

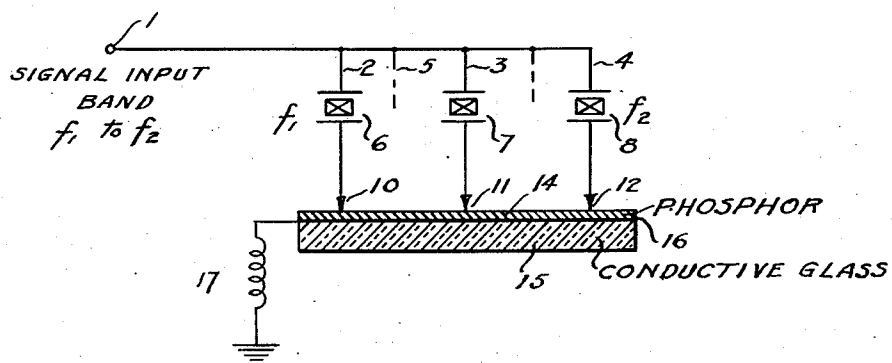
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FREQUENCY SENSITIVE VISUAL INDICATOR

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FREQUENCY SENSITIVE VISUAL INDICATOR

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The present invention relates generally to visual indicators, and more particularly to frequency selective visual devices employing electroluminescent indicators.

It is known that phosphors exist which are luminescent in response to time varying electric fields. These phosphors may be dispersed in a solid or liquid dielectric carrier, or may be disposed on a support independently of any carrier, in either event constituting an electroluminescent medium. The medium may be sandwiched between a pair of electrodes, one of which may be transparent, and then constitutes the dielectric of an electrical condenser, which is luminous in response to the application thereto of time varying voltages. Such a condenser has been described in the U. S. Patent to E. L. Mager, No. 2,624,857, to which reference is made for further detailed information as to preferred structural arrangements.

In accordance with the present invention, in its preferred form, a transparent electrically conductive plate is utilized as a support for a mass of electroluminescent phosphor, which is embedded in a high resistance solid dielectric carrier. A signal input terminal is connected in parallel to corresponding terminals of a series of piezo-electric crystals, the remaining terminals of which are connected with contacts located at discrete points of the phosphor. Each piezo-electric crystal is fabricated to be series resonant to a different frequency within a frequency band. If desired, the selectivity curves of the separate piezo-electric crystals may overlap sufficiently that at least one piezo-electric crystal of the plurality employed is responsive to every frequency within the band. It is then a characteristic of each piezo-electric crystal that in response to a frequency to which it is resonant it constitutes essentially a short circuit, while in response to other frequencies it constitutes an open circuit. The separate piezo-electric crystals accordingly apply signals at different frequencies to different points of the layer of electroluminescent phosphor, the signals passing through the phosphor and via a tuning inductance to ground. A plurality of electroluminescent condensers are thereby formed, each one consisting of (1) one of the contacts which proceed from the array of piezo-electric crystals, (2) the area of the transparent electrically conducting plate which immediately underlies the contact, and (3) the phosphor in its high resistance, high dielectric constant medium. The tuning coil, which is common to all the electroluminescent condensers, resonates the individual condensers to the frequency of the band under examination. It is possible to accomplish this by means of a single coil, provided the band of frequencies is not unduly great, because the Q of the coil and its associated condenser or condensers is relatively low, of the order of 20 or 30, while the Q of the associated piezo-electric crystals is of the order of 10,000 or 10,000,000.

It is well known that piezo-electric crystals are series resonant not only to their fundamental frequencies, but also to harmonics of these frequencies. By virtue of the fact that the condenser and tuning coil in series with

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each piezo-electric crystal is a series resonant circuit, it can in fact be resonant to only a single band of frequencies, and not to harmonically related frequencies. Any harmonic frequency to which the piezo-electric crystals may respond produces a relatively small response in terms of voltage across the electroluminescent condenser. For that frequency to which the electroluminescent condenser and its associated tuning coil is resonant a resonant rise of voltage takes place across the condenser, the resonant rise being of the order of 20 or 30. Since electroluminescent phosphors require a minimum voltage for firing the response of the system to harmonic frequencies at considerable amplitude may be completely eliminated, while the response of the system to relatively small amplitudes within a desired band may be considerable.

