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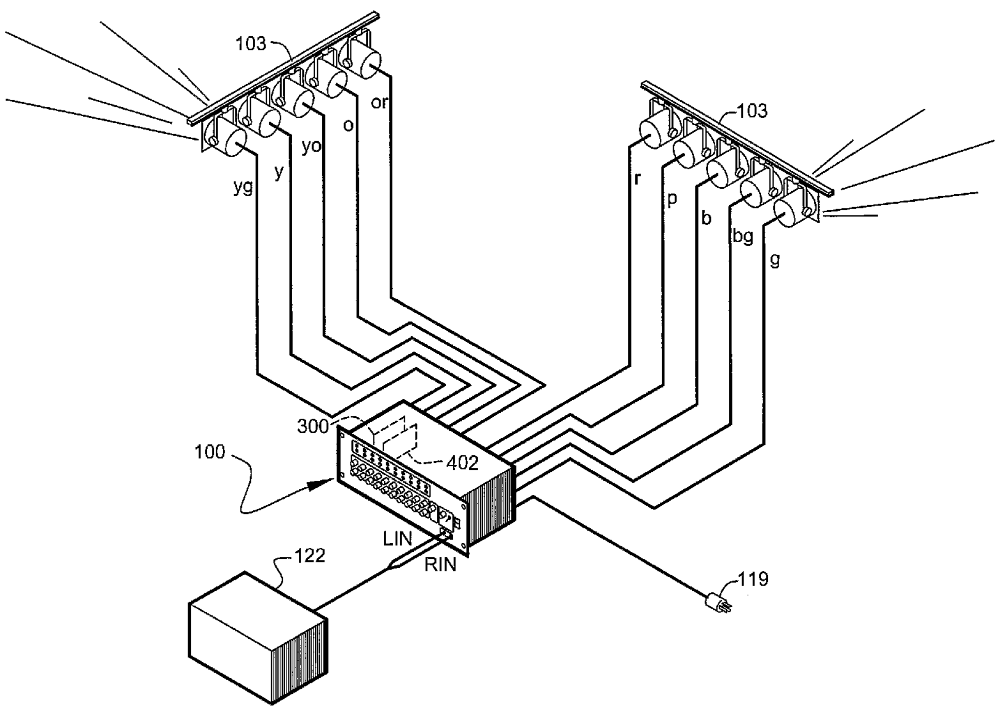

(57) Abstract: An analog to digital system for improved audio driven control of electrical devices, especially those relating to synchronizing lighting displays to music. Methods relating to modular system designs used to produce pleasurable visual effects responsive to analog music sounds are also disclosed.

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ENTERTAINMENT DISPLAY SYSTEMS

BACKGROUND

This invention relates to providing systems for improved audio driven control of electrical devices, especially those relating to entertainment lighting displays synchronized to music.

The use of frequency-isolated audio signals to control lighting or electromechanical devices has a large number of beneficial applications. For example, the presence of a specific frequency within an audio signal may be used to trigger a child's toy, or a musician may use the presence of specific audio frequencies to control stage lighting during a performance. In improvisational musical performances, such as during a jazz concert, it is impractical or impossible to pre-program a dynamic lighting display to respond to the spontaneous structure of the music. Clearly, near-instantaneous audio processing with an associated electrical device control feature would be of great value in producing many types of improvisational musical performances.

No device exists to inexpensively and accurately discriminate very narrow frequency band(s) within an audio signal, and to process such signal(s) to provide a trigger for one or more electrical devices. It is clear that development of highly efficient, accurate, and inexpensive audio control systems of this type would benefit many.

OBJECTS AND FEATURES OF THE INVENTION

A primary object and feature of the present invention is to provide a system to solve the above-mentioned problems and meet the above-mentioned needs.

Another primary object and feature of the present invention is to provide a system for producing, from at least one analog input signal comprising at least one wide frequency band of sound, at least one trigger signal corresponding to presence of at least one selected narrow frequency band of sound.

It is a further object and feature of the present invention to provide such a system having at least one display controller adapted to provide electrical control of at least one powered entertainment display such as colored lights.

It is a further object and feature of the present invention to provide such a system having a plurality of controller stages wherein each one of such plurality of controller stages is electro-optically coupled to at least one of such plurality of frequency filter stages.

It is a further object and feature of the present invention to provide such a system having at least one controllable effects generator adapted to generate at least one controllable illumination effect at the at least one illumination source.

It is a further object and feature of the present invention to provide a novel method of providing a trigger voltage to a phased controlled integrated circuit using a trigger voltage, supplied by optical coupling, and a user adjustable reference voltage.

It is a further object and feature of the present invention to provide a method, relating to modular design to produce pleasurable visual effects responsive to analog music sounds.

A further primary object and feature of the present invention is to provide such a system that is efficient, inexpensive, and handy. Other objects and features of this invention will become apparent with reference to the following descriptions.

SUMMARY OF THE INVENTION

In accordance with a preferred embodiment hereof, this invention provides circuit apparatus, relating to providing, from at least one analog input signal comprising at least one wide frequency band of sound, at least one trigger signal corresponding to presence of at least one selected narrow frequency band of sound, comprising: analog receiver means for receiving such at least one wide frequency band of sound; first band pass filter means for filtering such at least one wide frequency band of sound to select at least one first narrow frequency band of sound having a wider band than at least one second narrow frequency band of sound; second band pass filter means for filtering such at least one first narrow frequency band of sound to select such at least one second narrow frequency band of sound having a wider band than such at least one selected narrow frequency band of sound; voltage-comparator filter means, having a settable reference voltage usable to further narrow such at least one second narrow frequency band of sound, for filtering by voltage comparator to select such at least selected narrow frequency band of sound; and translator means for providing, for use as such at least one trigger signal, at least one direct-current signal corresponding to such presence of such at least one selected narrow frequency band of sound.

Moreover, it provides such a circuit apparatus wherein such voltage-comparator filter means comprises analog to square wave converter means for converting such at least selected narrow frequency band of sound of such at least one analog input signal to at least one fixed amplitude square wave signal. Additionally, it provides such a circuit apparatus wherein: such analog to square wave converter means comprises signal amplitude selector means for holding such at least one fixed amplitude square wave signal active over at least one selected portion of the amplitude of such at least one second narrow frequency band of sound; and such at least one selected portion of the amplitude of such at least one second narrow frequency band of sound is selected by setting such settable reference voltage. Also, it provides such a circuit apparatus wherein such settable reference voltage is settable by a user. In addition, it provides such a circuit apparatus wherein such translator means comprises direct-current rectifier means for outputting at least one direct-current signal corresponding to the presence of such at least one fixed amplitude square wave signal. And, it provides such a circuit apparatus wherein such direct-current rectifier means comprises signal sustainer means for sustaining such at least one direct-current signal over at least one minimum ergonomic duration related to human vision persistence.

Further, it provides such a circuit apparatus wherein such translator means further comprises voltage level shifter means for shifting a nominal voltage level of such at least one direct-current signal to about at least one standard logic voltage level. Even further, it provides such a circuit apparatus wherein such translator means further comprises voltage level shifter means for shifting a nominal voltage level of such at least one direct-current signal to a transistor-transistor logic level of more than about four volts and less than about six volts. Moreover, it provides such a circuit apparatus wherein such translator means further comprises: current amplifier means for amplifying the current of such at least one direct-current signal having at least one standard logic voltage; wherein the output of such current amplifier means comprises such at least one trigger signal.

Additionally, it provides such a circuit apparatus wherein such analog receiver means comprises preamplifier means for preamplifying such at least one analog input signal prior to frequency filtering. Also, it provides such a circuit apparatus wherein: such analog receiver means further comprises input level adjuster means for adjusting such at least one analog input signal to establish at least one compatible signal level at such first band pass filter means; and such analog receiver means further comprises impedance matching means for impedance matching such at least one analog input signal to such input level adjuster means.

In addition, it provides such a circuit apparatus further comprising: display controller means for assisting control of at least one powered entertainment display; wherein control of the at least one powered entertainment display by such display controller means is triggered by such at least one trigger signal. Circuit apparatus, relating to providing, from at least one analog input signal comprising at least one wide frequency band of sound, at least one trigger signal corresponding to presence of at least one selected narrow frequency band of sound, comprising: at least one analog receiver adapted to receive such at least one wide frequency band of sound; at least one first band pass filter adapted to filter such at least one wide frequency band of sound to select at least one first narrow frequency band of sound having a wider band than at least one second narrow frequency band of sound; at least one second band pass filter adapted to filter such at least one first narrow frequency band of sound to select such at least one second narrow frequency band of sound having a wider band than such at least one selected narrow frequency band of sound; at least one voltage-comparator filter, having at least one settable reference voltage usable to further narrow such at least one second narrow frequency band of sound, adapted to filter by voltage comparator to select such at least selected narrow frequency band of sound; and at least one translator circuit adapted to provide, for use as such at least one trigger signal, at least one direct-current signal corresponding to such presence of such at least one selected narrow frequency band of sound. And, it provides such a circuit apparatus further comprises: a plurality of frequency filter stages electrically coupled to such at least one analog receiver; wherein each one of such plurality of frequency filter stages comprises such at least one first band pass filter, such at least one second band pass filter, such at least one voltage-comparator filter, and such at least one translator circuit; and wherein each one of such plurality of frequency filter stages is adapted to provide at least one additional trigger signal corresponding to presence of at least one additional selected narrow frequency band of sound.

Further, it provides such a circuit apparatus wherein such at least one voltage-comparator filter comprises at least one analog to square wave converter adapted to convert such at least selected narrow frequency band of sound of such at least one analog input signal to at least one fixed amplitude square wave signal. Even further, it provides such a circuit apparatus wherein such at least one analog to square wave converter comprises: at least one signal amplitude selector adapted to hold such at least one fixed amplitude square wave signal active over at least one selected amplitude portion of such at least one second narrow frequency band of sound; wherein such at least one selected amplitude portion of such at least one second narrow frequency band of sound is selected by setting such settable reference voltage.

Moreover, it provides such a circuit apparatus wherein such settable reference voltage is settable by a user. Additionally, it provides such a circuit apparatus wherein such at least one translator circuit comprises at least one direct-current rectifier adapted to output at least one direct-current signal corresponding to the presence of such at least one fixed amplitude square wave signal. Also, it provides such a circuit apparatus wherein such at least one direct-current rectifier comprises at least one direct-current signal sustainer adapted to sustain such at least one direct-current signal over at least one minimum ergonomic duration related to human vision persistence.

In addition, it provides such a circuit apparatus wherein such at least one translator circuit further comprises at least one voltage level shifter adapted to shift a nominal voltage level of such at least one direct-current signal to about at least one standard logic voltage level. And, it provides such a circuit apparatus wherein such at least one translator circuit further comprises at least one voltage level shifter adapted to shift a nominal voltage level of such at least one direct-current signal to a transistor-transistor logic level of more than about three volts and less than about six volts.

Further, it provides such a circuit apparatus wherein such at least one translator circuit further comprises: at least one current amplifier adapted to amplify the current of such at least one direct-current signal having at least one standard logic voltage; wherein the output of such at least one current amplifier comprises such at least one trigger signal. Even further, it provides such a circuit apparatus wherein such at least one analog receiver comprises at least one preamplifier adapted to pre-amplify such at least one analog input signal from a line level to a first output gain prior to frequency filtering. Moreover, it provides such a circuit apparatus wherein such at least one analog receiver further comprises at least one filter driver adapted to amplify such at least one analog input signal from such first output gain to a second output gain compatible with the operation of such at least one first band pass filter.

Additionally, it provides such a circuit apparatus further comprising: at least one display controller adapted to provide electrical control of at least one powered entertainment display; wherein electrical control of the at least one powered entertainment display by such at least one display controller is triggerable by such at least one trigger signal. Also, it provides such a circuit apparatus wherein such at least one display controller comprises at least one phased controlled integrated circuit adapted to regulate at least one flow of electrical current to such at least one powered entertainment display. In addition, it provides such a circuit apparatus wherein such at least one display controller comprises at least one electro-optical coupler adapted to receive the at least one trigger signal by electro-optical coupling. And, it provides such a circuit apparatus wherein such at least one display controller is adapted to electrically control the illumination of at least one illumination source.

Further, it provides such a circuit apparatus further comprising: a plurality of controller stages; wherein each one of such plurality of controller stages is electro-optically coupled to at least one of such plurality of frequency filter stages; and wherein each one of such plurality of controller stages is adapted to provide electrical control of at least one powered entertainment display in response to the at least one trigger signal generated by such at least one of such plurality of frequency filter stages. Even further, it provides such a circuit apparatus wherein: each one of such plurality of controller stages is adapted to electrically control such at least one illumination source; and such at least one illumination source comprises a visually distinct color. Moreover, it provides such a circuit apparatus wherein such at least one display controller further comprises: at least one controllable effects generator adapted to generate at least one controllable illumination effect at the at least one illumination source; wherein such at least one controllable effects generator comprises at least one user control adapted to permit user initiated control of at least one feature of such at least one controllable illumination effect.

Additionally, it provides such a circuit apparatus wherein such at least one controllable effects generator comprises: at least one decade counter adapted to provide at least one logic pulse; wherein such at least one decade counter is structured and arranged to control such plurality of controller stages in at least one serial order to provide at least one sequenced illumination effect. Also, it provides such a circuit apparatus wherein such plurality of controller stages comprises a physically separate modular circuit board. In addition, it provides such a circuit apparatus wherein such physically separate modular circuit board comprises at least five of such plurality of controller stages. And, it provides such a circuit apparatus wherein such plurality of frequency filter stages comprises a physically separate modular circuit board. Further, it provides such a circuit apparatus wherein each physically separate modular circuit board comprises at least five of such plurality of frequency filter stages.

In accordance with a preferred method hereof, this invention provides a method of providing a trigger voltage to a phased controlled integrated circuit adapted to power at least one entertainment display system, comprising the steps of: providing at least one direct-current reference voltage having at least one direct-current trigger voltage superimposed therein; wherein such at least one direct-current trigger voltage is supplied by optical coupling from at least one external trigger source; and wherein such at least one direct-current reference voltage is adjustable by a user.

In accordance with another preferred method hereof, this invention provides a method, relating to modular design to produce pleasurable visual effects responsive to analog music sounds, comprising the steps of: designing at least one modular electronic architecture providing filtering of such analog music sounds into at least five narrow frequency bands by at least five frequency-selectable filtering circuits; wherein each of such at least five frequency-selectable filtering circuits comprise essentially the same circuits but for frequency-selecting values; and wherein essentially all electronic components used in such designing of such at least one architecture comprise standard off-the-shelf electronic components; and selecting at least five different visual effects, each designed to be triggerable by presence of selectable minimums of sound narrowly adjacent at least one selected sound frequency; and assigning each visual effect of such at least five different visual effects to at least one of such at least five narrow frequency bands; wherein such at least one modular electronic architecture assists ease of variability in assigning such at least five narrow-frequency bands to maximize visual pleasure from each of a variety of particular kinds of music sounds.

Even further, it provides such a method wherein such at least five different visual effects comprise selected colors of light. Even further, it provides such a method wherein such triggerability is designed, working within parameters of human visual systems, to produce essentially only light pulses of sufficient length to be seen as a full-color effect and brightness for each such selected color of light. Even further, it provides such a method wherein such at least five narrow-frequency bands are selected to correlate with at least one fundamental frequency of at least one source of musical sound. Even further, it provides such a method wherein such at least one source of musical sound comprises at least one musical instrument.

