

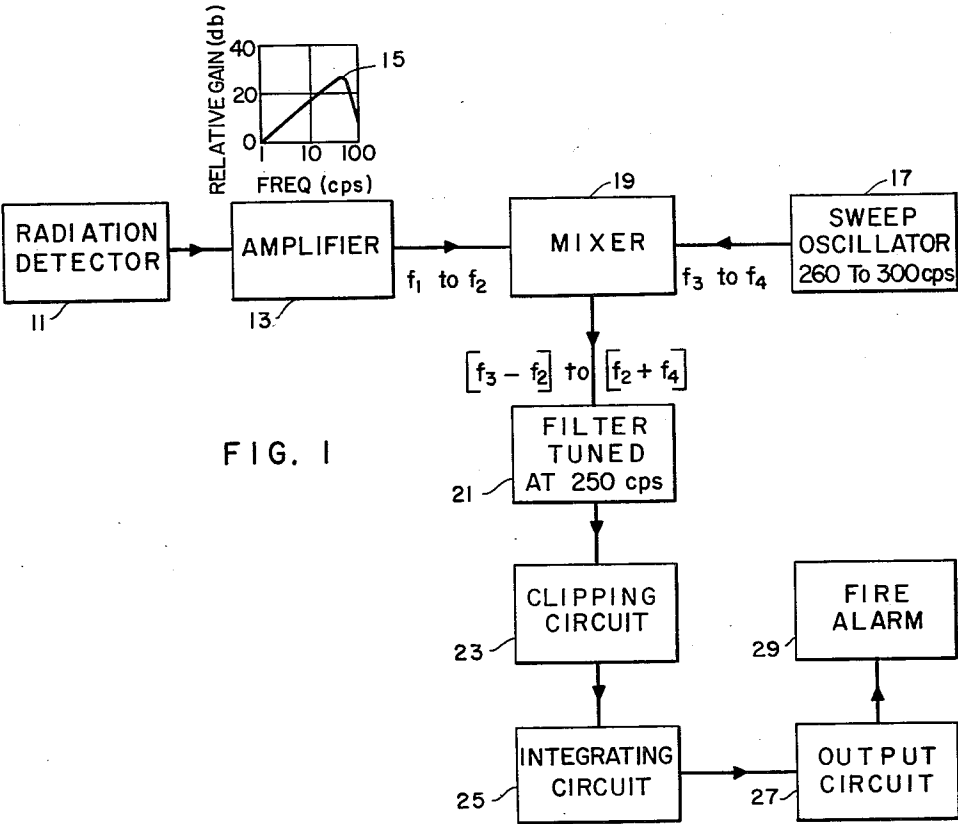
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FIRE DETECTORS

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FLAME FLICKER FREQUENCIES cps	SWEEP OSCILLATOR FREQUENCIES cps	MIXER OUTPUT FREQUENCIES cps
10	260	250 & 270
15	265	250 & 280
20	270	250 & 290
25	275	250 & 300
30	280	250 & 310
35	285	250 & 320
40	290	250 & 330
45	295	250 & 340
50	300	250 & 350

FIG. 2

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1

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4 Claims. (Cl. 340-227)

This invention relates to fire detectors.

In order not to be subject to false alarms, a fire detector should detect some physical phenomenon exclusively associated with fires in the environment in which the detector is to operate. One of the properties of flames is that the radiant energy emanating therefrom is modulated in amplitude. In other words, flames flicker, and this flicker occurs at frequencies in the sub-audio and lower-audio ranges. A satisfactory fire detector distinguishes flames from other sources of flickering radiation by means of a band-pass filter which makes the detector sensitive to flicker within lower and upper frequency limits only. The lower-frequency limit, which may be of the order of five cycles per second, prevents the actuation of the fire detector by very low-frequency transients occurring, for instance, when Venetian blinds are lowered. The upper-frequency limit, which may be of the order of twenty-five cycles per second, prevents the actuation of the fire detector by the flicker of lamps energized by alternating current. An integrating device is also provided to prevent the actuation of the fire detector until the occurrence of several cycles of flicker within the band-pass frequencies. The great advantage of this fire detector is its speed of response when compared with that of fire detectors which, instead of detecting flames, detect some secondary effect of fire, such as heat.

