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FIRE DETECTION APPARATUS

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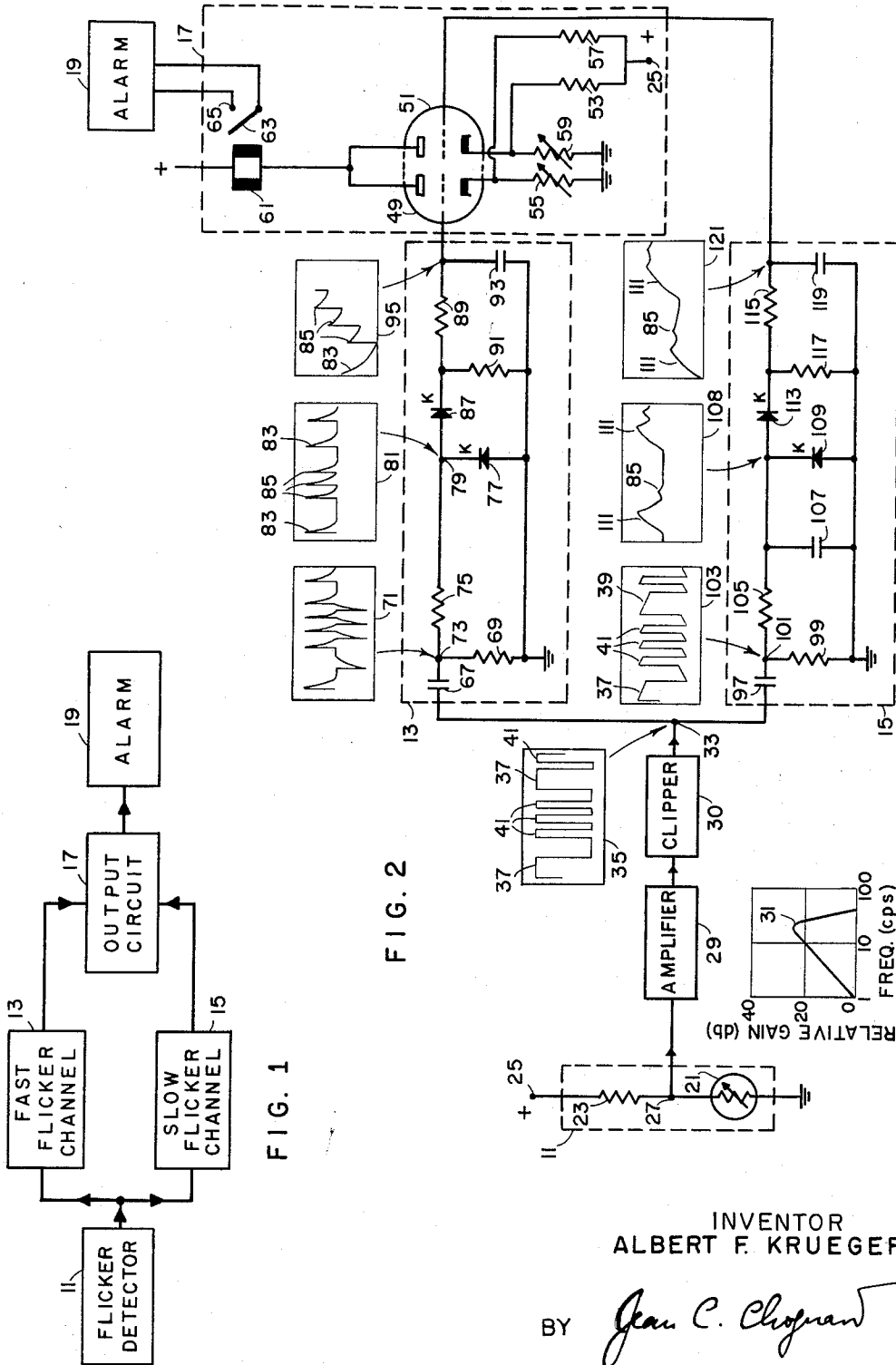
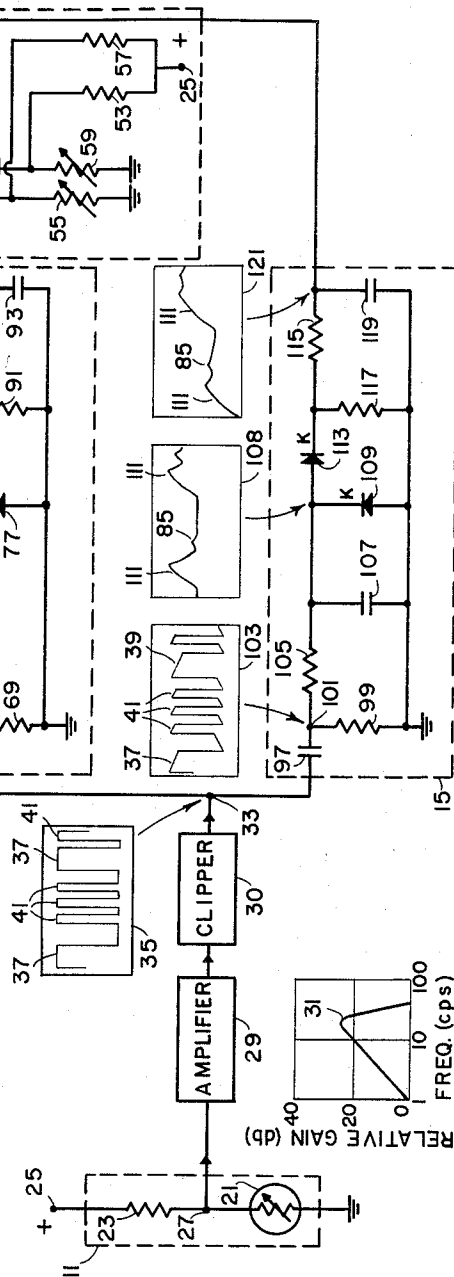


