May 31, 1955 M. H. NORTON 2,709,799

FLAME DETECTOR SYSTEM

Original Filed June 16, 1953 2 Sheets-Sheet 1

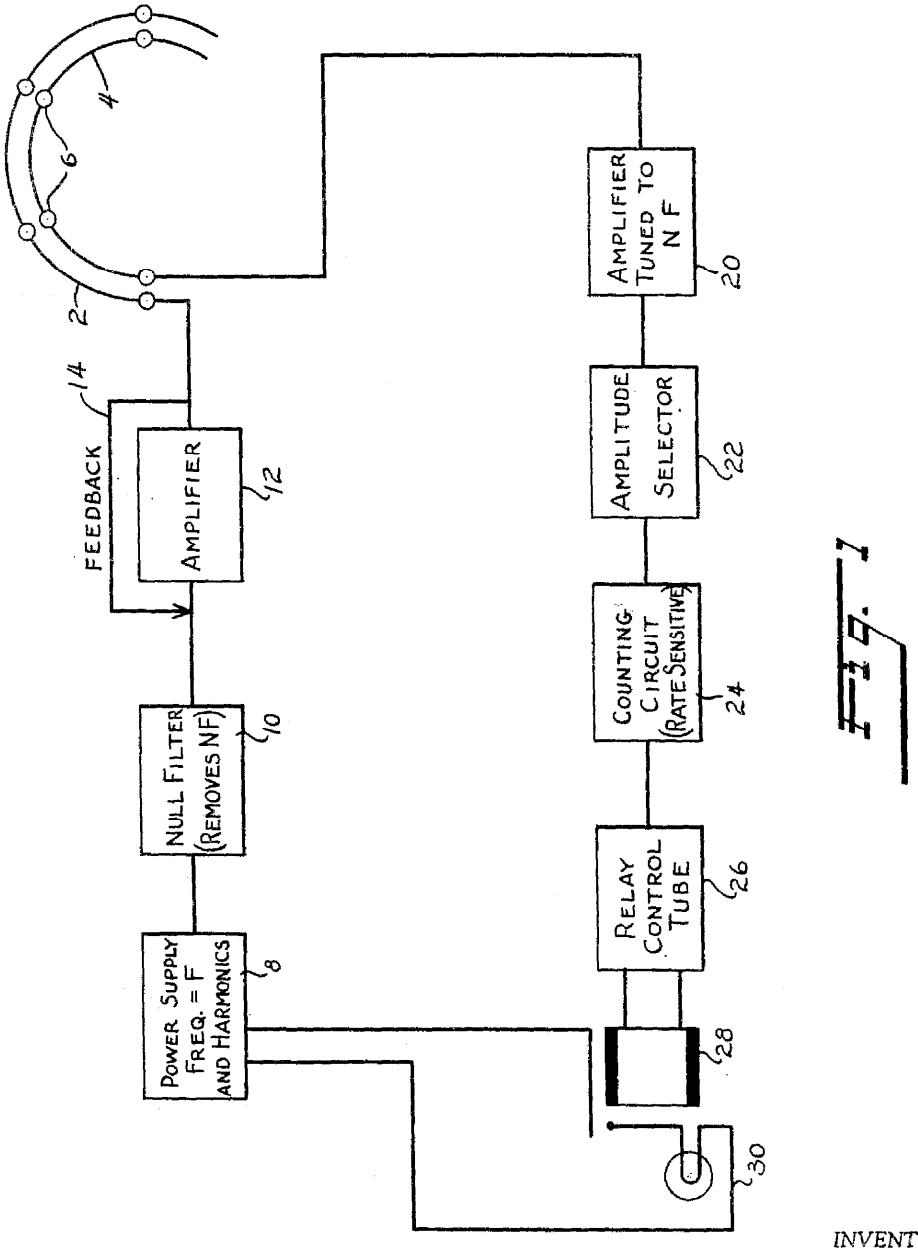

Fig. 1

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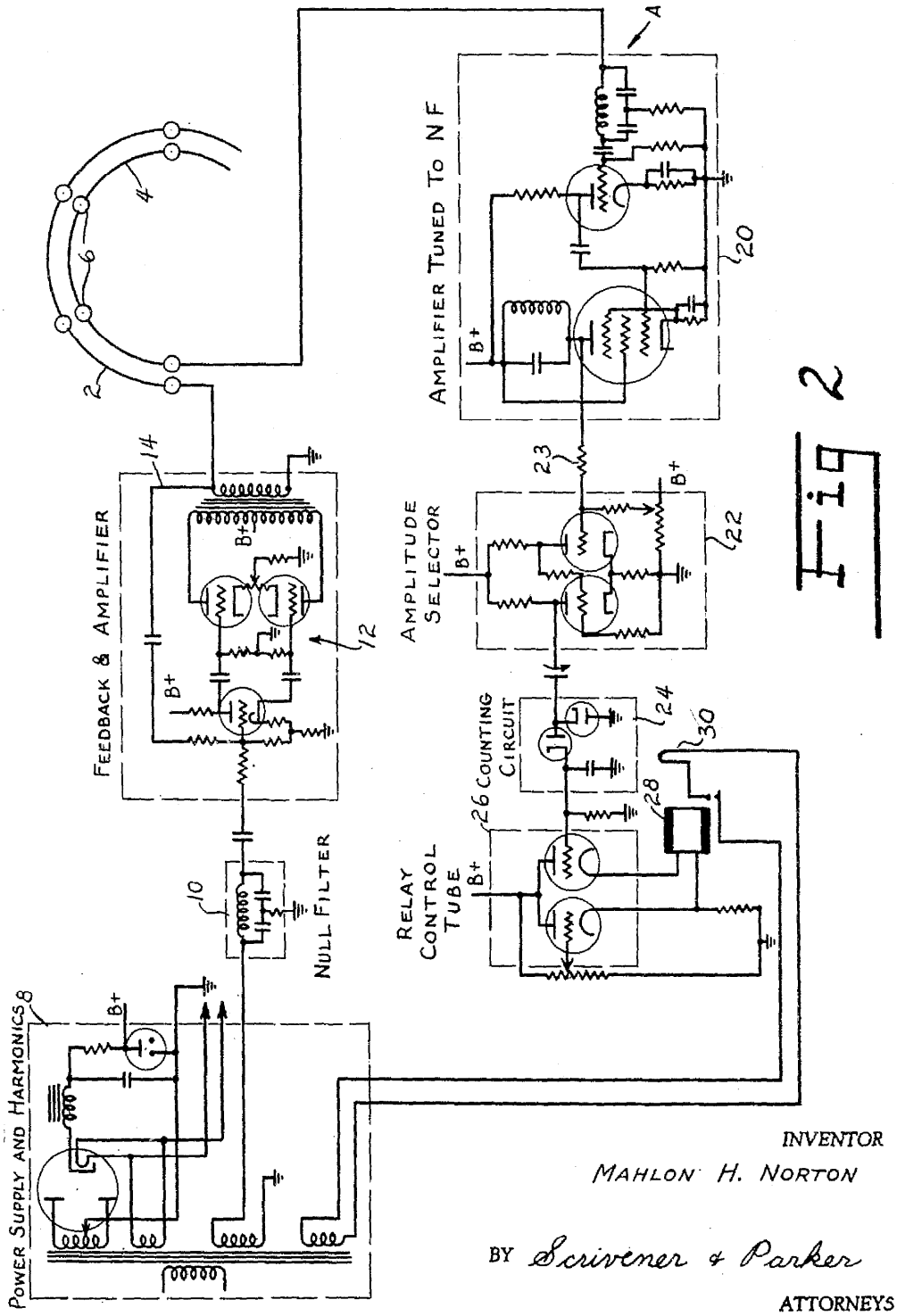

Fig. 2

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FLAME DETECTOR SYSTEM

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Continuation of application Serial No. 362,083, June 16, 1953. This application July 23, 1953, Serial No. 369,917

5 Claims. (Cl. 340—227)

This application is a continuation of my co-pending application Serial No. 362,083, filed June 16, 1953.

