

[72] Inventor **Henry N. Switsen**
2723 Kelton Ave., Los Angeles, Calif.
90064

[21] Appl. No. **41,024**

[22] Filed **May 27, 1970**

[45] Patented **Aug. 10, 1971**

3,228,278 1/1966 Wortman 84/464
3,234,847 2/1966 Williams..... 84/464 X

Primary Examiner—Milton O. Hirshfield
Assistant Examiner—Ulysses Weldon
Attorney—Lindenberg, Freilich & Wasserman

[54] **MUSIC FREQUENCY SELECTOR CIRCUIT**
6 Claims, 2 Drawing Figs.

[52] U.S. Cl. **84/1.01,**
84/464, 307/252

[51] Int. Cl. **G10h 1/00**

[50] Field of Search..... 321/27;
84/1.01, 1.24, 464; 240/3.1; 307/72, 73, 252.53,
252.55, 252.72, 252.78, 305, 221 B, 222 B, 223 B,
224 B, 225 B

[56] **References Cited**
UNITED STATES PATENTS

3,163,077 12/1964 Shank..... 84/464
3,215,022 11/1965 Orgo 84/464

ABSTRACT: A circuit for selectively energizing one of several different colored lights in accordance with the frequency of music being played, which prevents energization of all the lights by loud music passages. The circuit includes a silicon controlled rectifier (SCR) for each light, each SCR having an anode connected through the light to one terminal of a power source, a cathode connected through a common bias resistor to the other terminal of the power source, and a gate connected through a filter to the music source to allow only a certain frequency range of music to raise the gate potential high enough to turn on the SCR. The common bias resistor increases the effective selectivity of the filters, because as soon as one SCR turns on, the resulting voltage across the common bias resistor raises the potential of all of the SCR cathodes to prevent any other SCR's from turning on.