Moreover, it provides such a method further comprising the step of designing at least one light display matched for plug-in use with such at least one modular electronic architecture. Even further, it provides such a method further comprising the step of designing at least one light display matched for plug-in use with such at least one modular electronic architecture. Further, it provides such a method further comprising the step of manufacturing such designed at least one modular electronic architecture and such at least one light display. Even further, it provides such a method further comprising the step of offering such manufactured such designed at least one modular electronic architecture and such at least one light display for sale to businesses desiring a professional-quality color organ at non-custom pricing.

Even further, it provides such a method wherein such businesses comprise musical entertainment sources providing instant selectability of musical numbers. Even further, it provides such a method further comprising the step of manufacturing such designed at least one modular electronic architecture.

In accordance with another preferred embodiment hereof, this invention provides a method, relating to producing pleasurable visual effects responsive to analog music sounds, comprising the steps of: analyzing at least one entertainment market desiring digital-quality sound separation devices adaptable to a wide variety of analog musical pieces and buyable within analog, non-custom pricing; and designing a plurality of entertainment products each utilizing at least one essentially-analog sound separation device using essentially off-the shelf circuit components and providing essentially digital-quality sound separation; wherein such designing uses modular design and manufacturing techniques to provide a variety of different price range such entertainment products; and wherein each such at least one essentially-analog sound separation device comprises filtering distinguishing at least five different narrow-frequency bands. Even further, it provides such a method further comprising manufacture and sale of such entertainment products. Even further, it provides such a method wherein such entertainment products comprise color organs.

In accordance with all preferred embodiments hereof, this invention provides each and every novel feature, element, combination, step and/or method disclosed or suggested by this provisional patent application.

DEFINITIONS, ACRONYMS AND CROSS-REFERENCES

Bandpass Filter: A frequency filter adapted to pass one band of frequency while rejecting both higher and lower frequencies. An ideal bandpass filter passes all frequencies between two non-zero finite limits and rejects all frequencies not within such limits.

Color Organ: A lighting device in the past typically having three to four audio channels, each channel having crude sensitivity to a broad frequency range. For example, a low frequency range might illuminate a red light, a mid frequency range might illuminate yellow light, and a high frequency range might illuminate a blue light. "Color Organ", in referring to applicant's within preferred embodiments, includes such lighting systems with any number of audio channels and high sensitivity to a narrow frequency range.

DC: In the present disclosure, the term "DC" is an abbreviation for Direct Current.

Filter Q: In the present disclosure, the Q of a filter is defined as the center frequency divided by the bandwidth.

Op-amp: The term "Op-amp" is an abbreviation for operational amplifier, a class of high-gain DC-coupled amplifiers with two inputs and a single output.

RCA: In the present disclosure, "RCA" refers to a plug and a jack designed for use with audio coaxial cable.

Triac: An electronic component equivalent to two silicon controlled rectifiers joined end to end (or back to back) with their gates electrically coupled. This arrangement results in a bi-directional electronic switch which conducts current in both directions when the gate is triggered.

TTL: In the present disclosure the term "TTL" is an abbreviation for transistor-transistor logic. "TTL voltage" generally refers to a logic high input signal of between about 2.0 V to about 5.5 V and logic low input of between 0 V to about 0.8 V.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a perspective view of an entertainment and audio display system, driving a stage lighting display, according to a preferred embodiment of the present invention.

FIG. 2a shows a block diagram illustrating a preferred sequence of signal processors comprising a single filter channel of the embodiment of FIG. 1.

FIG. 2b shows a block diagram illustrating a preferred arrangement of components comprising a single dimmer module of the embodiment of FIG. 1.

FIG. 3 shows a circuit schematic illustrating a preferred embodiment of a filter driver board according to the embodiment of FIG. 2a.

FIG. 4 shows a circuit schematic illustrating a preferred embodiment of a dimmer module, used to control the operation of a lighting display, according to the embodiment of FIG. 2b.

FIG. 5 shows a block diagram illustrating the filter driver circuit and the wave forms produced by each component or sub-circuit according to the embodiment of FIG. 2a.

FIG. 6a shows a diagram illustrating a preferred embodiment of a system motherboard according to the preferred embodiment of FIG. 1.

FIG. 6b shows a schematic diagram illustrating a system power supply of the system motherboard according to the preferred embodiment of FIG. 6a.

FIG. 6c shows a schematic diagram illustrating an effects circuit of the system motherboard according to preferred embodiment of FIG. 6a.

FIG. 7 shows an exploded view generally illustrating the modular components of the audio display system according to the embodiment of FIG. 1.

FIG. 8 shows a diagram illustrating a method, relating to modular design to produce pleasurable visual effects responsive to analog music sounds, according to the present invention.

FIG. 9 shows a diagram illustrating a method, relating to producing pleasurable visual effects responsive to analog music sounds.

DETAILED DESCRIPTION OF THE BEST MODES

AND PREFERRED EMBODIMENTS OF THE INVENTION

FIG. 1 shows a perspective view of audio display system **100**, driving lighting display **103**, according to a preferred embodiment of the present invention. Preferably, audio display system **100** is adapted to receive an audio signal from right and left audio channels of analog audio source **122**, as shown. Analog audio source **122** may preferably comprise an amplified device such as a home entertainment system. Audio may also be derived from range of other sources, such as a mixer board, a splitter box or directly from an amplified instrument. Preferably, a filter driver board **300** (indicated in dashed lines) within audio display system **100** is adapted to precisely separate the incoming analog audio signal, by frequency range, into a plurality of audio processing channels. Each audio processing channel is adapted to output a TTL direct-current trigger signal. The direct-current trigger signal produced by filter driver board **300** is ideal for providing trigger data to a wide range of device controller circuits including the on-board dimmer module board **402** (indicated with dashed lines), used to control lighting display **103**, as shown.

The precision frequency discrimination capability of audio display system **100** permits the system to provide a high degree of device controller responsiveness. For example, in the embodiment of FIG. 1, where audio display system **100** is adapted to control a display of ten multi-colored lights, the large number of frequency bands, resolved by the system, can be assigned to an equally large number of visually unique colors, thus producing a lighting display of high visual interest. Furthermore, the preferred precision frequency discrimination capability of audio display system **100** permits the system to be flexibly tailored to a specific musical performance or genre. For example, audio display system **100** is selectively adjustable to respond to the higher frequency ranges of a string quartet, or to the lower frequency ranges of a rap group.

Audio display system **100** preferably comprises additional features adapted to provide advanced light controller functions. Preferably, audio display system **100** comprises an on-board light chaser circuit to provide enhanced visual interest. Preferably, audio display system **100** is adaptable to include such diverse display effects as timers, sequencers, faders, sweeps, etc. Preferably, audio display system **100** comprises AC power input **119** for powering both the internal electronics of the system and lighting display **103** controlled by the system. Preferably, the rear panel of audio display system **100** comprises a plurality of electrical sockets to permit plug-in connections for the wire conductors routed to lighting display **103,** as shown. Upon reading the teachings of this specification, those with ordinary skill in the art will now understand that, under appropriate circumstances, considering such issues as advances in technology, user preference, etc., other connection arrangements, such as combined conductors, addressable devices permitting a single conductor to fire a selected light, wireless light control arrangements, etc., may suffice.

FIG. 2a shows a block diagram illustrating a preferred sequence of signal processors comprising a single filter channel of filter driver board **300** of FIG. 1. Preferably, analog audio signal, at the input point designated as **AUDIO INPUT** (for example, right channel in **RIN** or left channel in **LIN**), is fed into line level preamp **106** and buffered to a group of five filter driver pathways (for clarity, only one filter driver pathway is illustrated - see FIG. 3 for an expanded description of specific circuiting). Each filter driver pathway preferably comprises filter driver **108** adapted to set different peaks of audio frequencies. Preferably, filter driver **108** is coupled to an active bandpass filtering stage wherein the signal is processed through first bandpass filter **110** (at least embodying herein first band pass filter means for filtering such at least one wide frequency band of sound to select at least one first narrow frequency band of sound having a wider band than at least one second narrow frequency band of sound) and second bandpass filter **112** (at least embodying herein second band pass filter means for filtering such at least one first narrow frequency band of sound to select such at least one second narrow frequency band of sound having a wider band than such at least one selected narrow frequency band of sound), as shown. It is at the bandpass filter stage that audio display system **100** becomes highly selective to the detection of specific audio frequencies.

Preferably, a peak amplitude signal is created at translator **114** when the center frequency of the filter bank is superimposed over the audio frequency to form a square wave. Preferably, this square wave remains present by varying a DC control voltage set at translator **114** (at least embodying herein voltage-comparator filter means, having a settable reference voltage usable to further narrow such at least one second narrow frequency band of sound, for filtering by voltage comparator to select such at least selected narrow frequency band of sound). Preferably, the lower the DC voltage that is set into translator **114**, the longer the square wave is present over the slope of the filter (effectively increasing the bandwidth response of the circuit). Following translator **114** is DC rectifier circuit **116**, which creates a low level DC signal as long as the square wave generated by translator **114** is present. If the square wave is not present, the signal level equals zero volts.

Preferably, the low level DC signal generated by DC rectifier circuit **116** is then amplified to a full TTL level (five-volt signal is high and zero is low) at level shifter **118**. This TTL level DC signal is then current-amplified by current amplifier **120** (essentially an emitter follower arrangement) to produce a final trigger signal output (this rectifier/amplifier arrangement at least embodies herein translator means for providing, for use as such at least one trigger signal, at least one direct-current signal corresponding to such presence of such at least one selected narrow frequency band of sound).

FIG. 2b shows a block diagram illustrating a preferred arrangement of components comprising a single dimmer module of the embodiment of FIG. 1. In a preferred embodiment of the present invention, the trigger signal generated at filter driver board **300** is passed, via optocoupler **419**, to dimmer module **400** of dimmer module board **402**, as shown. Preferably, the phase-controlled circuitry of dimmer module **400** is driven to produce full brightness at light **130** when the logic level at optocoupler **419** is high. In operation, a high trigger signal logic level at optocoupler **419** offsets the dimmer bias point, prompting phase control IC **430** to send a trigger signal to the gate terminal of triac **432**. Preferably, triac **432** is electrically coupled to line load power source **132**, and controls the passage of current to light **130**, as shown.

In addition, audio display system **100** preferably comprises effects circuit **124** adapted to provide complex illumination effects during operation. Preferably, effects circuit **124** comprises decade counter **126** coupled to clock generator **134**, as shown. Preferably, logic is pulsed from decade counter **126** to produce a "marquee effect" when used with several lighting channels in a serial order.

FIG. 3 shows a circuit schematic illustrating a preferred embodiment of filter driver board **300** of the present invention. Preferably, filter driver board **300** comprises a single, line-level pre-amplifier (hereinafter "pre-amp") **106** driving inputs for up to five individually tuned filter drivers **311**, **312**, **313**, **314**, and **315** (at least embodying herein a plurality of frequency filter stages electrically coupled to such at least one analog receiver). Pre-amp **106** preferably receives an audio signal, such as that produced by a home entertainment center, at the input coupling designated **RIN** (at least embodying herein analog receiver means for receiving such at least one wide frequency band of sound) and provides a gain of about 2 to the input signal.

Pre-amp **106** is preferably based on an LM741CM operational amplifier **U16** in a differentiator circuit configuration, as shown, that provides a substantially constant gain of 2 over the input audio signal frequencies. The LM741CM operational amplifier is an 8-pin integrated circuit available from PartMiner, Inc., of Melville, NY. Power is preferably supplied to operational amplifier **U16** as nominally +5 volts at the +V input (pin 7) and nominally –5 volts at the –V input (pin 4). The gain of pre-amp **106** is established primarily by the 10,000-ohm, ¼-watt, feedback resistor **R44**, while the frequency at which the gain curve flattens is established by the 10-microfarad 16-volt input capacitor **C23**. The 4700-ohm, ¼-watt input resistor **R47** substantially prevents ringing and oscillation otherwise created by the input capacitor **C23** and also establishes an input impedance for pre-amp **106** along with input capacitor **C23**. Input resistor **R47** also contributes to the gain determination. Preferably, pre-amp **106** is an inverting amplifier, with the input audio signal applied to the inverting input (pin 2) of operational amplifier **U16**, as shown. Preferably, the non-inverting input (pin 3) of the operational amplifier **U16** is connected to ground to complete the differentiator circuit configuration. Preferably, the inverted output signal is taken from pin 6 of operational amplifier **U16** and sent to each individually-tuned filter driver circuit **311** through **315**, as shown. Those skilled in the art, upon reading the teachings of this specification, will appreciate that, under appropriate circumstances, considering such issues as economics, improvements in operational amplifiers, and improvement in circuit manufacturing, other pre-amps, such as those with higher gain, lower cost, etc., may be used with filter driver board **300**.

Preferably, filter driver circuit **311** comprises seven stages connected in series, as shown. Preferably, the first stage, filter driver **108**, comprises an inverting operational amplifier U1 in a differentiator configuration similar to pre-amp **106** but with the input resistor **R8** sized as 2200 ohms (¼ watt) for impedance matching with pre-amp **106**. Filter driver **108** preferably includes LM741CM operational amplifier **U1** powered by +/-5 volts at pins 7 and 4, respectively. Preferably, input capacitor **C6** is sized as 10 microfarads (16 volts) to flatten the gain curve of filter driver **108** over the same audio input frequencies as pre-amp **106** produced. Feedback resistor **R2** is preferably sized at nominally 10,000 ohms (¼ watt) to establish, along with resistor **R8**, a nominal gain of about 5 over the input audio frequencies. Preferably, the non-inverting input (pin 3) of operational amplifier **U1** is connected to ground to complete the differentiator configuration of filter driver **108**, as shown. Preferably, the output resistor pair **R10** and **R14** establish the output signal from pin 6 of inverting amplifier **108** at their junction while assisting in the impedance match to the second stage: first bandpass filter **110**. Having been inverted twice, the output signal of the filter driver **108** has the same polarity as the input audio signal at coupling **RIN**. Those skilled in the art, upon reading the teachings of this specification, will appreciate that, under appropriate circumstances, considering such issues as economics, improvements in operational amplifiers, and improvement in circuit manufacturing, other filter drivers, such as those with higher gain, lower cost, adjustable resistors and capacitors, etc., may be used with filter driver board **300**.

Preferably, the output signal from filter driver **108** is coupled to the input of first bandpass filter **110**. First bandpass filter **110** is preferably a multiple feedback active bandpass filter, as shown. Operational amplifier **U2** is preferably an LM741CM operational amplifier in an active bandpass filter configuration. Preferably, feedback resistor **R3** and feedback capacitor **C4** form a differentiator-like, high-pass circuit while feedback capacitor **C1** and resistors **R10** (preferably 18,000 ohms) and **R14** (preferably 1200 ohms) form an integrator-like, low pass circuit. Feedback resistor **R3** is preferably sized to be nominally 56,000 ohms and feedback capacitors **C1** and **C4** are preferably both nominally 56 microfarads (60 volts), as shown. Taking C = C1+C4 and considering **R10** and **R14** as being in parallel to be R_{sum}, the relevant parameters of the first bandpass filter **110** are:

$$fo = \frac{1}{2\pi \cdot C\sqrt{R_{sum} \cdot R_3}} = \sim 30 \text{ Hz, for center frequency,}$$

$$Q = \frac{1}{2}\sqrt{\frac{R_3}{R_{sum}}} = \sim 3.5, \text{ for peak quality, and}$$

$$BW = \frac{2}{R_{sum}C} = \sim 16Hz \text{, for bandwidth.}$$

Preferably, operational amplifier **U2** is powered by +5 volts on the +V input pin 7 and –5 volts on the –V input pin 4. Preferably, the non-inverting input at pin 3 is coupled to ground to complete the multiple feedback active bandpass filter configuration. The output signal of the lead bandpass filter **110** is a sample of the input signal about the center frequency of 30 Hz having a bandwidth of about 16 Hz and having a Q of about 3.5. The output signal of the first bandpass filter **110** is coupled to the second bandpass filter **112.** Those skilled in the art, upon reading the teachings of this specification, will appreciate that, under appropriate circumstances, considering such issues as economics, improvements in operational amplifiers, and improvement in circuit manufacturing, other bandpass filters, such as those with higher gain, lower cost, adjustable resistors and capacitors, etc., may be used with filter driver board **300.**

Preferably, second bandpass filter **112** is identical to first bandpass filter **108** except that a portion of the output is coupled to transistor **Q1** through biasing resistors **R5** and **R1** to switch on a light-emitting diode coupled to output coupling **PEAK1**. Resistor **R5** is preferably 910 ohms and resistor **R1** is preferably 510 ohms, as shown. Both resistors **R5** and **R1** are preferably ¼ watt resistors, as shown. Resistors **R1** and **R5** bias the signal voltage to within the operating limits of the transistor **Q1**. Preferably, the emitter of transistor **Q1** is coupled to ground, as shown. Transistor **Q1** is preferably part number MMBT2222ALT1 from Digi-key, Inc., of Thief River Falls, MN, as shown. The light emitting diode is preferably a front-panel indicator that provides a user with an indication of when the output signal of second bandpass filter **112** is above its half-power points. Thus, a backstage production engineer can monitor performance without seeing the onstage display. Those skilled in the art, upon reading the teachings of this specification, will appreciate that, under appropriate circumstances, considering such issues as economics, improvements in operational amplifiers, and improvement in circuit manufacturing, other bandpass filters, such as those with higher gain, lower cost, adjustable resistors and capacitors, etc., may be used with filter driver board **300**.