This invention relates broadly to devices and systems for detecting the presence of fire and, more particularly, to such devices and systems which are responsive to the presence of actual flame rather than to the presence of a pre-determined elevated ambient temperature.

It has heretofore been proposed to provide flame-responsive detector systems including a pair of spaced wires or electrodes having a potential applied between them which systems, when the wires or electrodes are bridged by a flame, utilize the rectifying or other properties of the flame to produce a change in the potential between the electrodes to cause the operation of indicating means. These known systems have not been found to be successful for various reasons, among which is the important fact that the presence of water or water vapor between the electrodes causes a change in the potential between the electrodes resulting in false alarm of the indicating means. It has accordingly been the principal object of the present invention to provide a flame detecting system including spaced wires or electrodes which are adapted and intended to be bridged by a flame, but which system is operative in a new and improved manner and by reason of which false alarm by reason of the presence of water or water vapor between the electrodes, or by reason of grounding of one or both wires or electrodes, or by reason of short-circuiting of the wires or electrodes by touching each other, is wholly prevented, whereby the characteristic indication intended to be produced by the system will be produced only by flame bridging the wires or electrodes.

The present invention provides a system for flame detection comprising two spaced but adjacent electrodes which are insulated from ground and from each other and which are positioned within the space to be monitored. An alternating voltage is developed between one of these electrodes and ground which has a known fundamental frequency and from which one or more harmonics (except the zero or first harmonic) are attenuated to negligible value. The second electrode is connected at any point along its length to receiving means which are tuned to reject the fundamental frequency supplied to the first electrode and to accept only the attenuated harmonic or harmonics thereof. The flame is a non-linear impedance and when it bridges the two electrodes, harmonics of the fundamental frequency appear between the second electrode and ground. One (or more) of these harmonics is the one (or more) acceptable to the receiving means and suitable indicating means may be provided which are operable only upon reception of the acceptable harmonic or harmonics, thus indicating the presence of flame in the monitored space.

In certain applications of the invention which are of great interest in aircraft and other internal-combustion engine uses of fire detection systems, there are other phenomena that could conceivably produce the same indication as does the flame bridging the transmitting and

receiving electrodes. For example, a spray of water, such as driving rain, gives an indication that is similar, but definitely different, from that produced by actual flame. This definite difference may best be characterized by the difference in amplitude and duration of the responses. A flame impinging upon the electrodes produces in the output circuitry of the receiving electrode a long and steady, or relatively steady, voltage of the appropriate harmonic frequency, while rain or simulated rain gives bursts of energy of short duration. Therefore, to eliminate the possibility of a false indication due to such a cause, means may be added to the system so that it will not indicate phenomena other than flame. This may be accomplished by adding to the receiving means some device which will distinguish between long and short bursts of energy and which will pass current to the indicating means only when energy is supplied to it for a pre-determined time, or when a pre-determined number of pulses of energy is supplied to it per unit of time.

It is also desirable in systems according to this invention to eliminate noise, and means are provided by the invention to accomplish this, which is preferably done by amplitude selection means forming part of the output circuitry of the receiving electrode and which passes only signals having an amplitude greater than a pre-determined value.

An embodiment of the invention is described in the following specification and illustrated in the accompanying drawings, in which

Fig. 1 is a block diagram of a flame detecting system according to this invention, and

Fig. 2 is a schematic diagram of the system schematically disclosed in Fig. 1.