This fire detector is therefore actuated by several successive cycles of flicker within the band-pass frequencies of five to twenty-five cycles per second. Although these flicker frequencies occur very seldom in radiation sources other than flames, they may still be found, for instance, in the reflection of light from the blade of a slowly-rotating fan. This fire detector may therefore give an accidental false alarm. It may also purposely be made to give a false alarm by "chopping" a light beam directed against it with one's hand.

It is the principal object of this invention to provide a fire detector which is much less likely to be falsely alarmed than previous fire detectors of the flicker type.

Flame flicker comprises a plurality of frequencies having different amplitudes. A very rough estimate of the relationship between the amplitude and the frequency of flicker components emanating from a typical fire would be that, above one cycle per second, the amplitude of a flicker component is halved when the frequency is doubled. The amplitude of the flicker components above, let us say, fifty cycles per second is so small that these components can be disregarded. Thus flame flicker is characterized in that it comprises many different flicker frequencies occurring simultaneously.

The fire detector in accordance with the present invention operates a fire alarm only when it detects many different flicker frequencies which occur simultaneously. It comprises a radiation-sensitive device to convert the flickering radiation emanating from a flame into an electrical signal the amplitude of which varies as a function of flame intensity. It comprises also a local oscillator designed to sweep a given range of frequencies. The

2

output signals of the radiation detector and of the oscillator are applied to a mixer. The output of the mixer is applied to a filter which is tuned sharply. As the oscillator frequency is varied, there is a variation of the flicker frequency which, when mixed with the oscillator frequency, will give an output signal which is passed by the filter. Thus, the filter will give a continuous output signal only if the radiation detector detects many flicker frequencies occurring simultaneously. The fire alarm is made responsive to this continuous output.

Other and incidental objects of the present invention will be apparent to those skilled in the art from a reading of this specification and an inspection of the accompanying drawings in which:

Figure 1 is a block diagram of a fire detector in accordance with the present invention; and

Figure 2 is a table of frequencies illustrating the operation of the fire detector shown in Figure 1.

Referring to Figure 1, the fire detector comprises a radiation detector 11. This radiation detector is designed to convert the flickering radiation emanating from a flame into an electrical signal the amplitude of which varies as a function of the intensity of said radiation. The radiation detector 11 may comprise, for instance, a bolometer or a photoelectric cell. It has been found that lead sulfide photoconductive cells are particularly suitable for the detection of flame radiation.

As we have seen, flame flicker comprises flicker frequencies in a range from, let us say, 1 to 50 cycles per second, the amplitude of the lower flicker frequencies being much greater than the amplitude of the higher ones. In the presence of a flame, therefore, the output signal of the radiation detector 11 fluctuates, this fluctuation comprising slow variations of high amplitudes and faster variations of much lower amplitudes.

The output signal of the radiation detector 11 is passed through an amplifier 13, the gain of which varies with frequency in accordance with the graph 15. This graph shows the relative gain increasing between 1 and about 50 cycles per second, then dropping very sharply. The characteristics of amplifier 13 are such that its output signal, when the radiation detector 11 detects a flame, is characterized by variations in amplitude of approximately the same magnitude in a range of frequencies f_1 - f_2 from a few to about 50 cycles per second.

The fire detector also comprises a local sweep oscillator 17 which is designed to sweep a range of frequencies from a lower frequency f_3 to a higher frequency f_4 . For example, the sweep oscillator 17 may sweep frequencies in a range from 260 to 300 cycles per second at a rate of 1 cycle per second. The output signals of the amplifier 13 and of the sweep oscillator 17 are fed to a mixer 19. The output signal of the mixer 19 is two beat frequencies, equal to the difference between and the sum of the frequencies applied thereto by the amplifier 13 and the sweep oscillator 17. The output frequencies of the mixer 19 range therefore from the lowest difference of the frequencies applied thereto, i. e. ($f_3 - f_2$), to the sum of the highest frequencies applied thereto, i. e. ($f_2 + f_4$).