The output signal from second bandpass filter **112** is an audio sample peak centered on the center frequency of the second bandpass filter **112**. This output signal is preferably supplied to a voltage comparator circuit, hereinafter referred to as translator **114**, preferably configured for peak detection. Preferably, translator **114** includes an operational amplifier U4, preferably in an LM311M package, as shown. The output of the LM311M is compatible with all major logic circuit types, such as TTL and RTL (at least embodying herein wherein such translator means further comprises voltage level shifter means for shifting a nominal voltage level of such at least one direct-current signal to about at least one standard logic voltage level).

Preferably, input resistor **R9** provides impedance matching to the translator **114**. Input resistor **R9** is preferably 100 ohms with ¼ watt power dissipation capability, as shown.

The operational amplifier **U4** is preferably powered by nominally +5 volts and –5 volts at pins 8 and 4, respectively, as shown. The ground pin, pin 1, of the operational amplifier **U4** is connected directly to ground, as shown. Preferably, the input to the translator **114** from the second bandpass filter **112** is applied to the non-inverting input (pin 2) of operational amplifier **U4**. Preferably, a user-adjustable reference voltage is supplied to the inverting input of operational amplifier **U4** at pin 3. The reference voltage is preferably established via a front-panel variable potentiometer coupled to **BAND1** (at least embodying wherein such analog to square wave converter means comprises signal amplitude selector means for holding such at least one fixed amplitude square wave signal active over at least one selected portion of the amplitude of such at least one second narrow frequency band of sound; and such at least one selected portion of the amplitude of such at least one second narrow frequency band of sound is selected by setting such settable reference voltage; and further embodying herein wherein such settable reference voltage is settable by a user wherein such translator means comprises direct-current rectifier means for outputting at least one direct-current signal corresponding to the presence of such at least one fixed amplitude square wave signal). Preferably, inverting input resistor **R13** provides impedance matching into the operational amplifier **U4** and assists, along with inverting input capacitor **C10**, in filtering out any alternating current component in the direct current reference voltage, such as ripple in the power supply. Inverting input resistor **R13** is preferably sized as 1,000 ohms and ¼ watt, as shown. Inverting input capacitor **C10** is preferably sized as 1 microfarad and 50 volts, as shown. The reference voltage supplied to the inverting input of operational amplifier **U4** is compared with the filtered audio signal sample from the second bandpass filter **112**.

Portions of the filtered audio signal sample which have a voltage with a higher amplitude than the reference voltage create a negative-going square wave at output pin 7 of operational amplifier **U4**. The output signal is a negative-going square wave relative to the quiescent state of the output (at least embodying herein wherein such voltage-comparator filter means comprises analog to square wave converter means for converting such at least selected narrow frequency band of sound of such at least one analog input signal to at least one fixed amplitude square wave signal). The quiescent state of the output is established by a +5 volt source dropping a voltage across resistor **R6** to the output of operational amplifier **U4**. Preferably, the width of the square waves is determined by the user-selected reference voltage, with smaller voltages producing longer square waves. The frequency of the square waves will be the center frequency of the first and second bandpass filters **110** and **112**. Preferably, the output of operational amplifier **U4** is supplied to DC rectifier circuit **116**. Those skilled in the art, upon reading the teachings of this specification, will appreciate that, under appropriate circumstances, considering such issues as economics, improvements in operational amplifiers, and improvement in circuit manufacturing, other translators, such as those with lower cost, adjustable resistors and capacitors, etc., may be used with filter driver board **300**.

Preferably, DC rectifier circuit **116** sums and averages the square waves from the translator **114** to produce a DC logic level indicating the presence of the second bandpass filter **112** output. Any high-frequency components remaining in the square wave signal from the translator **114** are removed by shunting to ground though capacitor **C7**, diode **D1**, and capacitor **C3**. Capacitors **C3** and **C7** are preferably sized as 10 microfarads and 16 volts, as shown. Diode **D1** is part number S1AB-13 from Digikey, as shown. Diodes **D1** and **D2**, along with resistor **R16** and capacitors **C7** and **C3**, form DC rectifier **116** which sums and averages the square wave output of the translator **114** to produce a DC high level whenever the square wave is present. Preferably, the circuit components **C3**, **C7**, **D1**, **D2**, and **R16** are sized to ensure that the minimum duration of the output has a desired relationship to the persistence of human vision. Specifically, the minimum trigger length should be sufficient to bring a light to the appearance of full brightness to the human eye. This prevents colors from appearing diluted or "washed out" from insufficient duration in the ON state (this arrangement at least embodies herein wherein such direct-current rectifier means comprises signal sustainer means for sustaining such at least one direct-current signal over at least one minimum ergonomic duration related to human vision persistence). The time constant, established by capacitor **C3** and resistor **R16**, is kept short to improve reaction of the circuit to the absence of the 30 Hz signal. Resistor **R16** is preferably 1000 ohms and ¼ watt power dissipation, as shown. Diode **D2** is preferably part number S1AB-13 from Digikey, as shown. The DC high-level output of the DC rectifier circuit **116** has a level of about 2 volts. Preferably, the output of DC rectifier circuit **116** (at least embodying herein wherein such translator means comprises direct-current rectifier means for outputting at least one direct-current signal corresponding to the presence of such at least one fixed amplitude square wave signal) is supplied to level shifter **118**. Those skilled in the art, upon reading the teachings of this specification, will appreciate that, under appropriate circumstances, considering such issues as economics, improvements in DC rectifiers and their components, and improvement in circuit manufacturing, other DC rectifiers, such as those with less ripple, lower cost, adjustable components, etc., may be used with filter driver board **300**.

Preferably, level shifter **118** raises the level of the 2-volt high-level DC output from DC rectifier circuit **116** to about 4.5 volts for use in TTL or similar logic. Level shifter **118** preferably uses operational amplifier **U5** in a voltage comparator configuration to shift the input level upward. Operational amplifier **U5** is preferably an LM311M integrated circuit from Digikey, as shown. Preferably, the DC high-level output of the DC rectifier circuit **116** is applied to the non-inverting input of operational amplifier **U5**, as shown. Preferably, a fixed reference voltage, established by resistors **R17** and **R18** and by the +5 volts source applied thereto, is applied to the inverting input of operational amplifier **U5**, as shown.

Preferably, resistor **R17** is a 150-ohm resistor and resistor **R18** is a 2200-ohm resistor, as shown. Resistors **R17** and **R18** are preferably sized as ¼ watt resisters, as shown. Preferably, operational amplifier **U5** is powered by +5 volts and –5 volts applied to pins 8 and 4, respectively, as shown. Ground pin 1 of the operational amplifier **U5** is preferably coupled directly to ground, as shown. The output of operational amplifier **U5** is taken from pin 7, as shown, and supplied to current amplifier **120**, as shown. Those skilled in the art, upon reading the teachings of this specification, will appreciate that, under appropriate circumstances, considering such issues as economics, improvements in operational amplifiers, and improvement in circuit manufacturing, other level shifters, such as those with higher gain, lower cost, adjustable resistors and capacitors, etc., may be used with filter driver board **300**.

Current amplifier **120** (at least embodying herein current amplifier means for amplifying the current of such at least one direct-current signal having at least one standard logic voltage; wherein the output of such current amplifier means comprises such at least one trigger signal) preferably comprises transistor **Q2** configured as an emitter follower. Preferably, the input signal is applied from the output of level shifter **118** through resistor **R12** to the base of transistor **Q2**, as shown. Resistor **R12** is preferably a 2200-ohm, ¼-watt resistor, as shown. Preferably, the circuit portion containing resistor **R7**, resistor **R12**, and capacitor **C8** provides impedance matching and base voltage bias for transistor **Q2**. Resistor **R7** is preferably a 1500-ohm, ¼ –watt resistor, as shown. Preferably, capacitor **C8** is a 2.2 microfarad, 16-volt capacitor, as shown. Emitter resistor **R19** assists in stabilizing the DC operating point of the transistor **Q2**. The collector voltage for transistor **Q2** is +5 volts. Diode **D3** prevents backflow of any signal at output coupling **FOUT1**. Diode **D3** is preferably part number S1AB-13 from Digikey, as shown. Preferably, the output signal to **FOUT1** is a logic trigger (at least embodying herein at least one trigger signal) that goes high responsive to audio frequencies within the bandpass of the first and second bandpass filters **110** and **112**. Those skilled in the art, upon reading the teachings of this specification, will appreciate that, under appropriate circumstances, considering such issues as economics, improvements in operational amplifiers, and improvement in circuit manufacturing, other current amplifiers, such as those with higher gain, lower cost, adjustable resistors and capacitors, etc., may be used with filter driver board **300**.

Preferably, each of the five individually-tuned filter drivers **311**, **312**, **313**, **314**, and **315** on filter driver board **300** use the same circuitry except for the feedback capacitors, such as **C1** and **C4**, in the bandpass filters, which are unique to each individually tuned filter driver **311**, **312**, **313**, **314**, or **315**. This novel approach permits a large quantity of filter driver boards **300** to be initially manufactured without the feedback capacitors installed and permits a custom choice of filter driver frequencies to be made by installing such feedback capacitors responsive to market demand. For example, if a filter driver board **300** is needed for music from a brass quintet, capacitors could be installed on an otherwise complete filter driver board **300** in inventory to provide triggers for at least the center frequency of each instrument in the brass quintet. This novel approach strikes a highly economical balance between minimum manufacturing costs and customer responsiveness, because the filter driver boards **300** can be initially manufactured in very large lots and customized as desired with very little add-on labor. Those skilled in the art, upon reading the teachings of this specification, will appreciate that, under appropriate circumstances, considering such issues as economics, improvements in operational amplifiers, and improvement in circuit manufacturing, other economies may be realized, such as by pre-packaging feedback capacitor sets for easy addition to filter driver board **300**, adjustable resistors and capacitors, computer-controlled adjustable resistors and capacitors, etc., may be used with filter driver board **300**.

FIG. 4 shows a circuit schematic illustrating a preferred embodiment of dimmer module **400** according to the embodiment of FIG. 2b. Preferably, the trigger generated by filter driver board **300** (see FIG. 3) may be used to operate various devices in coordination with the input analog audio signals. Preferably, each individually tuned filter driver circuit **311-315** is used with a separate dimmer module **400**. Preferably, dimmer modules **400** (at least embodying herein display controller means for assisting control of at least one powered entertainment display) are substantially identical to one another and there are preferably five to a dimmer module board **402**. Each dimmer module is preferably coupled to an individually tuned filter driver circuit **311-315** by coupling the outputs **FOUT1-FOUT5** on filter driver board **300** to inputs **TRIG1-TRIG5** on dimmer modules **411-415** on dimmer module board **402**, respectively (at least embodying herein a plurality of controller stages; wherein each one of such plurality of controller stages is electro-optically coupled to at least one of such plurality of frequency filter stages). The disclosure herein of an example dimmer module **411** applies to each dimmer module **411-415**. Those skilled in the art, upon reading the teachings of this specification, will appreciate that, under appropriate circumstances, considering such issues as economics, improvements in operational amplifiers, and improvement in circuit manufacturing, other form factors may be realized, such as larger or smaller dimmer module boards, more or fewer dimmer modules, etc., may be used with the dimmer module board.

Preferably, dimmer module **411** receives a trigger on coupling **TRIG1**, as shown. Preferably, **TRIG1** supplies pin 1 of a Fairchild 4N26SM optocoupler **419** (at least embodying herein at least one electro-optical coupler). Preferably, pin 2 of the optocoupler **419** is coupled directly to ground, as shown. Preferably, the trigger signal energizes a light-emitting diode (LED) in optocoupler **419** between pin 1 and pin 2. Energy from the LED is sensed by a photodetecting transistor connected to pins 4, 5, & 6, causing it to conduct, and the resulting output signal is supplied on pins 4 and 5 of optocoupler **419**, as shown. Preferably, the output of optocoupler **419**, a logic high when the desired audio frequencies have been detected by the filter driver circuit **311**, is coupled to pins 3 and 4 of phase control integrated circuit **U1** (hereinafter refered to as phase control integrated circuit IC **420**), as shown. Preferably, phase control IC **420** has a soft start capability. Phase control IC **420** is preferably an ATMEL U2008B-MFP, as shown. Pin 3 of the phase control IC **420** is the control input, which is preferably used to determine the point in time at which the output trigger of the phase control IC **420** is generated. Preferably, pin 4 of the phase control IC **420** is the ground pin, which is also coupled to the board ground at NEUTRAL, as shown. Preferably, the voltage at pin 3 of the phase control IC is biased by an input voltage from **POT1**, which is preferably a front panel potentiometer that the user can adjust to establish the set point for the control input (this arrangement embodies herein providing at least one direct-current reference voltage having at least one direct-current trigger voltage superimposed therein; wherein such at least one direct-current trigger voltage is supplied by optical coupling from at least one external trigger source; and wherein such at least one direct-current reference voltage is adjustable by a user). Preferably, resistor **R449** drops the input voltage from **POT1** at the input to pin 3 of the phase control IC **420**. Resistor **R449** is preferably an 18,000-ohm, ¼ watt resistor, as shown. Resistor **R4411** is the collector resistor for the optocoupler **419**. Accordingly, the signal at the control input to the phase control IC **420** is a voltage determined by the potentiometer setting and the conduction state of the optocoupler **419**. Preferably, capacitor **C443** provides a path to ground for AC components in the bias voltage and some ramping of the optocoupler output. Preferably, capacitor **C443** is a one microfarad, 50-volt capacitor, as shown. Those skilled in the art, upon reading the teachings of this specification, will appreciate that, under appropriate circumstances, considering such issues as economics, ergonomics, and devices to be controlled, other modules, such as motor controllers, fountain controllers, and laser controllers, etc., may be used with dimmer module board **402**.

