **17**, **18**, and **19**, when the respective associated circuits of channels **10**, **11**, and **12** are energized. These lamps may have any suitable color and are interchangeable. The circuit of each of channels **10–12** contains a filter section **20**, **22** and **24**, respectively designed to transmit a preassigned band of frequencies and to suppress those outside the band. Each filter section contains a variable impedance section by which the selected channel circuit may be tuned to increase or decrease the signal intensity, whereby to respectively increase or decrease the illumination intensity of the corresponding lamps. An input transformer **28** is the primary source of electrical energy for the operation of channels **10–12** and is connected between an audio frequency signal source and said channels via lines **26** and **27**.

The operation of channel **10** is such that when an audio frequency signal is impressed across the secondary winding of input transformer **28**, the signal is applied to the filter section thereof which presents a high reactance to all frequencies other than those within the range of 0 to 410 cycles per second, thereby permitting only the bass frequencies to pass therethrough. The accepted bass signal is then applied to a rectifier **10***a* which is placed in channel **10** in such a manner that its polarity will permit only the positive portion of each cycle to continue therethrough, this positive portion of each cycle being applied to a wave shaping network **10***b*. The signal from wave shaping network **10***b* is applied via a resistor **10***c* to the grid of tube **14**.

The source of electrical energy for tube **14** is derived directly from any commercial 115 volt, A.C., 60 c.p.s. source via power plug **13**, lines **13***a*, **13***b* and **13***c* and lamp **17**. Since the total A.C. voltage is present at the plate of tube **14**, the same voltage is therefore placed across dual lamp **17**, the remainder of the circuit for current flow for the illumination of lamp **17** being from the plate to the cathode of tube **14** and through line **13***d* to the secondary of a transformer **35**, the primary of which is connected back to the A.C. source.

It is obvious that a continuous current flow through this circuit would result in a continual glow of dual lamp **17** which would completely defeat the purposes of the present circuit. Therefore, proper operation of the circuit is dependent on no current flow through tube **14** unless an

audio signal is present on the grid thereof. This condition is accomplished by placing a bias voltage on the grid of tube **14** to maintain such tube normally cut off. Since an A.C. voltage is always present at the plate of tube **14**, it is further necessary that this bias voltage be 180° out of phase with the voltage on the plate; that is, when a positive half cycle of A.C. voltage is present on the plate of tube **14**, a negative voltage must be applied to the grid thereof.

Such biasing is achieved by means of transformer **35** whose primary is connected to power plug **13** via lines **13***a* and **30** and whose secondary, in addition to providing the necessary voltage for the heaters of tubes **14**, **15** and **16**, serves as the source of the bias voltage mentioned hereinbefore. Since the primary winding of transformer **35** is connected to the same A.C. source as the plate circuits of tubes **14–16**, the voltage across the primary winding is in phase with said plate voltages. Therefore, the secondary winding of transformer **35** is connected to the grid circuits of tubes **14**, **15** and **16** in such a manner that the voltages applied thereto will be 180° out of phase with the voltage across the primary winding and therefore 180° out of phase with the voltage at the plates of said tubes.

Channel **10** further includes a bias control network **10***d* which comprises a potentiometer and capacitor combination. The purpose of the potentiometer is to provide the proper bias voltage to maintain tube **14** just below its cutoff point. The characteristics of tube **14** are such that when it is biased below its cutoff point, a positive signal from channel **10** energizes tube **14** thereby permitting activation of dual lamp **17**.

In this manner, tubes **14–16** act as threshold devices, positioned between the external audio signal source and dual lamps **17–19**, and operative to energize lamps **17–19** whenever the audio signals in the respective channels exceed an individually adjustable minimum value which is determined by the setting of the respective bias control networks.