FIG. 1

FIG. 2



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FIRE DETECTION APPARATUS

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This invention relates to apparatus for the detection of fires.

In order not to be subject to false alarms, a fire detector must 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 more unlikely 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 they 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 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. This electrical signal is applied to two

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parallel signal channels, one responsive to slow fluctuations of the signal and the other responsive to faster fluctuations of the signal. An output circuit is arranged to operate an alarm if and only if both signal channels transmit a signal simultaneously.

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 drawing in which:

Figure 1 is a simplified block diagram of a fire detector illustrating the principle of the present invention; and

Figure 2 shows, by means of a block and circuit diagram, one embodiment of the present invention.

Referring to Figure 1, the fire detector comprises a flicker detector 11. This flicker detector 11 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 this radiation. The flicker detector 11 may comprise, for instance, a bolometer or a photoelectric cell. The output signal from the flicker detector 11 is applied to a fast-flicker channel 13 and a slow-flicker channel 15. The fast-flicker channel 13 is responsive to flicker in the range of, let us say, twelve to thirty cycles per second, i. e. it produces an output signal in the presence of flicker frequencies in the range of twelve to thirty cycles per second. The slow-flicker channel 15 is responsive to flicker in the range of, let us say, two to six cycles per second, i. e. it produces an output signal in the presence of flicker frequencies in the range of two to six cycles per second. The output signals from both the fast-flicker channel 13 and the slow-flicker channel 15 are fed to an output circuit 17. This output circuit 17 is responsive to the simultaneous signal output of both channels 13 and 15. The output circuit 17 operates an output device such as alarm 19 if and only if it receives a signal from both channels 13 and 15 simultaneously. In other words, the alarm 19 is operated if and only if the flicker detector 11 detects flicker occurring simultaneously in two different frequency ranges, such as two to six cycles per second and twelve to thirty cycles per second.

Referring to Figure 2, the flicker detector 11 comprises a photoconductive cell 21 and a resistor 23 connected in series between a power-supply terminal 25 and ground. The potential at terminal 25 is a steady, unidirectional potential. The photoconductive cell 21 is preferably a lead-sulfide cell. As the conductivity of the cell 21 varies with the amount of radiation impinging upon it, so does the potential at the junction 27.

Flame flicker comprises flicker frequencies in a range from, let us say, one to fifty cycles, the amplitude of the lower-flicker frequencies being much greater than the amplitudes of the higher ones. In the presence of fire, therefore, the potential at junction 27 fluctuates, this fluctuation comprising slow variations of high amplitudes and faster variations of much lower amplitudes.

Junction 27 is connected to an amplifier 29 and a clipper 30. The gain of amplifier 29 varies with the frequency of the signal applied thereto in accordance with the graph 31. This graph shows the relative gain increasing between one and about thirty cycles per second, then dropping very sharply. The characteristics of amplifier 29 are such that, at its output terminal, the slow and fast variations due to flame flicker have about the same amplitude in the range from one to thirty cycles per second. The output of amplifier 29 is fed to clipper 30. The signal due to flame flicker at terminal 33 of clipper 30 is represented by the signal 35; it comprises

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relatively long pulses 37 due to slow flicker and relatively short pulses 41 due to fast flicker.

The signal 35, present at the output terminal 33 of the clipper 30, is applied to the fast-flicker channel 13 and to the slow-flicker channel 15. The outputs of both channels 13 and 15 are fed to output circuit 17 which comprises two tube sections 49 and 51. Tube sections 49 and 51 have biasing potentials applied to their cathodes in a conventional manner by means of resistors 53, 55 and 57, 59, respectively. A relay 61 in the common plate circuit of tube sections 49 and 51 closes contacts 63 and 65, thus operating alarm 19, if and only if both tube sections 49 and 51 are conducting simultaneously. In other words, the alarm 19 is operated if and only if the fast-flicker channel 13 and the slow-flicker channel are transmitting, at the same time, sufficient signal to render tube sections 49 and 51 fully conductive.