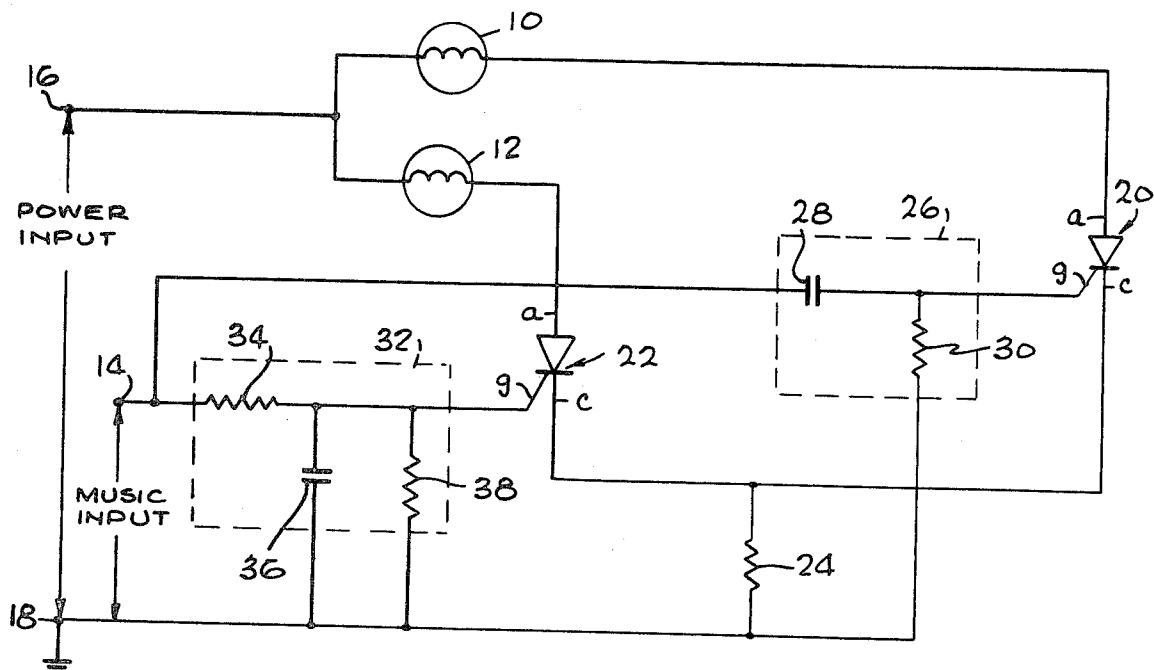


Fig. 1

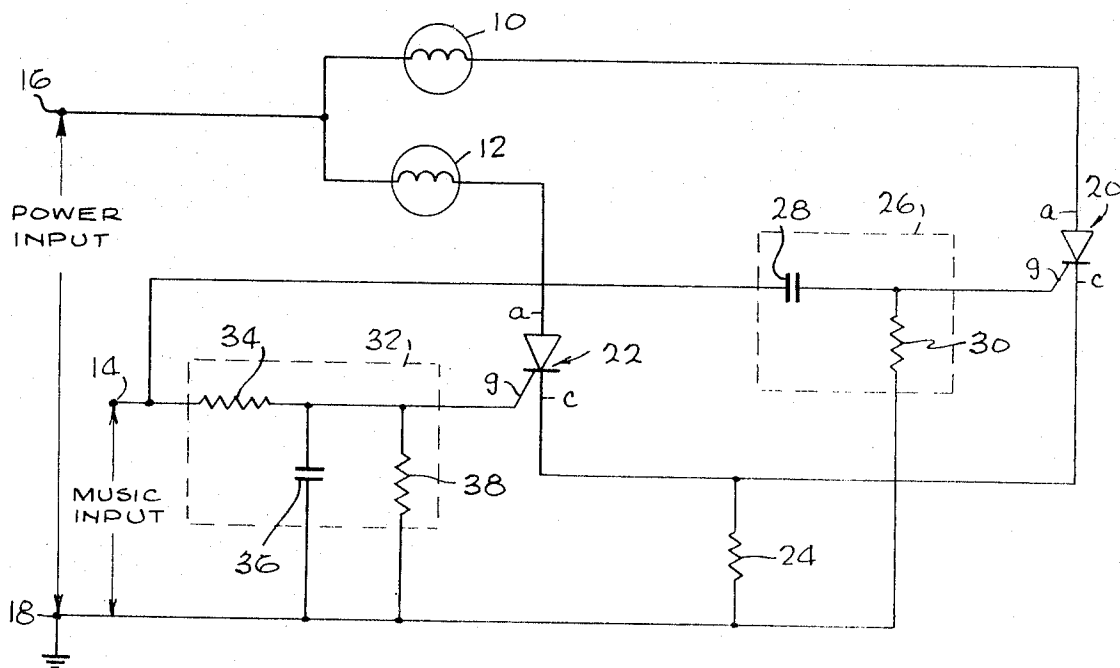
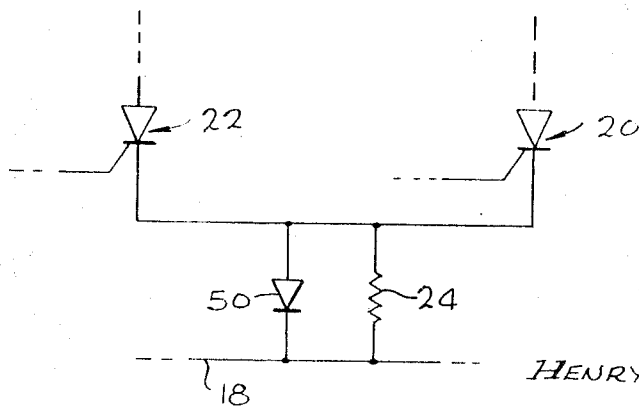


Fig. 2



HENRY N. SWITSEN
INVENTOR.

BY
Lindenberg, Friedich & Wasserman
ATTORNEYS

MUSIC FREQUENCY SELECTOR CIRCUIT

BACKGROUND OF THE INVENTION

1. Field of the invention

This invention relates to apparatus for controlling the energization of loads by the frequency of musical inputs.

2. Description of the Prior Art

Musical entertainment sometimes can be enhanced by providing several lights of different colors that are selectively energized by the frequency of the music being played, so that high, medium, or low frequency musical passages cause different colors of lights to be turned on. One type of circuit which can be used to energize the different lights includes a silicon controlled rectifier (SCR) for each lamp to connect it to a household power source, the gate of each SCR being connected through a filter to the record player or other musical source. Each filter passes primarily signals of a certain frequency range, so that a musical signal of a particular frequency will pass primarily through only one filter to turn on the corresponding SCR and cause illumination of the corresponding lamp which is of a particular color. The visual effect is a succession of different bright colors appearing in a sequence determined by the pitch of the music being played.