It is accordingly a broad object of the present invention to provide a novel electroluminescent indicator, in which indications are produced at discrete points of an electroluminescent medium in response to signals of discrete frequencies, and in which responses of the system to frequencies harmonically related to a desired band of frequencies are eliminated.

It is a more specific object of the present invention to provide a system employing a plurality of piezo-electric crystals as frequency separating devices, separate frequencies being applied to discrete portions of an electroluminescent medium, and the electroluminescent medium being tuned to a preselected band of frequencies, to the practical exclusion of frequencies falling outside the preselected band.

The above and still further features, objects, and advantages of the invention will become apparent upon consideration of the following detailed description of a specific embodiment of the invention, especially when taken in conjunction with the accompanying drawings, wherein the single figure of the drawings is a schematic circuit diagram of a system in accordance with the present invention.

Referring now more specifically to the accompanying drawings, the reference numeral 1 represents a signal input terminal to which may be applied signals deriving from any source, such as from the intermediate frequency amplifier of a radio receiver, a sonar receiver, or the like, the band of frequencies being applied in parallel to the input terminals 2, 3, 4, . . . of an array of piezo-electric crystals 6, 7, 8, ... The output electrodes 10, 11, 12, . . . of the piezo-electric crystals 6, 7, 8, . . . , respectively, are connected with or utilized as contacts, each directed to a different discrete point of a layer 14 of electroluminescent phosphor. This phosphor may be laid on a layer of dielectric material, or may be incorporated therein in accordance with the teachings of U. S. Patent to E. L. Mager 2,654,857. The layer of phosphor may be supported on a sheet of electrically conductive glass 15, or other transparent material, the reference 16 denoting a conductive coating on the glass plate 15. The conductive layer 16 is connected via a tuning coil 17 to a ground or other reference point.

The piezo-electric crystals 6, 7, 8, . . . , inclusive, there being three such crystals illustrated for the sake of example only, and not by way of limitation, may each be resonant to a different frequency, and the frequencies may be adjacent to one another, so that at least one of the crystals will be resonant to any frequency within a predetermined frequency band, f_1 to f_2 , which may be applied to the terminal 1. Accordingly, for any frequency falling within the predetermined band, an alternating current will appear at one of the output terminals 10, 11, 12, ... Each of the contacts 10 to 12, in conjunction with that portion of the conductive layer 16 which immediately underlies it, represents a condenser having as its

dielectric medium a portion of the electroluminescent layer 14. This condenser has a definite capacity which may be tuned by means of the inductance coil 17. Accordingly, each one of the piezo-electric crystals 6-8, inclusive, is connected in series with a further resonant circuit, tuned approximately to the same frequency as is the crystal. The Q of the piezo-electric crystal may be of the order of 10,000 to 10,000,000, depending upon the structure and mounting of the piezo-electric crystal. On the other hand the measured Q of a specific circuit consisting of a probe, a layer of electrically conductive plate, and an intermediate phosphor, in series with a tuning coil has been found to be approximately 20 to 40. Accordingly, the series tuned circuit which includes the coil and electroluminescent condenser is relatively low Q and the piezo-electric crystals are each extremely high Q circuits. It follows that a large number of crystals may fall substantially within the resonance curve of the electroluminescent condenser and its tuning coil 17.