The main supply voltage being controlled by the circuit is an AC voltage that may be as high as 230 volts and is available at the coupling on dimmer module board **402** labeled **HOT**. Preferably, the supply voltage is supplied to pin 7 of phase control IC **420** for use in voltage synchronization with the main supply voltage compensation that takes place internal to phase control IC **420**. Resistor **R443**, which is in the path from the main voltage supply to pin 7 of phase control IC **420**, is preferably sized as 500,000 ohms and ¼ watts, as shown. Preferably, voltage is supplied to pin 5 of phase control IC through negative half-wave rectifier diode **D441** and resistor **R441**, as shown. Pin 5 is the -V_s power supply to phase control IC **420**. Preferably, capacitor **C441** provides smoothing of the half-wave rectified voltage. Diode **D441** is preferably part S1GB-13 from Digikey, as shown. Resistor **R441** is preferably a VISHAY-RTO20C15K+/-5%, as shown. Capacitor **C441** is preferably sized as 47 microfarads, 25 volts, as shown. Resistor **R444** drops a portion of the -V_s voltage to pin 6 of the phase control IC for phase control. In the preferred embodiment, resistor **R444** is constant at 270,000 ohms and ¼ watts, enabling phase control through the output of optocoupler **419**. Preferably, the phase angle of the output trigger at pin 8 is determined by the relationship of the voltage at pin 2 with the voltage at pin 3. Preferably, resistor **R444** determines the charging rate of capacitor **C447**, which determines the steepness of the ramp of the voltage at pin 2. With resistor **R444** constant, the voltage ramp at pin 2 has the same steepness each time, but the voltage at pin 3 varies depending on the output of the optocoupler **419** and the setting of the potentiometer coupled to **POT1**, as previously discussed. Accordingly, the phase of the output trigger at **TRIGATE1** is preferably controlled by the input trigger pulse for a given potentiometer **POT1** setting. Those skilled in the art, upon reading the teachings of this specification, will appreciate that, under appropriate circumstances, considering such issues as circuit timing, various desired phase relationships, and improvement in circuit manufacturing, other phase control approaches could be implemented, such as using a variable resistance at the input of pin 6, influence the pin 6 voltage directly with the input trigger, etc., may be used with dimmer module board **402**.

Preferably, pin 1 of phase control IC **420** is used for load current sensing. Capacitor **C445** preferably determines the soft start characteristics of the circuit. Capacitor **C445** is preferably sized as 4.7 microfarads and 25 volts, as shown. Preferably, the output of phase control IC **420** is a trigger for triac **432** coupled to the board output **TRIGATE1**. Resistor **R447** provides current limiting to the triac gate. Resistor **R447** is preferably **150** ohms and ¼ watt, as shown. In a preferred embodiment, triac **432** energizes one or more lights when the gate is triggered. Triac **432** may preferably use the same main supply voltage as dimmer module **402**. Those skilled in the art, upon reading the teachings of this specification, will appreciate that, under appropriate circumstances, considering such issues as economics, stylistic considerations, and special effects production considerations, other sub-circuits may be included in the triac load circuit, such as marquee chasers, strobe generators, color-relational cross connections between dimmer modules **400**, etc., may be used with dimmer module board **402**.

FIG. 5 is a block diagram illustrating the filter driver circuit and the wave forms produced by each component or sub-circuit. An audio signal **102** comes into the circuit at the audio input jack **502**. Preferably, pre-amp **106** receives the input audio signal **102** and amplifies it by a gain of about 2 to produce inverted signal **504**, as shown. Preferably, filter driver **108** receives amplified inverted signal **504** and amplifies it by a gain of about 5 to produce driver audio signal **506**, as shown. Preferably, the driver audio signal **506** is filtered by first bandpass filter **110**, which produces filtered audio sample **508** (if driver audio signal

506 contains frequencies within the bandwidth of the first bandpass filter **110**). Preferably, filtered audio signal **508** is filtered in second bandpass filter **112** to produce a higher-Q audio sample **510**. Higher-Q audio sample **510** is preferably supplied to translator **114**, which produces negative-going square wave **512** of fixed amplitude with the wavelength proportional to the width of higher-Q audio sample **510** at its half-power points, or other fractional power points selected by user adjustment. Preferably, negative-going square wave **512** is supplied to DC rectifier **116**, where the square waves are summed and averaged to an output level **514** having an ergonomic duration related to human vision persistence and color perception. Preferably, output level **514** is supplied to level shifter **118**, which produces TTL high-level pulse **516** having the same ergonomic duration. Preferably, TTL high-level pulse **516** is supplied to current amplifier **120**, which produces a higher powered TTL high-level pulse **518** to output **520**.

FIG. 6a shows a diagram illustrating a preferred embodiment of system motherboard **138** according to the embodiment of FIG. 1. Preferably, system motherboard **138** comprises effects circuit **124**, first triac assembly **140**, second triac assembly **142**, power supply **144**, and edge connectors **146a-146h**.

Preferably, edge connectors **146a** (**J3**) and **146b** (**J10**) permits system motherboard **138** to removably couple with a first and second filter driver board **300** respectively. Similarly, edge connectors **146c** (**J1**) and **146d** (**J8**) preferably permit system motherboard **138** to removably couple with a first and second dimmer module board **402** respectively.

Preferably, edge connector **146e** (**J4**) and edge connector **146f** (**J5**) permits system motherboard **138** to couple with front panel board **150**. Similarly, edge connector **146g** (**J6**) and edge connector **146h** (**J7**) permits system motherboard **138** to couple with back panel board **152**.

The preferred modular architecture of audio display system **100** permits convenient modification to the frequency discrimination characteristics of the system. Preferably, by removing and replacing the modular circuit boards on system motherboard **138**, audio display system **100** can be matched to particular kinds of musical sounds or a specific music source, thus maximizing visual interest at the electrically powered entertainment display.

Preferably, first triac assembly **140** and second triac assembly **142** each comprise a bank of five general purpose triacs **432**, preferably model NTE5608 manufactured by NTE Electronic Inc. of Bloomfield, N.J., as shown. Preferably, a choke and capacitor are used to reduce RF noise at the circuit. Preferably, the triac trigger gates designated **TRIGATE1** through **TRIGATE5** are electrically coupled to pins 12 through 16 at edge connectors **146c** (**J1**), as shown. Preferably, the triac trigger gates designated **TRIGATE6** through **TRIGATE10** are electrically coupled to pins 12 through 16 at edge connectors **146d** (**J8**). Preferably, triac current supplied terminals **OUT1** through **OUT10** are electrically respectively coupled to pins 11 through 1 at edge connector **146h** (**J7**) serving back panel board **152**.

FIG. 6b shows a schematic diagram illustrating power supply **144** of system motherboard **138** according to the preferred embodiment of FIG. 6a. Power supply **144** preferably comprises a pair of dual primary transformers coupled to a series of rectifier/regulator circuits, as shown. Voltage switch **438** (**SW2**) permits selection of the incoming voltage (110v or 220v), routing the current to the appropriate primary inputs at the transformers.

Preferably, transformer **434** (**T1**) is coupled to bridge rectifier **D5**, as shown. Preferably, bridge rectifier **D5** is coupled to three voltage regulators, as shown. Smoothing is performed by electrolytic capacitors connected across the DC supply, as shown. Preferably, regulators **U3**, **U4**, and **U5** respectively supply +12v DC, +5v DC, and -5v DC, as shown.

coupled to the clock pin 14 of decade counter **126**, as shown. Actuation of effects circuit **124** is provided by marquee switch **136** (designated **MARQUEE ON/OFF**) preferably located at front panel board **150**, as shown (at least embodying herein wherein such at least one controllable effects generator comprises at least one user control adapted to permit user initiated control of at least one feature of such at least one controllable illumination effect). When closed, marquee switch **136** supplies +12v DC to the circuit thus bypassing the timing logic of clock generator **134**.

FIG. 7 shows an exploded view generally illustrating the modular components of audio display system **100** according to the entertainment display setup of FIG. 1. A preferred embodiment of audio display system **100** comprises a self-contained unit suitable for transport and set-up by a single user. Preferably, housing **522** provides a protective supporting structure for system motherboard **138** and a plurality of circuit modules removably mountable to system motherboard **138**, as shown. Preferably, housing **522** comprises a rack-mountable format, as shown. Upon reading the teachings of this specification, those with ordinary skill in the art will now understand that, under appropriate circumstances, considering such issues as intended use, user preference, etc., case formats, such as table mounted, wall mounted, etc., may suffice.

Preferably, housing **522** comprises front panel **524** and rear panel **526**, as shown. Preferably, front panel **524** comprises display control section **528**, indicator section **530**, audio inputs **532**, audio input level control **534**, main power switch **137**, and effects control section **536**, as shown.

Preferably, display control section **528** comprises a bank of ten band potentiometers, and ten dimmer potentiometers, as shown. Preferably, each band potentiometer is coupled to a filter driver (see FIG. 3) to permit user setting of the reference voltage at a translator **114**. Preferably, each dimmer potentiometer is coupled with a dimmer module **400** (for example

POT1 as described in FIG. 4) to permit a user to bias the input voltage at pin 3 of phase control IC **420**.

Preferably, indicator section **530** comprises a series of ten red LEDs, each coupled to the indicator output of a second bandpass filter **112** of a single filter driver, and ten green LEDs each coupled between a filter driver output and its associated dimmer module. Preferred indication functions of indicator section **530** are as described in FIG. 3 and FIG. 4.

Preferably, audio inputs **532** comprise a pair of RCA connectors, as shown. Preferably, each RCA connector is coupled to one of the pair of filter driver boards **300** installed in audio display system **100**, as shown. In a typical operational arrangement, the right and left channels of an analog stereo signal may be separately assigned to one of the two RCA connectors of audio inputs **532**, as shown.

Audio level control at audio inputs **532** is provided by audio input level control **534**, preferably comprising an audio taper potentiometer electrically coupled in-line with the RCA connectors of audio inputs **532**.

Preferably, effects control section **536** comprises rate potentiometer **128**, coupled to clock generator **134** of effects circuit **124**, and marquee switch **136** coupled to decade counter **126**.

Preferably, the functional components of front panel **524** are mounted to front panel board **150**, as shown. Preferably, front panel board **150** is situated behind front panel **524** and removably engages system motherboard **138** using a pair of edge connectors **146** **(J4)** and **(J5)**.

Preferably, back panel board **152** is positioned adjacent rear panel **526** and electrically engages system motherboard **138** using a matching pair of edge connectors **J6/JP1** and **J7/JP2**. Preferably, back panel board **152** comprises ten power connector outlets **540**, as shown. Preferably, each power connector outlet **540** is coupled to a triac **432** located on motherboard **138**. Preferably, each power connector outlet **540** is protected against over current by fuse **442**, as shown. Upon reading the teachings of this specification, those of ordinary skill in the art will now understand that, under appropriate circumstances, considering such issues as system component selection, intended use, etc., the use of other system components, such as cooling fans, heat sinks, power busses, etc., may suffice.

Preferably, system motherboard **138** is adapted to removably receive two separate filter driver boards **300** (at least embodying herein wherein such plurality of frequency filter stages comprises a physically separate modular circuit board) using edge connectors **146**. As previously described, each filter driver board **300** comprises five filter driver stages (at least embodying herein wherein each physically separate modular circuit board comprises at least five of such plurality of frequency filter stages). Preferably, system motherboard **138** is also adapted to removably receive two separate dimmer module board **402** (at least embodying herein wherein such plurality of controller stages comprises a physically separate modular circuit board). As previously described, each dimmer module board **402** preferably comprises five dimmer modules **400** (at least embodying herein wherein such physically separate modular circuit board comprises at least five of such plurality of controller stages). Preferably, housing **522** is adapted to provide access to the modular components of audio display system **100** by means of, for example, removable cover **536**, as shown.

FIG. 8 shows a diagram illustrating a method, relating to modular design to produce pleasurable visual effects responsive to analog music sounds, according to the present invention. According to a preferred method, a supplier designs an audio display system comprising at least one modular electronic architecture providing filtering of analog music sounds into at least five narrow frequency bands by at least five frequency-selectable filtering circuits, as indicated in step **600**. Preferably, each of the five frequency-selectable filtering circuits comprise essentially the same circuits but for frequency-selecting values of specific sub-components. Further, essentially all of the electronic components used in the design of the modular architecture preferably comprise standard off-the-shelf electronic components.

Preferably, the supplier selects at least five different visual effects, at indicated in step **602**, each effect designed to be triggerable by the presence of selectable minimums of sound narrowly adjacent at least one selected sound frequency. In subsequent step **604**, the supplier assigns each visual effect of the five different visual effects to at least one of the five narrow frequency bands. The preferred modularity of the electronic architecture assists ease of variability in selecting and assigning the least five narrow-frequency bands to maximize visual interest from a variety of unique musical sounds. In a preferred application of the present invention, the at least five different visual effects comprise selected colors of light. Preferably, the triggerability of audio display system is specifically designed, working within parameters of human visual systems, to produce essentially only light pulses of sufficient length to be seen as a full-color effect and brightness for each such selected color of light. Preferably, the at least five narrow-frequency bands are selected to correlate with at least one fundamental frequency of at least one source of musical sound. In preferred embodiments of the present invention, the source of musical sound comprises one or more musical instruments.

In subsequent preferred step **606**, the supplier designs at least one light display matched for plug-in use with the at least one modular electronic architecture of the audio display system. Preferably, the supplier then manufactures, based on the design, the audio display system, and the associated light display as indicated in step **608**.

On manufacturing an adequate number of units, the supplier offers the audio display system and light display for sale to businesses desiring a professional-quality color organ as indicated in step **609**. The preferred use of analog filtering and standard off-the-shelf electronic components permits the audio display system to be offered at non-custom pricing.

Most preferably, the supplier offers the audio display system for sale to musical entertainment sources providing instant selectability of musical numbers.

FIG. 9 shows a diagram illustrating a method, relating to producing pleasurable visual effects responsive to analog music sounds. Preferably, a supplier analyzes at least one entertainment market desiring digital-quality sound separation devices adaptable to a wide variety of analog musical pieces and buyable within analog, non-custom pricing as indicated in step **610**. Preferably, the supplier designs a plurality of entertainment products each utilizing at least one essentially-analog sound separation device using essentially off-the shelf circuit components and providing essentially digital-quality sound separation as indicated in step **612**. Preferably, the supplier's design uses modular design and manufacturing techniques to provide a variety of different price ranges for the entertainment products. Preferably, each of the essentially-analog sound separation devices comprises filtering distinguishing at least five different narrow-frequency bands.

Preferably, the supplier then manufactures and sells the entertainment products as indicated in step **614**. Most preferably, the entertainment products comprise color organs. Upon reading the teachings of this specification, those of ordinary skill in the art will now understand that, under appropriate circumstances, considering such issues as user preference, intended use, etc., the entertainment products may comprise a diverse range of products, such as, musically synchronized holiday lighting, musically synchronized animatronic characters, musically synchronized fireworks launchers, musically synchronized laser projectors, etc.

Although applicant has described applicant's preferred embodiments of this invention, it will be understood that the broadest scope of this invention includes such modifications as diverse shapes and sizes and materials. Such scope is limited only by the below claims as read in connection with the above specification.

Further, many other advantages of applicant's invention will be apparent to those skilled in the art from the above descriptions and the below claims.

What is claimed is:

1) Circuit apparatus, relating to providing, from at least one analog input signal comprising at least one wide frequency band of sound, at least one trigger signal corresponding to presence of at least one selected narrow frequency band of sound, comprising:

a) analog receiver means for receiving such at least one wide frequency band of sound;

b) first band pass filter means for filtering such at least one wide frequency band of sound to select at least one first narrow frequency band of sound having a wider band than at least one second narrow frequency band of sound;

c) second band pass filter means for filtering such at least one first narrow frequency band of sound to select such at least one second narrow frequency band of sound having a wider band than such at least one selected narrow frequency band of sound;

d) voltage-comparator filter means, having a settable reference voltage usable to further narrow such at least one second narrow frequency band of sound, for filtering by voltage comparator to select such at least selected narrow frequency band of sound; and

e) translator means for providing, for use as such at least one trigger signal, at least one direct-current signal corresponding to such presence of such at least one selected narrow frequency band of sound.