If the filters that couple the music source to the SCR gate were extremely selective, i.e., if they had high Q's or sharp cutoff points, then the desired lighting sequence would appear regardless of the volume of the music. However, economical construction necessitates the use of simple filters of only moderate selectivity. As a result, during loud musical passages a strong enough signal passes through all of the filters to cause all of the lights to remain on, regardless of the frequency of the music. For soft musical passages, on the other hand, not enough current passes through even one of the filters and not even one light is turned on. The constant illumination of all or none of the different colored lights reduces the entertainment value of the device.

SUMMARY OF THE INVENTION

In accordance with one embodiment of the present invention, a simple circuit is provided for selectively energizing different colored lamps or other loads in accordance with the frequency of a musical input, which prevents the energization of more than one lamp at a time even during loud musical passages. The circuit includes several silicon controlled rectifiers (SCR) or their equivalents, each having an anode connected through a lamp to one terminal of the power source and a cathode connected through a common biasing resistor to the other power terminal. The gate of each SCR is connected through a filter to the music signal source, each filter constructed to allow a different frequency of signals to pass to the gate and turn on the respective SCR. The common bias resistor increases the effective selectivity of the filters because once one SCR is turned on, the common bias resistor experiences a voltage drop. This voltage drop increases the cathode-to-ground potential of all of the SCR's. As a result, the firing voltage at the gates of all other SCR's is raised and none of the other SCR's can fire even if the musical passage is loud so that considerable current passes through filters which should have blocked them.

In another embodiment of the invention, which is designed to enable lamps of a variety of wattages to be used, a diode is connected in parallel with the common biasing resistor. The diode allows large currents to pass without experiencing a large voltage drop and therefore without dissipating considerable power. This allows a large load (high wattage lamp) to be used without dissipating considerable power through the biasing resistor, while also allowing small loads (low wattage lamps) to be used.

The novel features of the invention are set forth with particularity in the appended claims. The invention will be best understood from the following description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of a circuit constructed in accordance with one embodiment of the invention; and

FIG. 2 is a partial schematic diagram of another embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates a circuit constructed in accordance with the invention, for energizing two lamps 10 and 12 of different colors in accordance with the frequency of music received over a music input terminal 14. The terminal 14 may be connected to a phonograph, radio, microphone, or the like. Power for energizing the lamps is received from a pair of power terminals 16, 18 which may be connected to an ordinary household outlet, which typically carries a 110 volt AC current. The circuit is designed to energize one lamp 10 only during the receipt of musical signals of primarily high frequency, and to energize the other lamp 12 only during the receipt of musical signals of primarily low frequency. The circuit is designed so that there will generally be one and only one lamp illuminated. That is, even during the receipt of strong or high volume musical signals, only one lamp will be illuminated, and during the receipt of weak or low volume signals at least one lamp will generally be illuminated. This manner of selection is accomplished using a simple and inexpensive circuit. Although only two lamps 10, 12 are shown, for energization in the frequency range of 0 to some selected frequency, or in the frequency range above that selected frequency, many systems will employ three or more lamps, each energized primarily by music within a different frequency range.

The circuit includes two silicon controlled rectifiers (SCR's) 20 and 22 which control the energization of the lamps 10, 12, respectively. The anode a of each SCR is connected through one lamp 10, 12 to one power terminal 16. The cathode c of each SCR is connected through a common biasing resistor 24 to the other power terminal 18. When the gate g of an SCR experiences a sufficient increase in potential, it fires its SCR to allow current to flow from the anode to the cathode of that SCR. Thus, if the gate potential at SCR 20 is raised and SCR 20 fires, current can flow from power terminal 16 through lamp 10, through the SCR 20, and through the common biasing resistor 24 to the other power terminal 18, thereby illuminating the lamp 10. In a similar manner, an increase in potential of the gate of SCR 22 allows current to flow from the power source through the other lamp 12 and the common biasing resistor 24. As will be explained below, the flow of current through the common biasing resistor 24, increases the selectivity of the circuit.

In order to couple only high frequency signals to the gate of SCR 20, a high-pass filter 26 is provided to couple the music input terminal 14 to the gate of SCR 20. This filter 26 includes a capacitor 28 in series with terminal 14 and gate g of the SCR 20, and a resistor 30 connected between the gate and ground. Thus, a very simple high frequency filter is used. In order to couple only low frequency signals to the gate of SCR 22, a low-pass filter 32 is provided to couple the music input terminal 14 to the gate of SCR 22. This filter 32 includes a resistor 34 for carrying signals from the music terminal 14 to the gate of SCR 22, a capacitor 36 connected between the gate and ground to short out high frequency signal components, and a resistor 38 connected between the gate and ground. Thus, a very simple low frequency filter is also employed.