A block diagram of a flame detecting system constructed and operable in accordance with this invention is disclosed in Fig. 1 and comprises a transmitting electrode 2 and a receiving electrode 4 which, in the disclosed embodiment, take the form of elongated, bare wires which are mounted in closely spaced relation on insulator supports 6 and are trained through the space to be monitored, which may be the engine zone of an aircraft engine nacelle. A source of alternating voltage 8 is connected to the transmitting wire 2 through a null filter 10 which eliminates from the energy supplied to the wire 2 one harmonic of the frequency generated by the source, and an amplifier 12, thus developing between wire 2 and ground an alternating voltage having all of the basic and harmonic frequencies produced by the source 8 except the frequency attenuated by filter 10. A feedback circuit 14 is associated with amplifier 12 and stabilizes the operation of the signal source against supply voltages changes and lowers the output impedance. The latter is desirable in order to render the system operative even though an accidental low resistance circuit may appear on a portion of wire 2 far from the source. The receiving wire 4 is connected through amplifier 20, amplitude selector 22, counting rate circuit 24 and relay control tube 26 to a relay 28 which is operable, when energized, to close the circuit through an indicating device such as lamp 30.

A schematic diagram of the system shown in Fig. 1 is disclosed in Fig. 2 and it will be seen that the various elements of the schematic diagram are, in themselves, of conventional design. Thus, the power source 8 may be of any known construction to produce an alternating frequency and, as such, may have the circuitry illustrated in Fig. 2. The null filter 10 which is illustrated is of the well-known Bridge-T type but may have any other form which will be operative to attenuate an harmonic of the basic frequency supplied to the filter by the power source. The amplifier 12 illustrated in Fig. 2 comprises a phase-inverter followed by a pair of triodes connected in push-pull. The inverse feedback link 14

provides that the amplifier be linear, low-gain and that it have a low output impedance. The amplifier **20** comprises two stages, the first of which contains circuitry for the rejection of the frequency developed by the source, and the second stage of which is sharply tuned to the harmonic eliminated from the frequency of the source. A resistor **23** connects the amplifier **22** to the amplitude selector and has the function of isolating the rather severe discontinuity presented by the amplitude selector when the latter is in the "on" or "fixed" position. The amplitude selection circuit **22** illustrated in Fig. 2 is a device or circuit known as the Schmitt trigger circuit, which is described in "Electronics of the Nuclear Energy Series" by Elmore and Sands (McGraw-Hill), but may be any other known circuit or device which will be operative to pass only signals greater than some pre-determined value. The counting rate circuit illustrated in Fig. 2 is of conventional design and for the illustrated circuit there may be substituted any known or other circuit which will respond only to signals continuing for a pre-determined length of time. The relay control tube **26**, relay **28** and lamp **30** as shown in Fig. 2 are entirely conventional.

In the use and operation of the flame detector system provided by the invention, the two electrodes are placed in a space in which a flame may occur and which is to be monitored for flame. In a typical embodiment of the invention, the electrodes will take the form of elongated bare wires which are trained throughout a space which is to be monitored for fire, and which are arranged in closely spaced parallel relation throughout their lengths, a typical spacing being of the order of an inch. The source of power supplies to the transmitting wire an alternating frequency from which one harmonic has been substantially completely attenuated. Thus, if the source generates alternating voltage having frequency F and harmonics thereof the voltage supplied to the transmitting wire will have the basic frequency F and harmonics thereof except a selected harmonic nF, in which n is a whole number which is not 0 or 1. This harmonic is removed from the frequency of the source **8** by null filter **10** and the resulting voltage is amplified at **12** and stabilized by the feedback circuit **14**. The receiver wire is connected to the tuned amplifier **20**, one stage of which rejects the basic transmitted frequency F, while the second stage of which is tuned to receive only the harmonic frequency which is removed from the basic frequency by the filter **10**. In the absence of a flame bridging the wires **2**, **4** no signs will appear in amplifier **20** but, upon the advent of such a flame, the harmonic nF will be detected. The amplitude selector **22** is set to admit signals having at least a pre-determined amplitude which is determined so as to eliminate signals of the nature of noise, hum, etc., whereby the threshold of the selector **22** is such that these extraneous signals will never operate the indicator, which will be operated only by signals of pre-determined level due to reception of the field harmonic nF in the presence of a flame. The output of the amplitude selector is supplied to the counting rate circuit **24** which, while not necessary to the detection of flame, is desired for the purpose of eliminating the effect of short duration signals due to the presence of water, water vapor, rain and the like between the two wires. This counting rate circuit may be so adjusted that it will pass only signals of some pre-determined duration, i. e. number of pulses of energy per unit of time, thus differentiating between the signals producing a pre-determined number of pulses per unit of time, which are due to flame, and those producing a lesser number of pulses per unit of time which are due to other causes. The output of the counting rate circuit when flame is present is a direct current which is supplied to the relay control tube **26** and will operate the relay **28** to connect the lamp **30** to the source of power and energize the same.