2) The circuit apparatus according to Claim 1 wherein said voltage-comparator filter means comprises analog to square wave converter means for converting such at least selected narrow frequency band of sound of such at least one analog input signal to at least one fixed amplitude square wave signal.

3) The circuit apparatus according to Claim 2 wherein:

a) said analog to square wave converter means comprises signal amplitude selector means for holding such at least one fixed amplitude square wave signal active over at least one selected portion of the amplitude of such at least one second narrow frequency band of sound; and

b) such at least one selected portion of the amplitude of such at least one second narrow frequency band of sound is selected by setting such settable reference voltage.

4) The circuit apparatus according to Claim 3 wherein such settable reference voltage is settable by a user.

5) The circuit apparatus according to Claim 2 wherein said translator means comprises direct-current rectifier means for outputting at least one direct-current signal corresponding to the presence of such at least one fixed amplitude square wave signal.

6) The circuit apparatus according to Claim 5 wherein said direct-current rectifier means comprises signal sustainer means for sustaining such at least one direct-current signal over at least one minimum ergonomic duration related to human vision persistence.

7) The circuit apparatus according to Claim 5 wherein said translator means further comprises voltage level shifter means for shifting a nominal voltage level of such at least one direct-current signal to about at least one standard logic voltage level.

8) The circuit apparatus according to Claim 5 wherein said translator means further comprises voltage level shifter means for shifting a nominal voltage level of such at

least one direct-current signal to a transistor-transistor logic level of more than about four volts and less than about six volts.

9) The circuit apparatus according to Claim 7 wherein said translator means further comprises:

a) current amplifier means for amplifying the current of such at least one direct-current signal having at least one standard logic voltage;

b) wherein the output of said current amplifier means comprises such at least one trigger signal.

10) The circuit apparatus according to Claim 1 wherein said analog receiver means comprises preamplifier means for preamplifying such at least one analog input signal prior to frequency filtering.

11) The circuit apparatus according to Claim 1 wherein:

a) said analog receiver means further comprises input level adjuster means for adjusting such at least one analog input signal to establish at least one compatible signal level at said first band pass filter means; and

b) said analog receiver means further comprises impedance matching means for impedance matching such at least one analog input signal to said input level adjuster means.

12) The circuit apparatus according to Claim 9 further comprising:

a) display controller means for assisting control of at least one powered entertainment display;

b) wherein control of the at least one powered entertainment display by said display controller means is triggered by such at least one trigger signal.

13) Circuit apparatus, relating to providing, from at least one analog input signal comprising at least one wide frequency band of sound, at least one trigger signal corresponding to presence of at least one selected narrow frequency band of sound, comprising:

a) at least one analog receiver adapted to receive such at least one wide frequency band of sound;

b) at least one first band pass filter adapted to filter such at least one wide frequency band of sound to select at least one first narrow frequency band of sound having a wider band than at least one second narrow frequency band of sound;

c) at least one second band pass filter adapted to filter such at least one first narrow frequency band of sound to select such at least one second narrow frequency band of sound having a wider band than such at least one selected narrow frequency band of sound;

d) at least one voltage-comparator filter, having at least one settable reference voltage usable to further narrow such at least one second narrow frequency band of sound, adapted to filter by voltage comparator to select such at least selected narrow frequency band of sound; and

e) at least one translator circuit adapted to provide, for use as such at least one trigger signal, at least one direct-current signal corresponding to such presence of such at least one selected narrow frequency band of sound.

14) The circuit apparatus according to Claim 13 further comprises:

a) a plurality of frequency filter stages electrically coupled to said at least one analog receiver;

b) wherein each one of said plurality of frequency filter stages comprises

i) said at least one first band pass filter,

ii) said at least one second band pass filter,

iii) said at least one voltage-comparator filter, and

iv) said at least one translator circuit; and

c) wherein each one of said plurality of frequency filter stages is adapted to provide at least one additional trigger signal corresponding to presence of at least one additional selected narrow frequency band of sound.

15) The circuit apparatus according to Claim 13 wherein said at least one voltage-comparator filter comprises at least one analog to square wave converter adapted to convert such at least selected narrow frequency band of sound of such at least one analog input signal to at least one fixed amplitude square wave signal.

16) The circuit apparatus according to Claim 15 wherein said at least one analog to square wave converter comprises:

a) at least one signal amplitude selector adapted to hold such at least one fixed amplitude square wave signal active over at least one selected amplitude portion of such at least one second narrow frequency band of sound;

b) wherein such at least one selected amplitude portion of such at least one second narrow frequency band of sound is selected by setting such settable reference voltage.

17) The circuit apparatus according to Claim 16 wherein such settable reference voltage is settable by a user.

18) The circuit apparatus according to Claim 15 wherein said at least one translator circuit comprises at least one direct-current rectifier adapted to output at least one direct-current signal corresponding to the presence of such at least one fixed amplitude square wave signal.

19) The circuit apparatus according to Claim 18 wherein said at least one direct-current rectifier comprises at least one direct-current signal sustainer adapted to sustain such at least one direct-current signal over at least one minimum ergonomic duration related to human vision persistence.

20) The circuit apparatus according to Claim 18 wherein said at least one translator circuit further comprises at least one voltage level shifter adapted to shift a nominal voltage level of such at least one direct-current signal to about at least one standard logic voltage level.

21) The circuit apparatus according to Claim 18 wherein said at least one translator circuit further comprises at least one voltage level shifter adapted to shift a nominal voltage level of such at least one direct-current signal to a transistor-transistor logic level of more than about three volts and less than about six volts.

22) The circuit apparatus according to Claim 20 wherein said at least one translator circuit further comprises:

a) at least one current amplifier adapted to amplify the current of such at least one direct-current signal having at least one standard logic voltage;

b) wherein the output of said at least one current amplifier comprises such at least one trigger signal.

23) The circuit apparatus according to Claim 14 wherein said at least one analog receiver comprises at least one preamplifier adapted to pre-amplify such at least one analog input signal from a line level to a first output gain prior to frequency filtering.

24) The circuit apparatus according to Claim 23 wherein said at least one analog receiver further comprises at least one filter driver adapted to amplify such at least one analog input signal from such first output gain to a second output gain compatible with the operation of said at least one first band pass filter.

25) The circuit apparatus according to Claim 23 further comprising:

a) at least one display controller adapted to provide electrical control of at least one powered entertainment display;

b) wherein electrical control of the at least one powered entertainment display by said at least one display controller is triggerable by such at least one trigger signal.

26) The circuit apparatus according to Claim 25 wherein said at least one display controller comprises at least one phased controlled integrated circuit adapted to regulate at least one flow of electrical current to such at least one powered entertainment display.

27) The circuit apparatus according to Claim 25 wherein said at least one display controller comprises at least one electro-optical coupler adapted to receive the at least one trigger signal by electro-optical coupling.

28) The circuit apparatus according to Claim 27 wherein said at least one display controller is adapted to electrically control the illumination of at least one illumination source.

29) The circuit apparatus according to Claim 28 further comprising:

a) a plurality of controller stages;

b) wherein each one of said plurality of controller stages is electro-optically coupled to at least one of said plurality of frequency filter stages; and

c) wherein each one of said plurality of controller stages is adapted to provide electrical control of at least one powered entertainment display in response to the at least one trigger signal generated by said at least one of said plurality of frequency filter stages.

30) The circuit apparatus according to Claim 29 wherein:

a) each one of said plurality of controller stages is adapted to electrically control said at least one illumination source; and

b) said at least one illumination source comprises a visually distinct color.

31) The circuit apparatus according to Claim 27 wherein said at least one display controller further comprises:

a) at least one controllable effects generator adapted to generate at least one controllable illumination effect at the at least one illumination source;

b) wherein said at least one controllable effects generator comprises at least one user control adapted to permit user initiated control of at least one feature of such at least one controllable illumination effect.

32) The circuit apparatus according to Claim 31 wherein said at least one controllable effects generator comprises:

a) at least one decade counter adapted to provide at least one logic pulse;

b) wherein said at least one decade counter is structured and arranged to control said plurality of controller stages in at least one serial order to provide at least one sequenced illumination effect.

33) The circuit apparatus according to Claim 29 wherein said plurality of controller stages comprises a physically separate modular circuit board.

34) The circuit apparatus according to Claim 33 wherein said physically separate modular circuit board comprises at least five of said plurality of controller stages.

35) The circuit apparatus according to Claim 14 wherein said plurality of frequency filter stages comprises a physically separate modular circuit board.

36) The circuit apparatus according to Claim 34 wherein each physically separate modular circuit board comprises at least five of said plurality of frequency filter stages.

37) A method of providing a trigger voltage to a phased controlled integrated circuit adapted to power at least one entertainment display system, comprising the steps of:

a) providing at least one direct-current reference voltage having at least one direct-current trigger voltage superimposed therein;

b) wherein such at least one direct-current trigger voltage is supplied by optical coupling from at least one external trigger source; and

c) wherein such at least one direct-current reference voltage is adjustable by a user.

38) A method, relating to modular design to produce pleasurable visual effects responsive to analog music sounds, comprising the steps of:

a) designing at least one modular electronic architecture providing filtering of such analog music sounds into at least five narrow frequency bands by at least five frequency-selectable filtering circuits;

b) wherein each of such at least five frequency-selectable filtering circuits comprise essentially the same circuits but for frequency-selecting values; and

c) wherein essentially all electronic components used in such designing of such at least one architecture comprise standard off-the-shelf electronic components; and

d) selecting at least five different visual effects, each designed to be triggerable by presence of selectable minimums of sound narrowly adjacent at least one selected sound frequency; and

e) assigning each visual effect of such at least five different visual effects to at least one of such at least five narrow frequency bands;

f) wherein such at least one modular electronic architecture assists ease of variability in assigning such at least five narrow-frequency bands to maximize visual pleasure from each of a variety of particular kinds of music sounds.

39) The method according to Claim 38 wherein such at least five different visual effects comprise selected colors of light.

40) The method according to Claim 39 wherein such triggerability is designed, working within parameters of human visual systems, to produce essentially only light pulses of sufficient length to be seen as a full-color effect and brightness for each such selected color of light.

41) The method according to Claim 38 wherein such at least five narrow-frequency bands are selected to correlate with at least one fundamental frequency of at least one source of musical sound.

42) The method according to Claim 41 wherein such at least one source of musical sound comprises at least one musical instrument.

43) The method according to Claim 38 further comprising the step of designing at least one light display matched for plug-in use with such at least one modular electronic architecture.

44) The method according to Claim 42 further comprising the step of designing at least one light display matched for plug-in use with such at least one modular electronic architecture.

45) The method according to Claim 44 further comprising the step of manufacturing such designed at least one modular electronic architecture and such at least one light display.

46) The method according to Claim 45 further comprising the step of offering such manufactured such designed at least one modular electronic architecture and such at least one light display for sale to businesses desiring a professional-quality color organ at non-custom pricing.

47) The method according to Claim 46 wherein such businesses comprise musical entertainment sources providing instant selectability of musical numbers.

48) The method according to Claim 38 further comprising the step of manufacturing such designed at least one modular electronic architecture.

49) A method, relating to producing pleasurable visual effects responsive to analog music sounds, comprising the steps of:

a) analyzing at least one entertainment market desiring digital-quality sound separation devices adaptable to a wide variety of analog musical pieces and buyable within analog, non-custom pricing; and

b) designing a plurality of entertainment products each utilizing at least one essentially-analog sound separation device using essentially off-the shelf circuit components and providing essentially digital-quality sound separation;

c) wherein such designing uses modular design and manufacturing techniques to provide a variety of different price range such entertainment products; and

d) wherein each such at least one essentially-analog sound separation device comprises filtering distinguishing at least five different narrow-frequency bands.

50) The method according to Claim 49 further comprising manufacture and sale of such entertainment products.

51) The method according to Claim 50 wherein such entertainment products comprise color organs.