Upon application to the terminal 1 of a signal falling within the predetermined band of frequencies, f_1 and f_2 , one of piezo-electric crystals 6, 7, 8, . . . represents a short circuit to the frequency of the signal, all the remaining crystals being essentially open circuits. The signal passes through the crystal which is conductive and thence through the phosphor and the tuning coil to ground. A resonant rise of voltage occurs across the condenser, and the phosphor which subsists immediately under the activated one of contacts 10, 11, 12, . . . glows. Any signal which leaks through the associated shunt capacity of the remaining crystals, or which occurs at frequencies harmonically related to those desired, produces no response in the phosphor, unless they are of extremely high amplitude, because the phosphor possesses a firing threshold, and does not glow in response to any voltage lower than its required firing voltage. This firing voltage is a function of the constitution of the phosphor, the constitution of its medium, if any, and the thickness of the layer of phosphor. Firing voltages having values of 40 volts R. M. S. have been observed, at frequencies of several mc., and luminous effects have been observed in electroluminescent phosphors of the general type described in the Mager patent at frequencies as high as 50 mc./s. and as low as 10 C. P. S.

While I have described and illustrated one specific example of the present invention it will be clear that variations of the specific details of construction may be resorted to without departing from the true spirit of the invention as defined in the appended claims.

What I claim is:

1. A frequency sensitive visual indicator, including a thin layer of electroluminescent phosphor material, said layer having a high electrical resistance in the direction of its thickness, a first electrically conductive electrode in contact with one side of said layer, a further plurality of electrically conductive electrodes in contact with discrete points of the other side of said layer, which are opposed to said first electrode, a plurality of piezo-electric crystals, each resonant to a different frequency in a frequency band, means connecting each of said piezo-electric crystals in series with one of said further plurality of electrically conductive electrodes, means for supplying signals within said frequency band to said piezo-electric crystals in

parallel, and means for tuning the condensers formed by said further conductive electrodes and said first electrically conductive electrode to series resonance over said frequency band.

2. The combination in accordance with claim 1, wherein said means for tuning is an inductance.

3. A frequency sensitive visual indicator, including a thin layer of material including electroluminescent phosphor, said layer having high electrical resistance in the direction of its thickness, a pair of conductive electrodes on opposite sides of said layer, a piezo-electric crystal filter in series with one of said pair of electrodes, and means for tuning the condenser formed by said electrodes and said phosphor to a frequency equal to one response frequency of said piezo-electric crystal filter.

4. A frequency sensitive visual indicator, including a thin layer of material including electroluminescent phosphor, said layer having high electrical resistance in the direction of its thickness, a pair of conductive electrodes on opposite sides of said layer, a band-pass filter in series with said pair of electrodes, and means for series tuning the condenser formed by said electrodes and said layer of material to a frequency equal to a response frequency of said filter.

5. The combination in accordance with claim 4 wherein said means for series tuning is a coil in series with said pair of electrodes.

6. A frequency indicating system including an electroluminescent condenser, a band-pass filter in series with said electroluminescent condenser, and means for series tuning said electroluminescent condenser to resonate over the band-pass of said filter.

7. The combination in accordance with claim 6 wherein said means for series tuning is a coil.

8. A frequency indicating system including a plurality of electroluminescent condensers, a relatively narrow band-pass filter in series with each of said electroluminescent condensers, each of said filters tuned to a different mean frequency, and a single tuning element for simultaneously tuning all said condensers broadly to all the frequencies passed by said filters.

9. The combination in accordance with claim 8 wherein said means for tuning is a single coil.

10. A frequency indicating system including an electroluminescent condenser, a band-pass filter in series with said electroluminescent condenser, and means for tuning said electroluminescent condenser to resonate in the band-pass range of said filter.

11. A frequency sensitive visual indicator, including a thin layer of material including electroluminescent phosphor, said layer having high electrical resistance in the direction of its thickness, a pair of conductive electrodes on opposite sides of said layer, a band-pass filter in series with one of said pair of electrodes, and means for tuning the condenser formed by said electrodes and said phosphor to a frequency in the band-pass range of said filter.

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