Suitable shielding for the leads of the described circuit may be provided if this is desired or necessary.

While in the embodiment of the invention which is specifically described in this application a single harmonic of the frequency of the source is suppressed, and the receiving means are tuned to receive only the suppressed harmonic, it will be understood that, as stated hereinbefore, more than one harmonic frequency may be suppressed. In this case, the output circuitry of the receiving electrode will be tuned to receive one or more of the suppressed harmonic frequencies.

While I have disclosed certain embodiments of my invention, it will be apparent to those skilled in the art that other embodiments, as well as modifications of those disclosed, may be made without departing in any way from the spirit or scope of the invention, for the limits of which reference must be made to the appended claims.

What is claimed is:

1. An electrical flame detecting system comprising electrode means positioned within a space to be monitored, means for supplying to said electrode means an alternating voltage having a fundamental frequency from which there has been attenuated to negligible value an harmonic which is neither the zero nor first harmonic of the fundamental frequency, receiving means capacitatively connected to said electrode means and tuned to receive only the attenuated harmonic frequency whereby a signal of the attenuated harmonic frequency will be detected by said receiving means upon impingement of a flame on said electrode means, and means for indicating the detection of such a received signal.

2. An electrical flame detecting system according to claim 1, in which said receiving means comprises, in addition, means for eliminating signals of an amplitude less than a pre-determined value, and means for eliminating signals having less than a predetermined number of pulses per unit of time.

3. An electrical flame detecting system comprising a plurality of spaced electrodes arranged within a space to be monitored and insulated from each other and from ground, means for developing between one group of said electrodes and ground an alternating voltage of a known ensemble of harmonically related frequencies from which one or more of such harmonic frequencies has been attenuated to negligible value, the attenuated harmonic or harmonics being neither the zero nor first harmonic of the fundamental frequency of the alternating voltage, receiving means connected between a second group of said electrodes and ground and being tuned in complex manner to respond only to the attenuated harmonic or harmonics whereby upon bridging of said groups of electrodes by a flame a signal of complex waveshape will be detected by said receiving means, and means for indicating the detection of such a signal.

4. An electrical flame detecting system comprising two spaced electrodes arranged within a space to be monitored and insulated from each other and from ground and adapted to be bridged by a flame, means for developing between one of said electrodes and ground an alternating voltage of a known fundamental frequency from which at least one harmonic has been attenuated to negligible value, which is neither the zero nor the first harmonic of the fundamental frequency, receiving means connected between the second electrode and ground which is responsive only to the attenuated harmonic or harmonics of the fundamental frequency whereby upon bridging of said electrodes by a flame a signal of the attenuated harmonic frequency will appear between the second electrode and ground and will be received in said receiving means, and indicating means operated upon such reception.

5. An electrical flame detecting system comprising two spaced wires arranged in spaced parallel capacitative relation within a space to be monitored, means for sup-

plying to one of said wires an alternating frequency from which one harmonic frequency has been suppressed, said suppressed harmonic being other than the zero or first harmonic, receiving means connected to the second wire tuned to accept only the harmonic frequency suppressed from the energy supplied to the first wire, whereby a signal of said suppressed harmonic frequency will be detected by said receiving means upon impingement of a flame on both said wires, and means for indicating the detection of such a received signal.

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