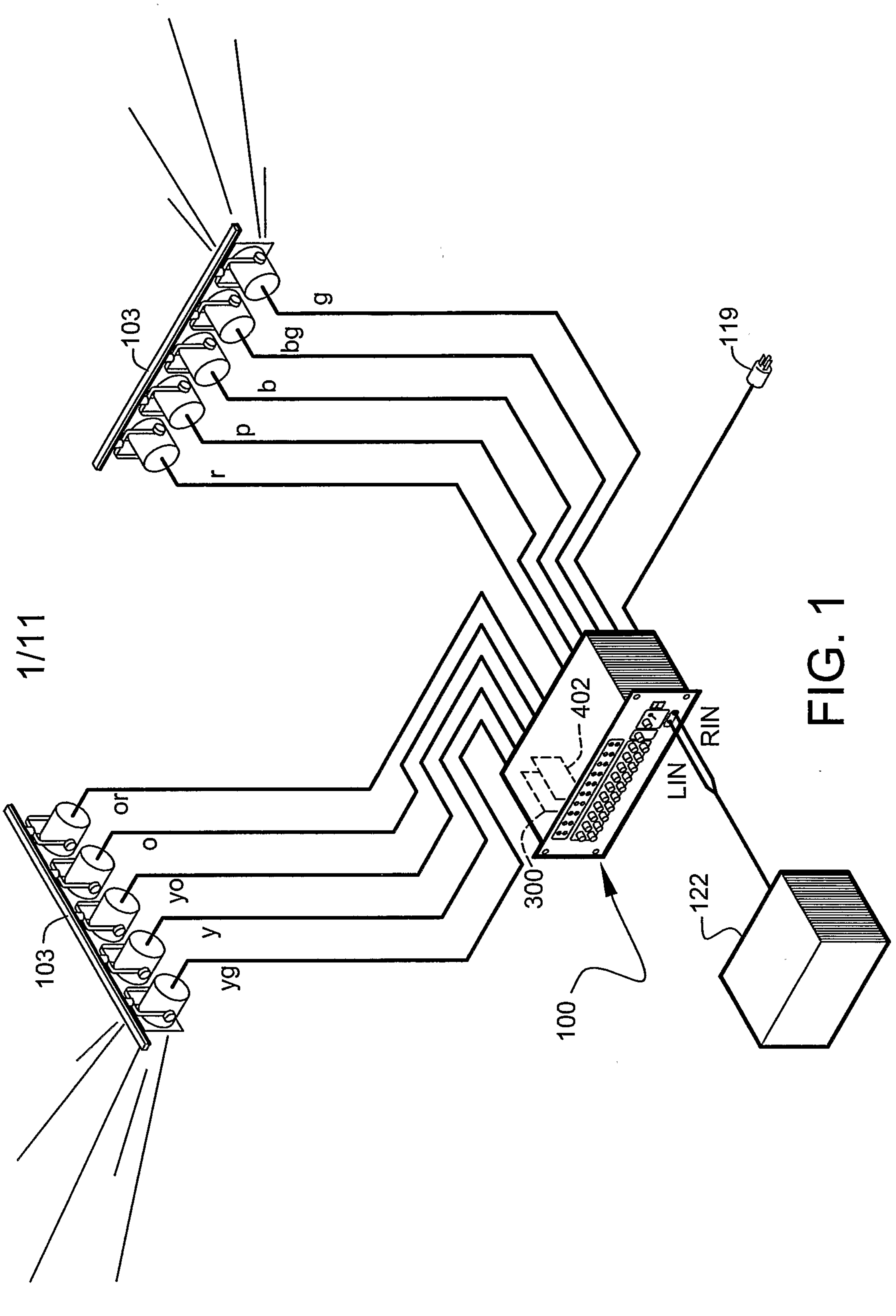


FIG. 1

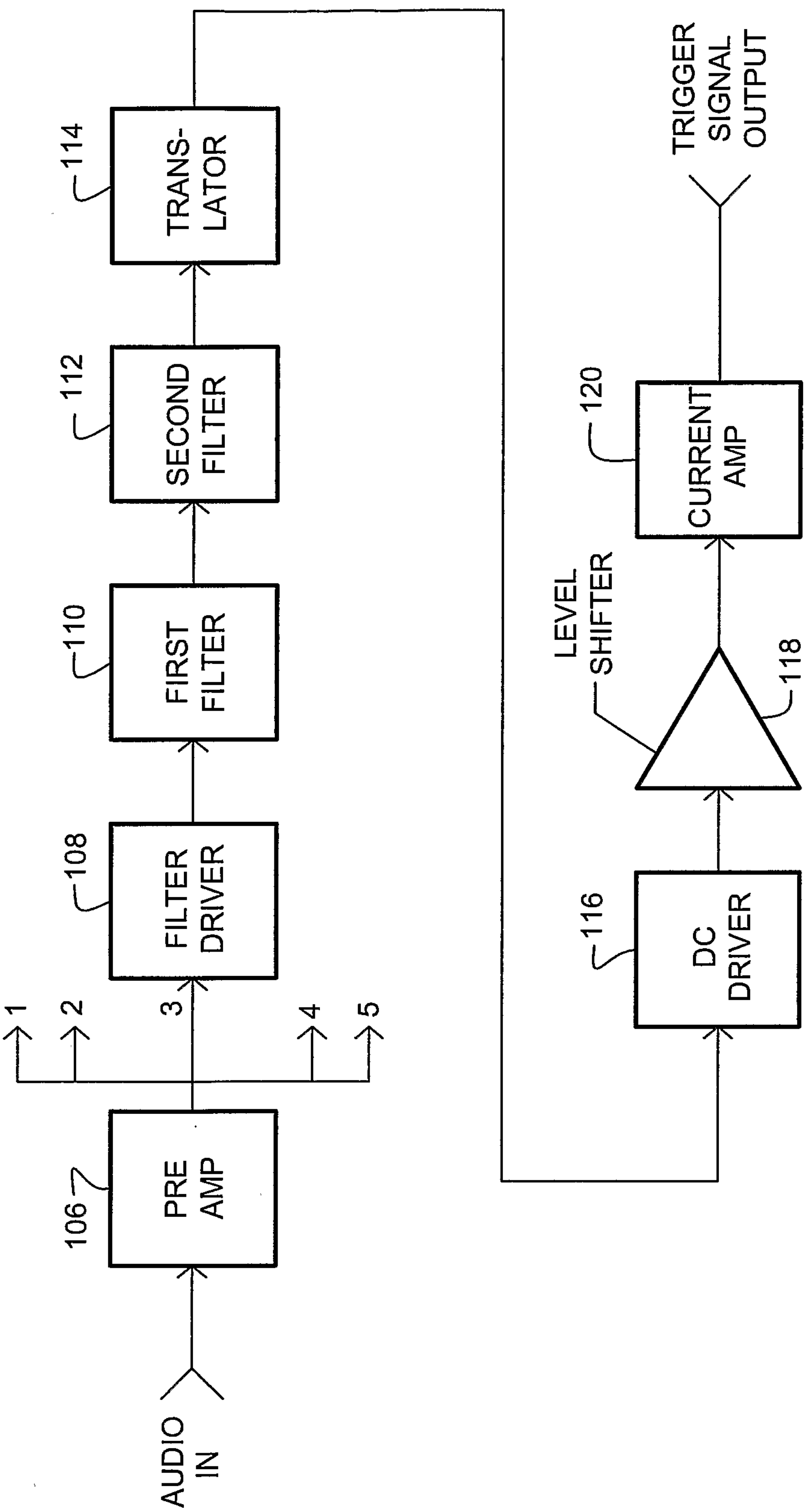

AUDIO IN
106
PRE AMP
1
2
3
4
5
108
FILTER DRIVER
110
FIRST FILTER
112
SECOND FILTER
114
TRANS-LATOR
116
DC DRIVER
LEVEL SHIFTER
118
120
CURRENT AMP
TRIGGER SIGNAL OUTPUT

FIG. 2a

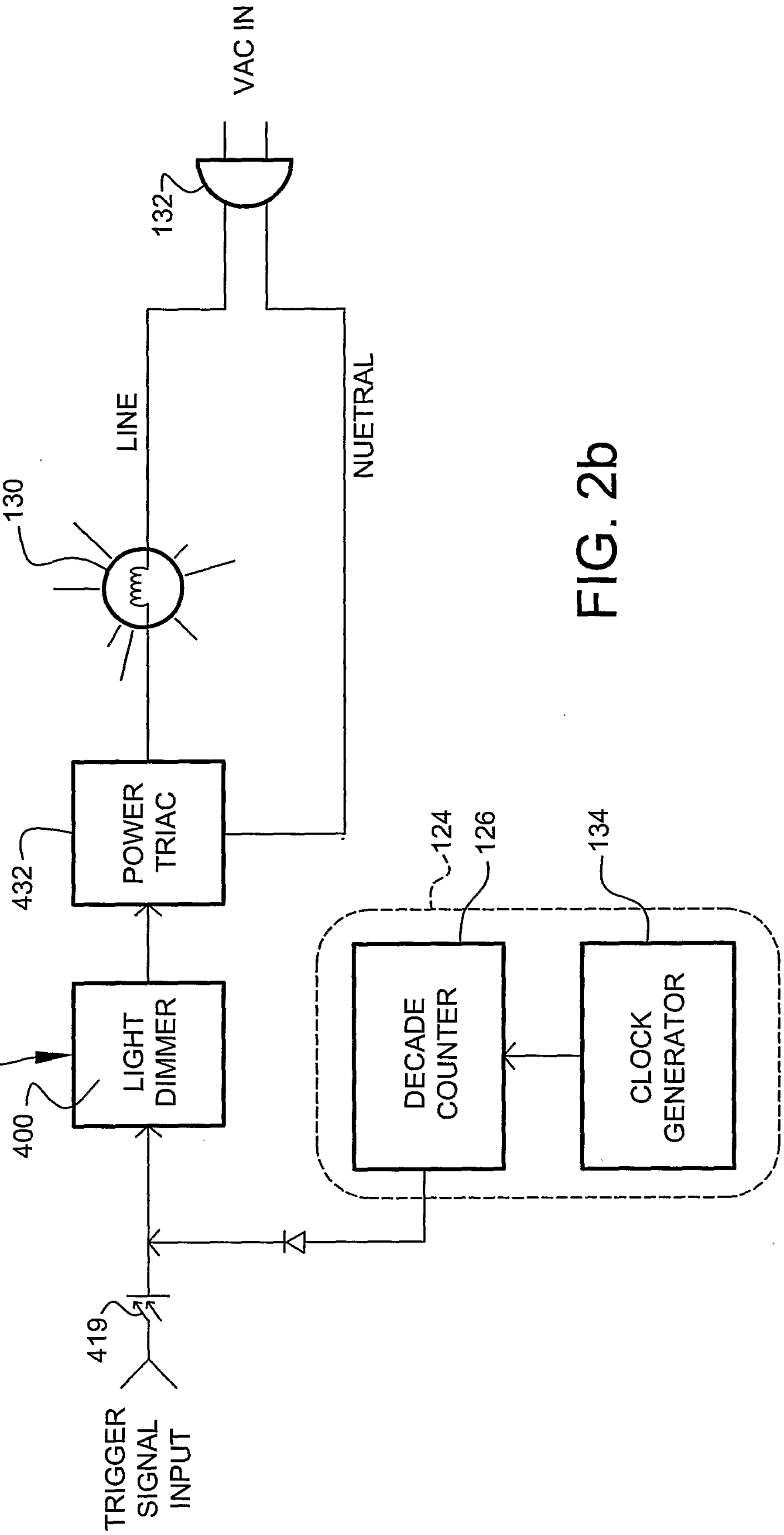

VAC IN
132
LINE
NUETRAL
130
POWER TRIAC
432
LIGHT DIMMER
402
400
124
126
134
DECADE COUNTER
CLOCK GENERATOR
419
TRIGGER SIGNAL INPUT

FIG. 2b

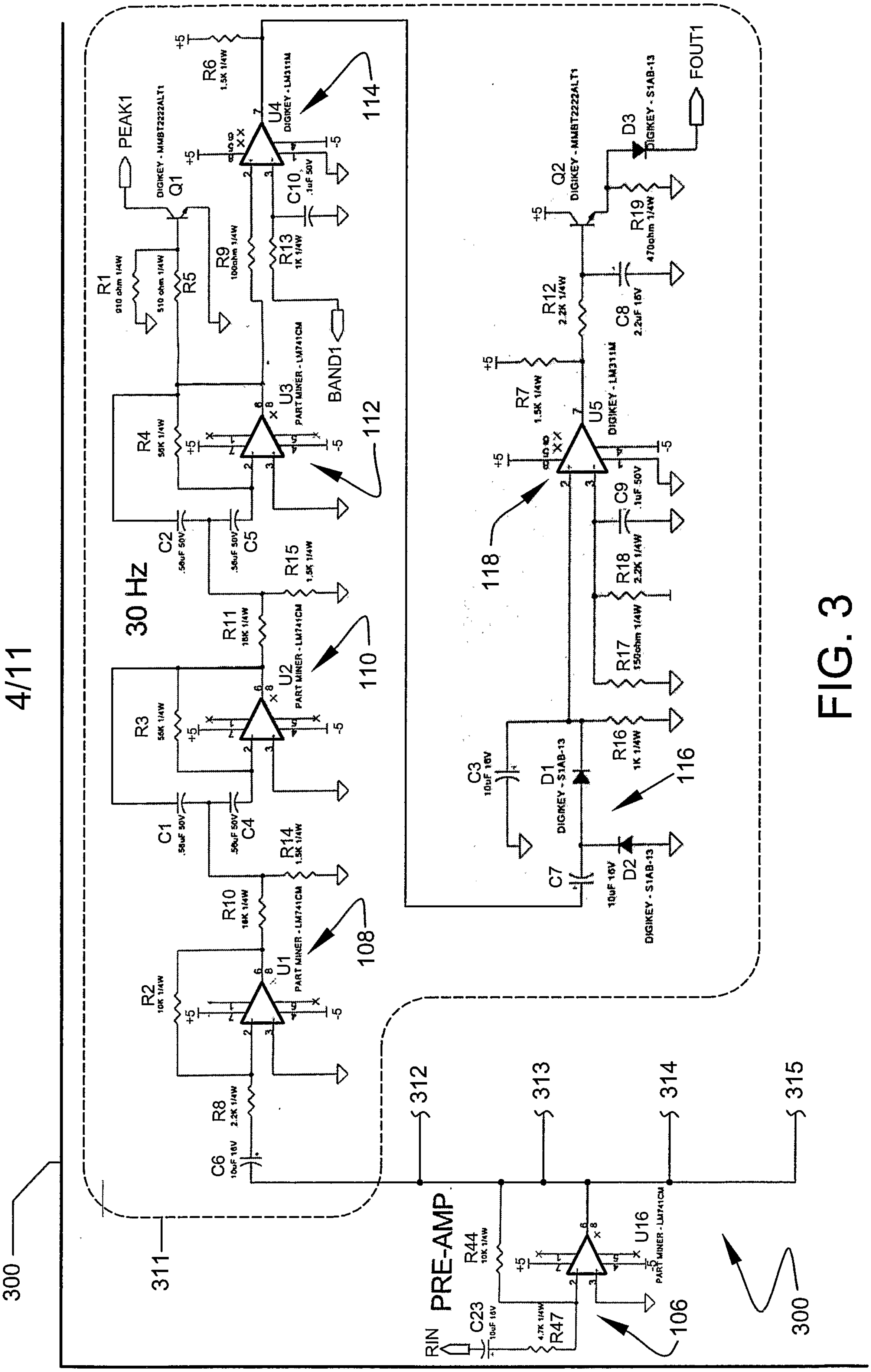

PEAK1
BAND1
FOUT1
RIN
PRE-AMP
30 Hz
Q1
DIGIKEY - MMBT2222ALT1
Q2
DIGIKEY - MMBT2222ALT1
U1
PART MINER - LM741CM
U2
PART MINER - LM741CM
U3
PART MINER - LM741CM
U4
DIGIKEY - LM311M
U5
DIGIKEY - LM311M
U16
PART MINER - LM741CM
D1
DIGIKEY - S1AB-13
D2
DIGIKEY - S1AB-13
D3
DIGIKEY - S1AB-13
R1
910 ohm 1/4W
R2
10K 1/4W
R3
56K 1/4W
R4
56K 1/4W
R5
510 ohm 1/4W
R6
1.5K 1/4W
R7
1.5K 1/4W
R8
2.2K 1/4W
R9
100ohm 1/4W
R10
18K 1/4W
R11
18K 1/4W
R12
2.2K 1/4W
R13
1K 1/4W
R14
1.5K 1/4W
R15
1.5K 1/4W
R16
1K 1/4W
R17
150ohm 1/4W
R18
2.2K 1/4W
R19
470ohm 1/4W
R44
10K 1/4W
R47
4.7K 1/4W
C1
.56uF 50V
C2
.56uF 50V
C3
10uF 16V
C4
.56uF 50V
C5
.56uF 50V
C6
10uF 16V
C7
10uF 16V
C8
2.2uF 16V
C9
.1uF 50V
C10
.1uF 50V
C23
10uF 16V
+5
-5
106
108
110
112
114
116
118
300
311
312
313
314
315