The operation of channels **11** and **12** and the filter sections **22** and **24**, respectively, thereof is substantially identical to that described above for channel **10** and filter section **20** thereof with the following exceptions. The filter section **22** of channel **11** transmits only frequencies lying between 410 and 820 cycles, and the impedance section **23** provides the necessary grid-leak bias for the normal operation of the tube **15**, as described for tube **14**. The filter section **24** is a high-pass filter and transmits all frequencies within the range of 820 and 20,000 cycles; the impedance section **25** may be employed to adjust the bias of tube **16**. The grid-leak impedance sections are particularly useful because when it is desired to make the music soft, the same intensities of illumination as for loud music can be produced in the lamps as when loud music is playing.

In operation, audio signals from the loudspeaker of a radio, phonograph, or a similar musical instrument are led by conductors **26** and **27** selectively into the circuit of one or more of the filter sections **10**, **11**, and **12**, depending on the frequencies of the audio signals entering the system. A transformer **28** amplifies the audio frequency voltage prior to applying it to the filter responsive to the particular frequency and intensity of the transmitted signal, and the variable resistor **28***a* is used to shut off any static interferences. For instance, all audio frequency signals within zero and 410 cycles bandwidth of the detector **14** circuit will energize this tube, which will then pass current to the associated lamps **17** to light them to a brilliancy dependent on the transmitted energy. One of the lamps of the dual lamp section **17** has a red color and the other an orange color. The filament of the orange colored lamp has a lower resistance than that of the red colored lamp. Consequently, lower-energy signal intensity received from tube **14** will light the orange colored lamp first, the higher-intensity energy lighting the red lamp and increasing the brilliancy of illumination of the orange colored lamp.

Similar to the operation of detector **14** circuit, all audio frequency signals within 410 and 820 cycle bandwidth received by the detector circuit of tube **15** will light the dual lamps **18**, one of which is green and the other is yellow. The filament of the yellow lamp has a lower resistance than that of the green lamp and therefore the yellow lamp will glow first. Higher intensity signals within the bandwidth of this circuit will cause the green lamp to glow, while the yellow lamp will glow more brilliantly.

The circuit of channel **12** operates on the same principle as that in both of the previously described channels **10** and **11**. Audio frequency signals having frequencies above 820 cycles received through the conductors **26** and **27** will energize the detector **16** circuit. This action will cause a current flow to the lamps **19** from the plate circuit of tube **16**. One of the lamps of section **19** is light blue and the other magenta. The filament of the light-blue lamp has a lower resistance than that of the magenta lamp. Thus, lower-level (low intensity) signals energizing the tube **16** will cause the light-blue lamp to glow first. The higher-level signals will energize the magenta lamp and increase the brilliancy of illumination of the light-blue lamp.

It will thus be seen that the dual lamps **17**, **18**, and **19** will light with an intensity (brilliancy) in accordance with the variations of the incoming audio signal energies selectively activating the circuits of the detectors **14**, **15**, and **16**. Consequently, the variation in the pitch or frequency of audible sound of music or spoken words will selectively energize the detector circuits of channels **10**, **11**, and **12**, while the increase or decrease in loudness or amplitude of sound waves will respectively increase or decrease the intensity of the signal which energizes the detector tubes. Therefore, the intensity of the dual lamps **17**, **18**, and **19** will change selectively from a minimum to a maximum in accordance with the changes in loudness of the sound signal received through conductors **26** and **27**. With a very loud music program, if it is desired to reduce the sound amplitude and at the same time to retain the intensity of variations of light in the individual pairs of lamps, the respective tuning sections **21**, **23**, and **25** may be adjusted to obtain the desired illumination intensity from the lamps.

The entire electronic and illumination sections of the system may be compactly housed in a cabinet, an exemplary design configuration of which, designated by numeral **29**, is shown in FIGURE 1. The electric power is led into the cabinet **29** through the electric cord **30**, which may be plugged into any convenient 115-volt circuit outlet. The system operation can be performed in one of two modes: (1) a continuous-operation mode, and (2) a programmed-operation mode. If a continuous-operation mode is desired, the main switch **31** is first turned on, then the switch **32** is turned on. For a programmed operation, the switch **33** is turned on, while the main switch **31** is still on. The two switches **32** and **33** are so arranged that if switch **32** is closed, the switch **33** opens, and vice versa. For a programmed operation, the switch **33** channels the current from cord **30** into a clock mechanism **34**, which can be set, similar to a conventional electric-oven clock, to any predetermined time of start and stop in accordance with the program schedule of the radio, television, or similar programs, such as an orchestra program given in a theatre.