In the fast-flicker channel 13, the signal 35 present at terminal 33 is differentiated over the RC network comprising capacitor 67 and resistor 69. Signal 35 thus becomes signal 71 at the upper terminal 73 of resistor 69. The negative portion of these pulses is clipped by means of the rectifying circuit comprising resistor 75 and diode 77. At the cathode terminal 79 of diode 77, the signal 35 has become signal 81. Signal 81 comprises positive pulses which correspond to the leading edges of the positive pulses of signal 35. Thus pulses 83 correspond to the leading edges of long pulses 37, while pulses 85 correspond to the edges of short pulses 41. It can be seen that when long pulses are present at terminal 33, their leading edges are far apart, and the pulses 83 corresponding to these leading edges are also far apart. On the other hand, when short pulses are present at terminal 33, their leading edges are close together and the pulses 85 corresponding to these leading edges are also close together. Signal 81 is coupled to the control grid of tube section 49 through an integrating network comprising diode 87, resistors 89 and 91 and capacitor 93. The pulses present at point 79 are passed through the low resistance of diode 87 and build up a positive charge on capacitor 93. A discharge path for capacitor 93 is provided through low resistance 89 and high resistance 91 to ground. When long, and therefore widely-spaced pulses 83 are applied to this integrating network, the charge built on capacitor 93 by a pulse 83 has the time to leak through resistors 89 and 91 to ground, but when short, and therefore closely-spaced pulses 85 are applied to capacitor 93, a positive charge is built on capacitor 93 as shown by waveform 95. In other words, a positive voltage is built up on the grid of tube section 49 when the flicker detector 11 detects fast flicker.

In the slow-flicker channel 15, the signal 35 present at terminal 33 is partially differentiated over the RC network comprising capacitor 97 and resistor 99. The waveform resulting at the upper terminal 101 of resistor 99 is shown as waveform 103. Waveform 103 is integrated over the network comprising resistor 105 and capacitor 107, and the negative portion of the resulting waveform 108 is clipped by means of diode 109. The waveform 108 comprises large positive pulses 111 corresponding to the slow pulses 37 of waveforms 35 and 103 and small positive pulses 85 corresponding to the fast pulses 41 of waveforms 35 and 103. Waveform 108 is coupled to the control grid of tube section 51 through an integrating network comprising diode 113, resistors 115 and 117 and capacitor 119. The pulses of waveform 108 are passed through the low resistance of diode 113 and build up a positive charge on capacitor 119. A discharge path for capacitor 119 is provided through low resistance 115 and high resistance 117 to ground. The occurrence of slow pulses 111 builds up a positive charge on capacitor 119, while the fast pulses 85 do not, as shown by waveform 121. In other words, a positive voltage is built up on the grid of tube section 51 when the flicker detector 11 detects slow flicker.

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Thus tube sections 49 and 51 are both conductive if and only if the flicker detector 11 detects the simultaneous occurrence of slow and fast flicker, and alarm 19 is operated only under these conditions. If either slow or fast flicker alone is detected, alarm 19 does not operate. This reduces considerably the chances of false alarms.

I claim:

1. A fire detector comprising 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 the intensity of said radiation, a first frequency-selective signal channel responsive to slow fluctuations of said electrical signal, a second frequency-selective signal channel responsive to faster fluctuations of said electrical signal, means to apply said electrical signal to said first and second signal channels, and output means responsive to the simultaneous signal output of both of said channels.

2. A fire detector comprising 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 the intensity of said radiation, a first frequency-selective signal channel responsive to fluctuations of a few cycles per second of said electrical signal, a second frequency-selective signal channel responsive to fluctuations of said electrical signal which are several times faster than those to which said first signal channel is responsive, means to apply said electrical signal to said first and second signal channels, and output means responsive to the simultaneous signal output of both of said channels.

3. A fire detector comprising 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 said radiation, a first frequency-selective signal channel responsive to slow fluctuations of said electrical signal which range approximately from two to six cycles per second, a second frequency-selective signal channel responsive to faster fluctuations of said electrical signal which range approximately from twelve to thirty cycles per second, means to apply said electrical signal to said first and second signal channels, and output means responsive to the simultaneous signal output of both of said channels.

4. A fire detector comprising 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 said radiation, a first frequency-selective signal channel responsive to slow fluctuations of said electrical signal, a second frequency-selective signal channel connected in parallel with said first channel and responsive to faster fluctuations of said electrical signal, means to apply said electrical signal to said first and second signal channels, and output means responsive to the simultaneous signal output of both of said channels.

5. A fire detector comprising 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 the intensity of said radiation, means to amplify said electrical signal, a first frequency-selective network responsive to slow fluctuations of said electrical signal, a second frequency-selective network responsive to faster fluctuations of said electrical signal, means to apply said amplified electrical signal to said first and second networks, and output means responsive to the simultaneous output of both of said networks.

6. A fire detector comprising 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 the intensity of said radiation, amplifier means to amplify said electrical signal, means to clip said electrical signal, a first frequency-selective network responsive to slow fluctuations of a few cycles per second of said electrical signal, a second frequency-selective network responsive to faster fluctuations of said elec-

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trical signal which are several times greater than those to which said first network is responsive, means to apply said amplified and clipped electrical signal to said first and second networks, and output means responsive to the simultaneous signal output of both of said networks.

7. A fire detector according to claim 6 wherein said amplifier means amplifies said slow fluctuations considerably less than said faster fluctuations.

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