FIG. 3

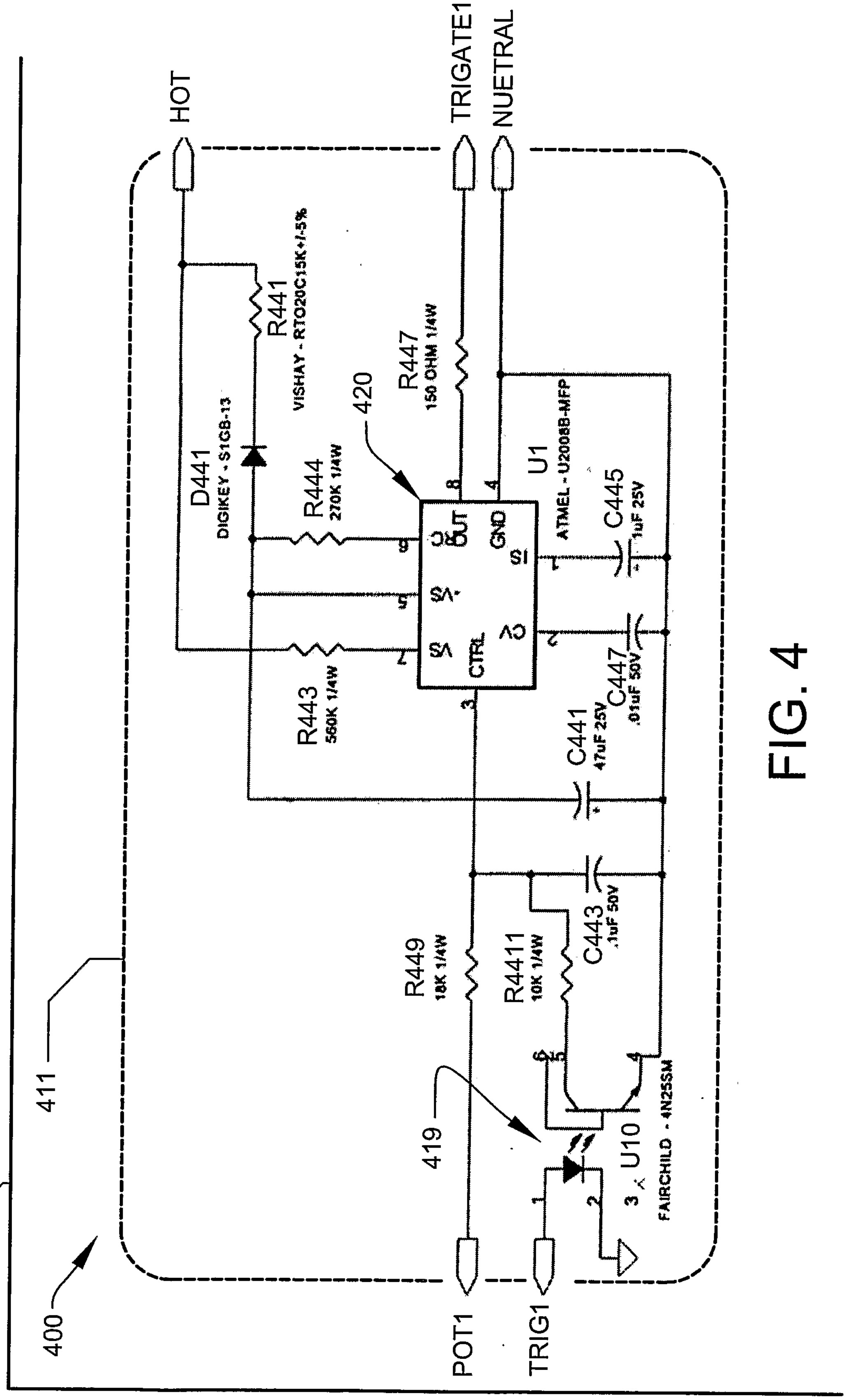

HOT
TRIGATE1
NUETRAL
R441
VISHAY - RTO20C15K+/-5%
D441
DIGIKEY - S1GB-13
R444
270K 1/4W
420
R447
150 OHM 1/4W
U1
ATMEL - U2008B-MFP
OUT
GND
CTRL
C445
.1uF 25V
R443
560K 1/4W
C441
47uF 25V
C447
.01uF 50V
R449
18K 1/4W
R4411
10K 1/4W
C443
.1uF 50V
U10
FAIRCHILD - 4N25SM
419
411
402
400
POT1
TRIG1

FIG. 4

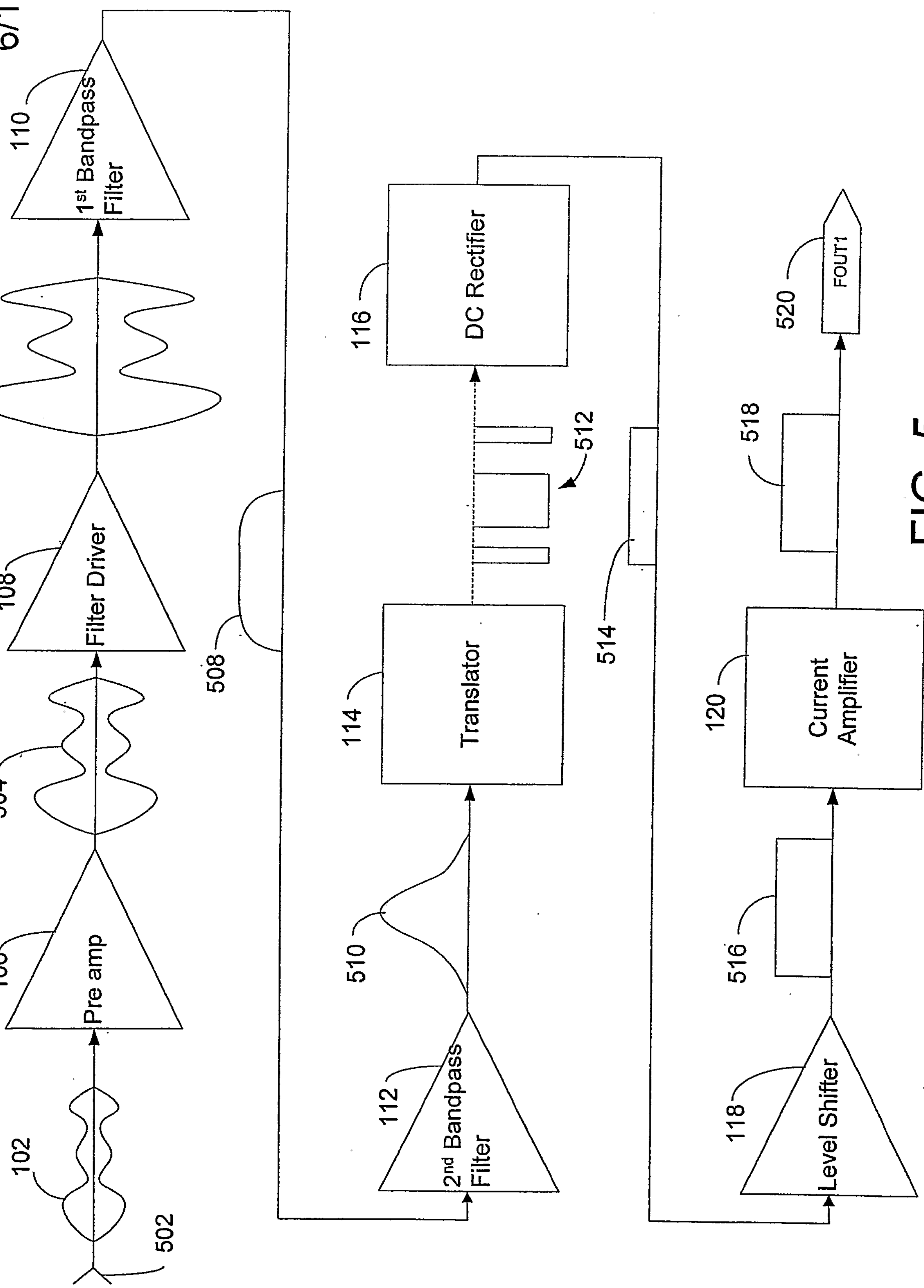
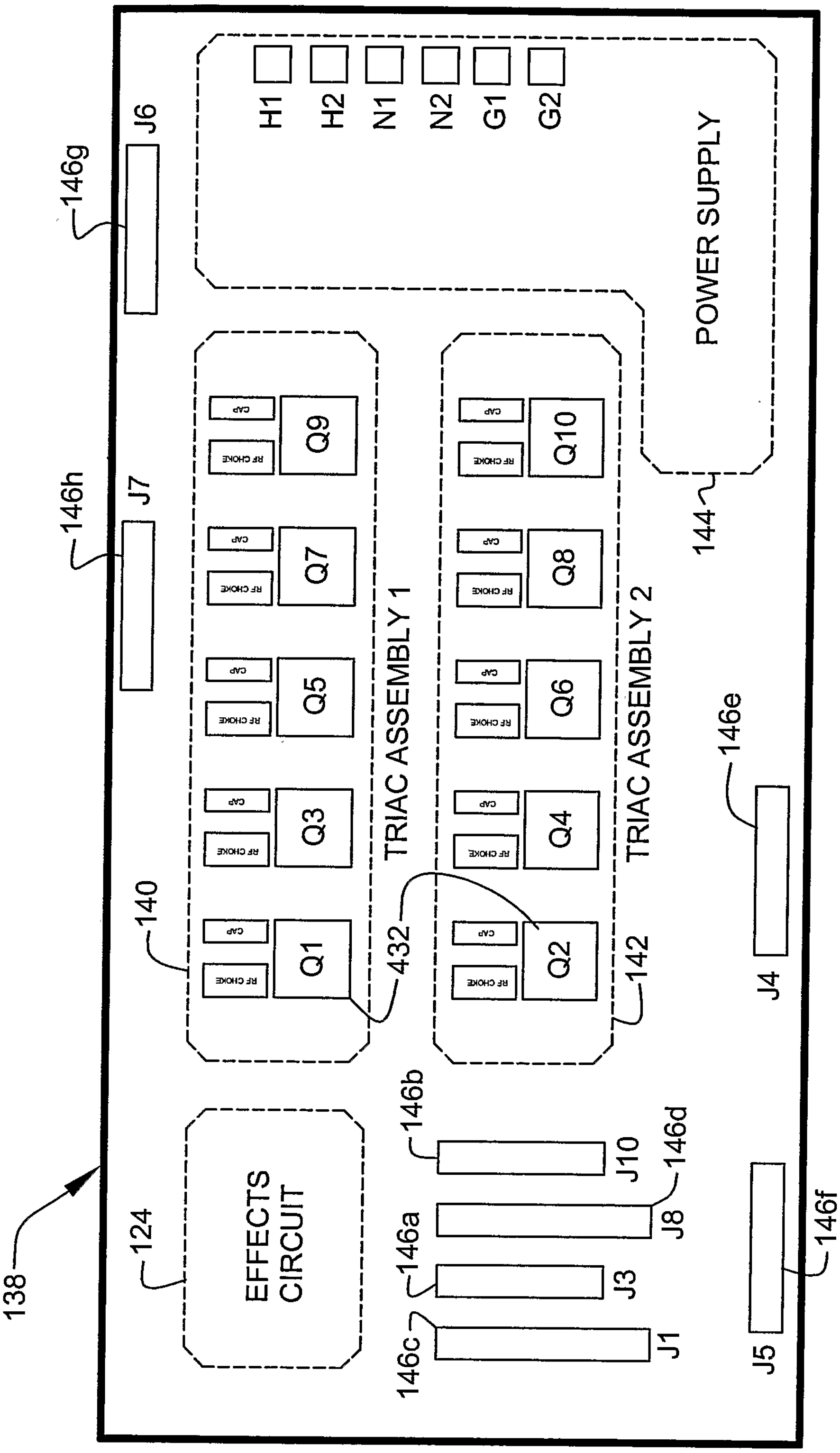

502
102
106
Pre amp
504
108
Filter Driver
506
110
1st Bandpass Filter
508
112
2nd Bandpass Filter
510
114
Translator
512
116
DC Rectifier
514
118
Level Shifter
516
120
Current Amplifier
518
520
FOUT1

FIG. 5



138
124
EFFECTS CIRCUIT
146a
146b
146c
146d
146e
146f
146g
146h
J1
J3
J4
J5
J6
J7
J8
J10
140
142
144
432
TRIAC ASSEMBLY 1
TRIAC ASSEMBLY 2
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
RF CHOKE
CAP
POWER SUPPLY
H1
H2
N1
N2
G1
G2

FIG. 6a

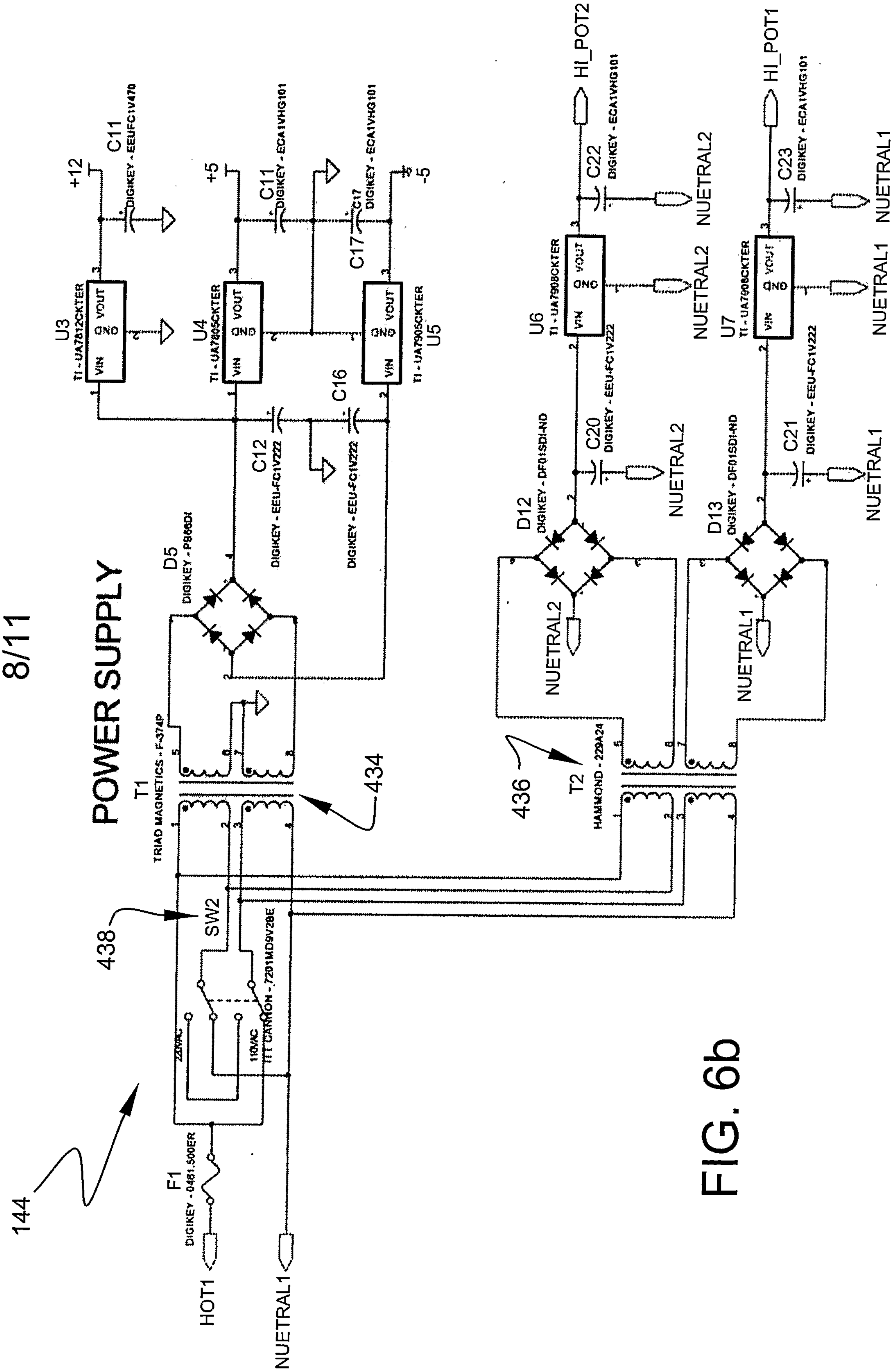

POWER SUPPLY
144
F1
DIGIKEY - 0461.500ER
HOT1
NUETRAL1
438
SW2
220VAC
110VAC
ITT CANNON - 7201MD9V28E
T1
TRIAD MAGNETICS - F-374P
434
D5
DIGIKEY - PB66DI
C12
DIGIKEY - EEU-FC1V222
C16
DIGIKEY - EEU-FC1V222
U3
TI - UA7812CKTER
U4
TI - UA7805CKTER
U5
TI - UA7905CKTER
C11
DIGIKEY - EEUFC1V470
+12
C11
DIGIKEY - ECA1VHG101
+5
C17
DIGIKEY - ECA1VHG101
-5
436
T2
HAMMOND - 229A24
D12
DIGIKEY - DF01SDI-ND
NUETRAL2
C20
DIGIKEY - EEU-FC1V222
U6
TI - UA7908CKTER
C22
DIGIKEY - ECA1VHG101
HI_POT2
D13
DIGIKEY - DF01SDI-ND
C21
DIGIKEY - EEU-FC1V222
U7
TI - UA7908CKTER
C23
DIGIKEY - ECA1VHG101
HI_POT1