In either mode of operation, the input power from inlet **13** energizes the step-down transformer **35**; the low-voltage secondary **36** of this transformer supplies current to the filaments **37**, **38**, and **39** of the respective tubes **14**, **15**, and **16** as well as the beforementioned bias. The secondary current also furnishes energy to a low-speed motor **40**, which, through pulleys **41** connected to its shaft **42** and belts **43** together with respective pulleys **43***a* and **44***a* connected to the reflectors **45**, **46**, and **47**, rotates them at a slow rate. Each of the reflectors is shaped into a dish configuration, such as that illustrated in FIG. 3. Each reflector is segmented, such as at **48** and **49**, and each segment is slightly twisted to a random direction, so that light from each segment reflects in a different direction. The lamps **17**, **18**, and **19** and the respective reflectors **45**,

46, and 47 are enclosed in the cabinet 29 behind a translucent screen 50. Accordingly, the light reflecting from reflector, for instance, 45 may blend on the screen 50 with that reflected from reflector 46 or 47, or vice versa. In this manner, the screen is illuminated with a variable pattern at all times regardless of the frequency-responsive operative condition of channels 10, 11, and 12.

The arrangement of the lamps and the reflectors within the cabinet is illustrated, viewed from top, in FIGURE 4. Posteriorly to the reflectors are secondary reflectors of polished metal sheets or glass mirrors designated by numerals 51, 52, and 53. The mirrors are employed to further amplify the direct and stray illuminations reaching the screen 50.

From the preceding description, it will be apparent that the system is susceptible to various other modifications, such as by being transistorized, and by addition or subtraction of parts not specifically referred to in the specification, without departing from the scope of the appended claims.

I claim:

1. An audio-to-visual pattern converting apparatus adapted to receive audio signals and an A.C. voltage from an external source, comprising, a plurality of audio frequency channels responsive to said audio signals, each of said channels being responsive to a different band of frequencies in the audible frequency range, each of said channels comprising:

at least one illuminator; and

means operatively coupled between said external source of audio signals and said illuminator for energizing said illuminator when said audio signal exceeds a predetermined minimum value, said energizing means comprising:

a vacuum tube having a plate, a cathode and at least one control grid, said plate and cathode being connected in series circuit with said illuminator and said external source of A.C. voltage, said audio signals being applied to said control grid; and

means for applying said A.C. voltage to said control grid with a phase shift of 180° with respect to the A.C. voltage applied to said plate so as to maintain said tube in a cut-off condition in the absence of an audio frequency signal which exceeds said minimum value.

2. An audio-to-visual pattern converting apparatus according to claim 1 wherein said means for applying said A.C. voltage to said control grid comprises a transformer.

3. An audio-to-visual pattern converting apparatus according to claim 1 wherein said energizing means further comprises:

means coupled between said control grid and said cathode for varying the cut-off level of said tube to thereby adjust said predetermined minimum value, the predetermined minimum value of each of said channels being individually adjustable.

4. An audio-to-visual pattern converting apparatus according to claim 3 wherein said means for varying the cut-off level of said tube comprises a potentiometer.

5. An audio-to-visual pattern converting apparatus according to claim 1 wherein each of said channels comprises:

a plurality of illuminators, said illuminators being arranged in parallel between said energizing means and said external source of audio signals, said illuminators being arranged to be sequentially energized as the intensity of said audio signal increases, each of said illuminators remaining illuminated and increasing in brilliance as the intensity of said audio signal increases and as subsequent illuminators are energized.

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U.S. Cl. X.R.

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