The circuit of FIG. 1 would function fairly well for music of moderate volume, even if the common biasing resistor 24 were eliminated and replaced by a wire connection. Then, high frequency music would trigger SCR 20 and turn on lamp 10 while low frequency music would trigger SCR 22 and turn on lamp 12. However, during loud high frequency music, when only SCR 20 should be triggered, sufficient current could leak past the low-pass filter 32 to trigger the other SCR 22 and turn on the other lamp 12. One way of preventing unwanted frequencies from passing through is to utilize more selective filters. However, such filters are substantially more

complex and therefore, more expensive. The average music signal level received at terminal 14 could be adjusted so that only extremely loud musical passages will cause more than one lamp to be energized. However, at low music volumes, not enough music signal level will pass through any of the filters and one of the lamps will be energized.

The common biasing resistor 24 provides a simple way of increasing the effective selectivity of the filters. When a loud high frequency music passage is being played, somewhat more of the signal passes through the high pass filter 26 than the low-pass filter 32. Accordingly, the gate of SCR 20 will reach a firing level before the gate of the other SCR 22. The SCR 20 therefore will fire first and current will first flow through the lamp 10, the SCR 20, and the common biasing resistor 24. The current flowing through resistor 24 causes a voltage drop across it, and therefore raises the potential of the cathodes c of both SCR's 20 and 22. The increased potential of the cathode of SCR 22 prevents SCR 22 from firing unless its gate is raised to a much higher potential above ground. In a similar manner, if both SCR's were off and a low frequency signal were received which caused SCR 22 to fire first, then the cathode of the other SCR 20 would experience an increase in potential that prevented it from firing. Thus, once one SCR fires, there is a sudden increase in the required signal level for firing any other SCR.

A clearer understanding of the operation of the circuit of FIG. 1 may be had by considering a typical example of operation. The lamps 10 and 12 may be 50 watt lamps which draw about one-twentieth ampere when the voltage at the AC power input has risen to about 10 volts (at approximately 4° in the sinusoidal AC cycle). The common bias resistor 24 may have a resistance of 20 ohms, so that the voltage across it is 1 volt when one-twentieth ampere is passing through it. The gate-to-cathode voltage required to fire an SCR is about 1 volt (actually about 0.7 volt). Before any of the SCR's have fired, the cathodes are all at ground potential and a voltage of about 1 volt on any gate will fire its SCR. If it is assumed that a loud high frequency music signal is being received, then the gates of both SCR's will experience a voltage rise, although the gate of SCR 20 will rise faster. As soon as the gate of SCR 20 reaches about 1 volt, SCR 20 fires and current passes through the lamp 10, the SCR 20, and the common bias resistor 24. Assuming this current to be one-twentieth ampere, the voltage across resistor 24 is 1 volt, and the cathode potential of both SCR's has increased to 1 volt. Thereafter, it requires a gate potential of about 2 volts relative to ground to fire an SCR. While the musical input voltage at the gate of SCR 22 may reach somewhat over 1 volt, it is less likely to exceed 2 volts, and therefore SCR 22 is less likely to fire. Thus, the threshold firing voltage is suddenly raised when one lamp is turned on, thereby reducing the likelihood of the other lamp being turned on. Of course, the SCR which has been turned on remains on regardless of its gate voltage, so long as there is a positive voltage at the power input. It may be noted that for the AC power input, the SCR which was on is extinguished when the power voltage becomes negative. Thus, if the music frequency changes, a different lamp can be illuminated during the next cycle of the AC power input.

The fact that even fairly high volume music passages will not trigger more than one SCR, allows the operator to adjust the circuit to permit high signal strengths to enter the music input terminal 14. As a result, even low volume music is likely to cause at least one SCR to fire and therefore cause at least one lamp to be illuminated. Thus, there is one and only one lamp illuminated regardless of the music volume, within a wide range of volumes, and the selection of the lamp is determined only by the frequency of the music.

The common bias resistor 24 serves as a load sensitive biasing means that may be considered as having the effect of raising the effective Q or selectivity of the filters 26, 32. However, it does even more than this. If extremely selective filters were utilized, more than one light would still be energized in many cases. This is because musical passages often include a variety

of frequencies. However, the common biasing resistor 24 largely prevents the energization of more than one lamp, even if several frequencies are present, since as soon as one lamp is illuminated, the signal threshold for the other lamp is raised. The amount by which the threshold of the other SCR is raised is determined by the value of the common biasing resistor 24 in relation to the resistances of the lamps. If a large resistor is used at 24, then the threshold will be raised even higher, and the discrimination that prevents more than one lamp from being energized, is even greater.