FIG. 6b

MARQUEE CIRCUIT

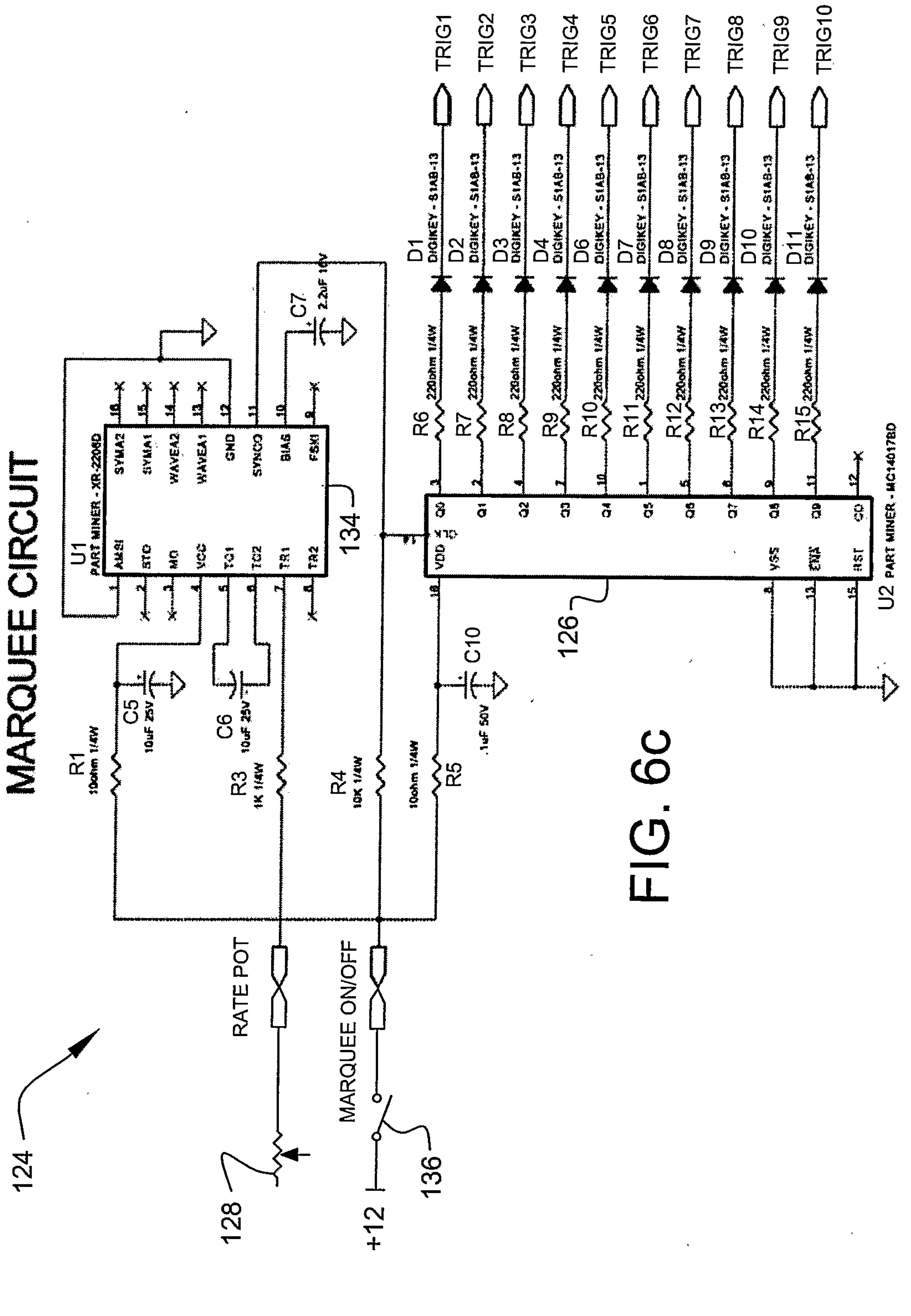


FIG. 6c

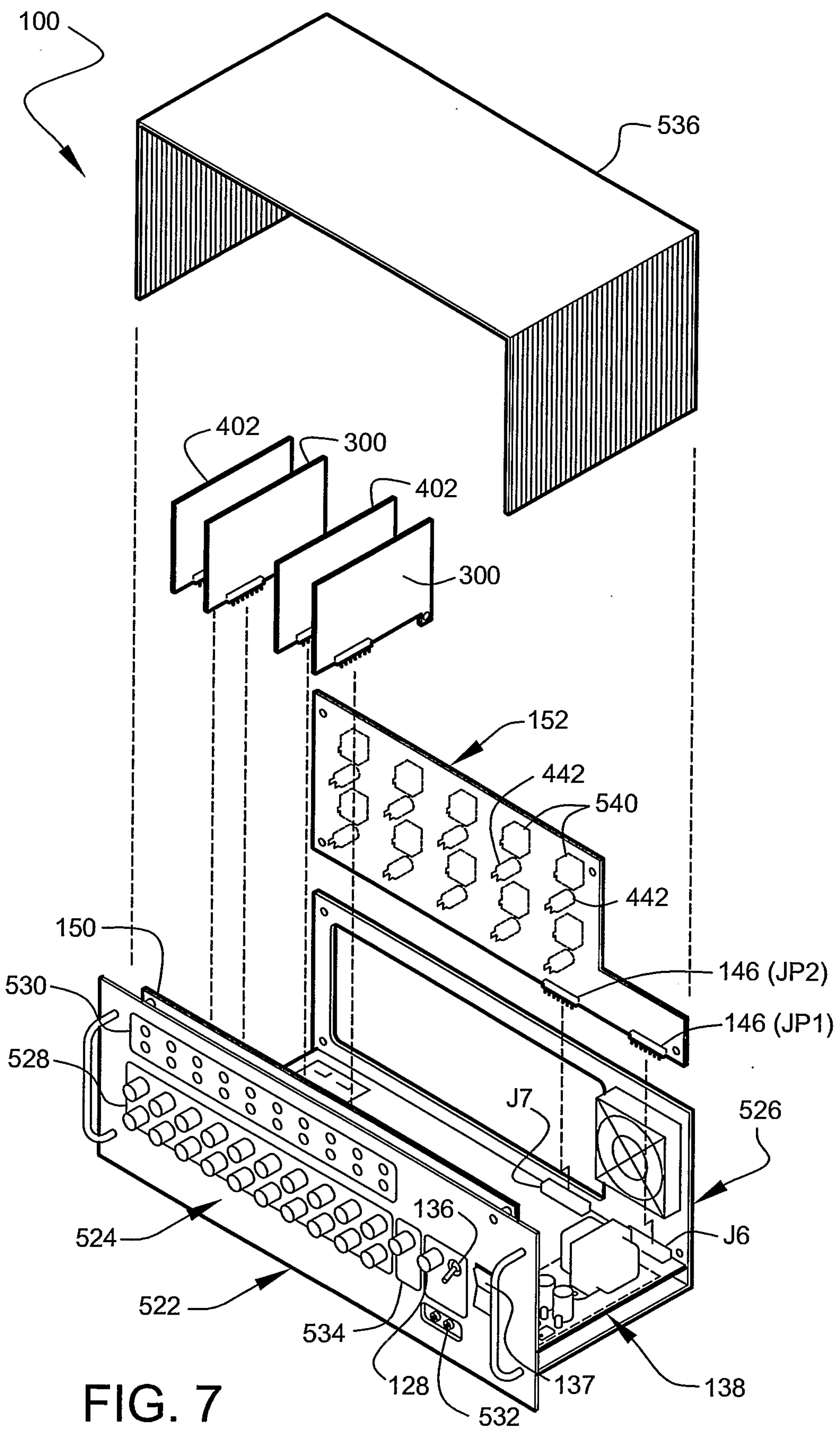

100
536
402
300
402
300
152
442
540
442
146 (JP2)
146 (JP1)
150
530
528
J7
526
J6
136
524
522
534
128
137
138
532

FIG. 7

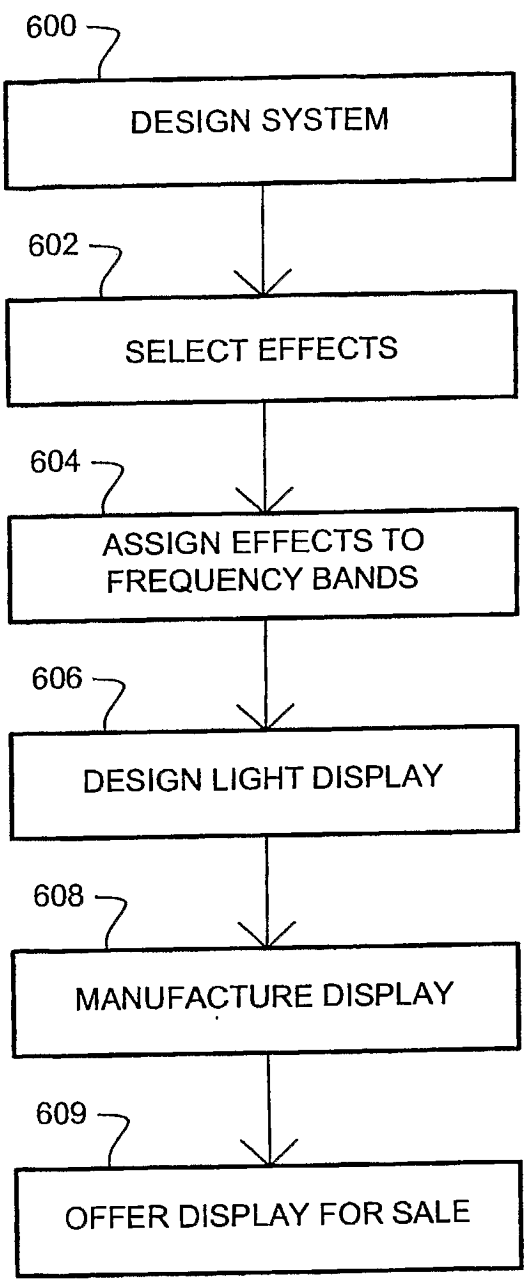

600
DESIGN SYSTEM
602
SELECT EFFECTS
604
ASSIGN EFFECTS TO FREQUENCY BANDS
606
DESIGN LIGHT DISPLAY
608
MANUFACTURE DISPLAY
609
OFFER DISPLAY FOR SALE

FIG. 8

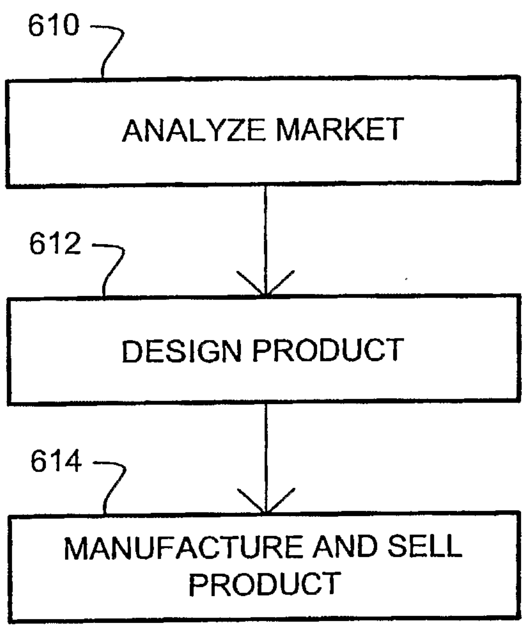

610
ANALYZE MARKET
612
DESIGN PRODUCT
614
MANUFACTURE AND SELL PRODUCT

FIG. 9

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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International Bureau

(43) International Publication Date
18 May 2006 (18.05.2006)

PCT

(10) International Publication Number
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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

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Declaration under Rule 4.17:
— *of inventorship (Rule 4.17(iv))*

Published:
— *with international search report*

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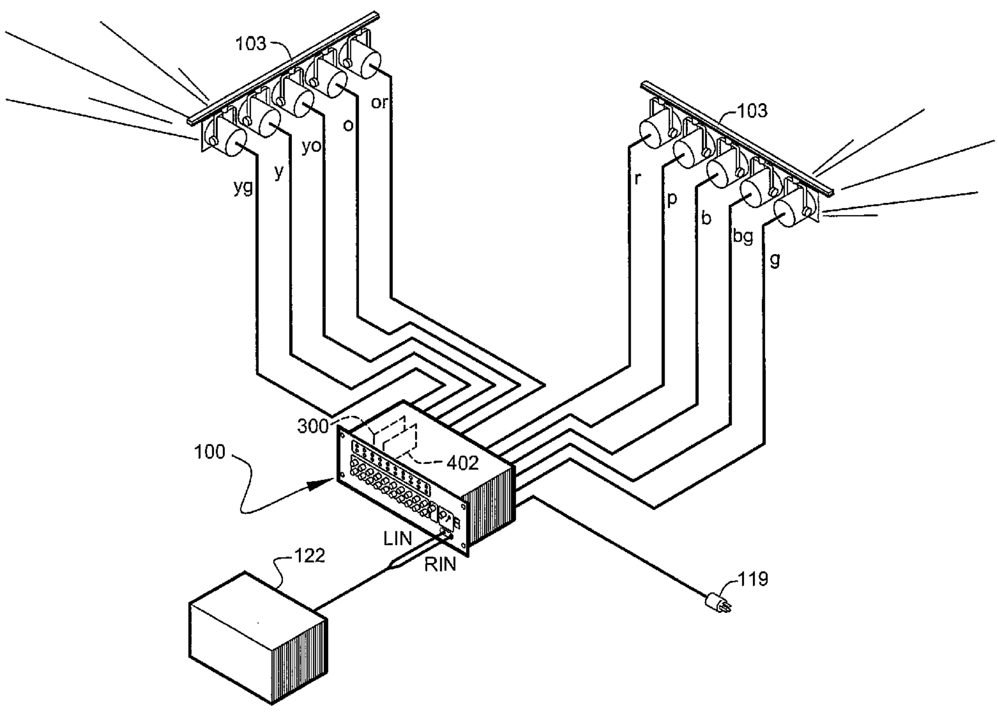
[Continued on next page]

(54) Title: ENTERTAINMENT DISPLAY SYSTEMS



(57) Abstract: An analog to digital system for improved audio driven control of electrical devices, especially those relating to synchronizing lighting displays to music. Methods relating to modular system designs used to produce pleasurable visual effects responsive to analog music sounds are also disclosed.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US05/40752

A. CLASSIFICATION OF SUBJECT MATTER
IPC: **H04R 29/00**(2006.01),**1/02**(2006.01);**G09F 27/00**(2006.01)

USPC: 381/56,58,87,124
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
U.S. : 381/56,58,87,124

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 5,402,702 (HATA) 4 April 1995 (04.04.1995)	38-45,48 --- 1-32
Y	US 4,412,100 (ORBAN) 25 October 1983 (25.10.1983) figures 1 and 3	1-32
Y	US 2002/0154787 A1 (RICE et al.) 24 October 2002 (24.10.2002) figure 5	27-32

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 December 2006 (16.12.2006)	26 FEB 2007
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	Authorized officer Douglas Suthers Telephone No. (571) 272-5582

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US05/40752

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
Please See Continuation Sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of any additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1-36 and 38-48

Remark on Protest
☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
☐ No protest accompanied the payment of additional search fees.

BOX III. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claim(s) 1-36, and 38-48, drawn to a circuit and method of providing at least one trigger signal corresponding to a presence of at least one selected narrow frequency band of sound.

Group II, claim(s) 37, drawn to a method of providing a voltage to a phase controlled integrated circuit.

Group III, claim(s) 49-51, drawn to a method relating to a producing pleasurable visual effects.

The inventions listed as Groups I-III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: Group I requires processing sound signals and providing an indicator of existence of a narrow band of frequencies. It does not require market analysis, or a phase controlled IC. Group II includes providing a trigger voltage to a phase controlled integrated circuit, which does not require sound processing or market analysis. Group II requires market analysis and design steps based off such. It does not require production of trigger signals