The output signal of the mixer 19 is applied to a sharply-tuned filter 21. This filter 21 may be tuned, for instance, at 250 cycles per second, which is outside the range of frequencies swept by the oscillator 17. In other words, the filter 21 passes only signals having a frequency of 250 cycles per second. The output signal from the filter 21 is fed through a clipping circuit 23 to an integrating circuit 25. The output signal from the integrating circuit 25 is applied to an output circuit 27 which actuates a fire alarm 29.

The operation of the fire alarm shown in Figure 1 will be explained by reference to the table shown in Figure 2.

As the sweep oscillator frequencies vary from 260 to

3

300 cycles per second, there is a single frequency detected by the radiation detector 11 which, when mixed with the sweep oscillator frequency, will give a beat frequency of 250 cycles per second. In other words, the filter 21 will provide a continuous output signal only if there is impressed upon radiation detector 11 a composite signal comprising all the frequencies between 10 and 50 cycles per second. On the other hand, if there is impressed upon the radiation detector 11 a signal having only one or a few of the frequencies comprised between 10 and 50 cycles per second, the output signal of filter 21 will not be continuous.

The output signal of the filter 21, which when radiation detector 11 detects a flame comprises a series of closely-spaced pulses, is passed through a clipping circuit which clips these pulses, and integrated over integrating circuit 25. The integrating circuit 25 counts these pulses and when a predetermined number of them have occurred over a predetermined time interval, the output circuit 27 operates the fire alarm 29.

Thus the fire alarm 29 is operated only when the radiation detector 11 detects many different flicker frequencies, in the range of 10 to 50 cycles per second, occurring simultaneously. This reduces considerably the chances of false alarms.

I claim:

1. A fire detector comprising a radiation detector to convert the flickering radiation emanating from a flame into an electrical signal the amplitude of which varies as a function of the intensity of said radiation, an oscillator designed to sweep a range of frequencies, a mixer, means to apply to said mixer the output signals of said oscillator and of said radiation detector, a filter tuned at a frequency outside the range of frequencies of said oscillator, means to apply to said filter the output signal of said mixer, and a fire alarm responsive to the output of said filter.

2. A fire detector comprising a radiation detector to convert the flickering radiation emanating from a flame into an electrical signal the amplitude of which varies as a function of the intensity of said radiation and over a range of frequencies ranging from a lower frequency f_1

4

to a higher frequency f_2 , an oscillator designed to sweep a range of frequencies ranging from a lower frequency f_3 to a higher frequency f_4 , a mixer, means to apply to said mixer the output signals of said oscillator and of said radiation detector, a filter tuned at a frequency not lower than $(f_3 - f_2)$ and not higher than $(f_2 + f_4)$, means to apply the output signal of said mixer to said filter, and a fire alarm responsive to the output of said filter.

3. A fire detector comprising a radiation detector to convert the flickering radiation emanating from a flame into an electrical signal the amplitude of which varies as a function of the intensity of said radiation and over a range of frequencies ranging from a lower frequency f_1 to a higher frequency f_2 , an oscillator designed to sweep a range of frequencies ranging from a lower frequency f_3 to a higher frequency f_4 , a mixer, means to apply to said mixer the output signals of said oscillator and of said radiation detector, a filter tuned at a frequency not lower than $(f_3 - f_2)$ and not higher than $(f_2 + f_4)$ but outside the range between f_3 and f_4 , means to apply the output signal of said mixer to said filter, and a fire alarm responsive to the output of said filter.

4. A fire detector comprising a radiation detector to convert the flickering radiation emanating from a flame into an electrical signal the amplitude of which varies as a function of the intensity of said radiation and over a range of frequencies ranging from a lower frequency f_1 to a higher frequency f_2 , an oscillator designed to sweep a range of frequencies ranging from a lower frequency f_3 to a higher frequency f_4 , a mixer, means to apply to said mixer the output signals of said oscillator and of said radiation detector, a filter tuned at a frequency not lower than $(f_3 - f_2)$ and not higher than $(f_2 + f_4)$, means to apply the output signal of said mixer to said filter, an integrating circuit, means to apply the output signal of said filter to said integrating circuit, and a fire alarm responsive to the output of said integrating circuit.

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