In some situations, a circuit must be designed for use with lamps of a wide variety of wattages. Thus, a circuit may be used with lamps having a wattage ranging from 7 watts to several hundred watts. If a biasing resistor is used which has a high enough resistance to create a sufficient voltage drop at low current levels, then it will have to dissipate large amounts of power when a large load is employed which results in large current flowing through the resistor. A large power dissipation requires the use of a biasing resistor of large capacity, which is generally more expensive, and the large amounts of heating results in the necessity for designs which allow larger heat dissipation.

In accordance with another embodiment of the invention, shown in the partial circuit diagram of FIG. 2, a diode 50 is connected between the cathode and ground of the SCR's. A silicon diode experiences a voltage drop of approximately 0.7 volts when it conducts. Accordingly, the voltage drop across the diode is limited to about 0.7 volts and there is only a moderate amount of power to be dissipated. In addition, the filter Q will remain approximately the same regardless of load. If it is desired to increase the firing voltage by more than 0.7 volts when one SCR fires, then two or more diodes can be placed in series.

The diode 50 can be used alone, and it then works well with moderately high loads, making use of the inherent diode bulk resistance and diode knee characteristics. However, at low loads, the diode will not conduct heavily enough to make use of these characteristics. To take care of both low and high loads, the resistor 24 is retained and connected in parallel with the diode 50 between the cathodes of the SCR's and the ground power terminal.

The advantage of using a diode in parallel with a biasing resistor, as opposed to a biasing resistor alone, is that a larger biasing resistor can now be used without encountering large power losses at high loads. In addition, this assures that the full bias level will be applied early in the positive part of the AC power cycle.

Accordingly, the invention provides a circuit for selectively connecting lamps or other loads to a power source, which includes a plurality of silicon controlled rectifiers or other controlled rectifier means whose gates are coupled to a music source through different filters, and whose cathodes are coupled through a common biasing means to a terminal of the power source, the biasing means providing a bias dependent upon the conduction of current through one of the common loads. The biasing means may include only a resistor, only one or more diodes, or both connected in parallel.

Although particular embodiments of the invention have been described and illustrated herein, it is recognized that modifications and variations may readily occur to those skilled in the art and, consequently, it is intended that the claims be interpreted to cover such modifications and equivalents.

What I claim is:

1. A music frequency selector circuit for selectively connecting loads to terminals of a power source comprising:
 - a plurality of controlled rectifier means, each having an anode, a cathode, and a gate;
 - means for coupling a first of said power terminals to a first terminal of each of said loads;
 - means for coupling a second terminal of each of said loads to a respective anode of said controlled rectifier means;
 - a plurality of filter means, each coupling primarily only a certain frequency range of signals representing said music to the gate of a respective rectifier means; and

5

biasing means having a first terminal coupled to the cathodes of said plurality of controlled rectifier means and a second terminal coupled to a second terminal of said power source, for providing a voltage drop thereacross upon the firing of one of said rectifier means. 5

2. The circuit described in claim 1 wherein: said biasing means includes a resistor.

3. The circuit described in claim 1 wherein: said biasing means includes a diode.

4. The circuit described in claim 1 wherein: said biasing means includes a resistor and at least one diode connected in parallel. 10

5. The apparatus described in claim 1 wherein: each of said loads has a resistance within a predetermined limited range; 15

said power source is approximately a 110 volt root means square sinusoidal source; and

said biasing means includes a resistor of a resistance value which provides a voltage on the order of one volt thereacross when connected to the voltage which said 20

power source has on the order of several degrees past its

6

zero voltage point substantially only through the resistance of one of said loads.

6. The circuit described in claim 1 including:

a music input terminal for receiving signals representing said music; and wherein

a first of said filter means includes a resistor coupled between said music input terminal and the gate of a first of said rectifier means, a capacitor coupled between said gate and said second terminal of said power source, and a resistor coupled between said gate and said second terminal of said power source, for biasing said gate in accordance with low frequency components of said music signals; and

a second of said filter means includes a capacitor coupled between said music input terminal and the gate of a second of said rectifier means and a resistor coupled between said gate and said second power terminal, for biasing said gate in accordance with high frequency music components.

25

30

35

40

45

50

55

60

65

70

75