

[54] **LIGHT DETECTION MONITORING DEVICE**

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[51] Int. Cl. **G08b 17/10**

[58] Field of Search **340/228.1, 228.2,
 340/228.5, 227, 213 R**

[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|-----------|---------|-----------------|-------------|
| 3,315,244 | 4/1967 | Voight | 340/227 R |
| 3,416,041 | 12/1968 | Guiffrida | 340/227 R X |
| 3,544,792 | 12/1970 | Giltaire | 340/227 X |
| 3,683,372 | 8/1972 | Horn | 340/227 X |
| 2,556,961 | 6/1951 | Feigal | 340/228.1 X |
| 3,076,897 | 2/1963 | Skirvin | 340/228.5 X |
| 3,546,692 | 12/1970 | Salzer | 340/228.5 X |

| | | | |
|-----------|---------|-----------------|-------------|
| 3,548,395 | 12/1970 | Gilbert | 340/228.2 R |
| 3,555,532 | 1/1971 | White | 340/228.5 X |
| 3,573,777 | 4/1971 | Kompelien | 340/228.1 X |

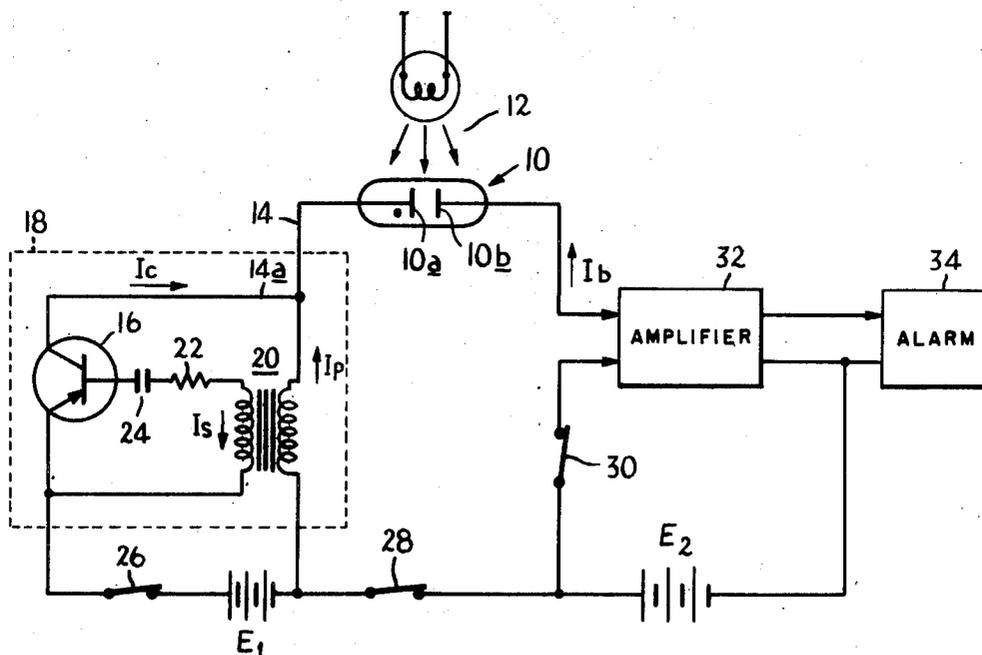
Primary Examiner—Harold I. Pitts

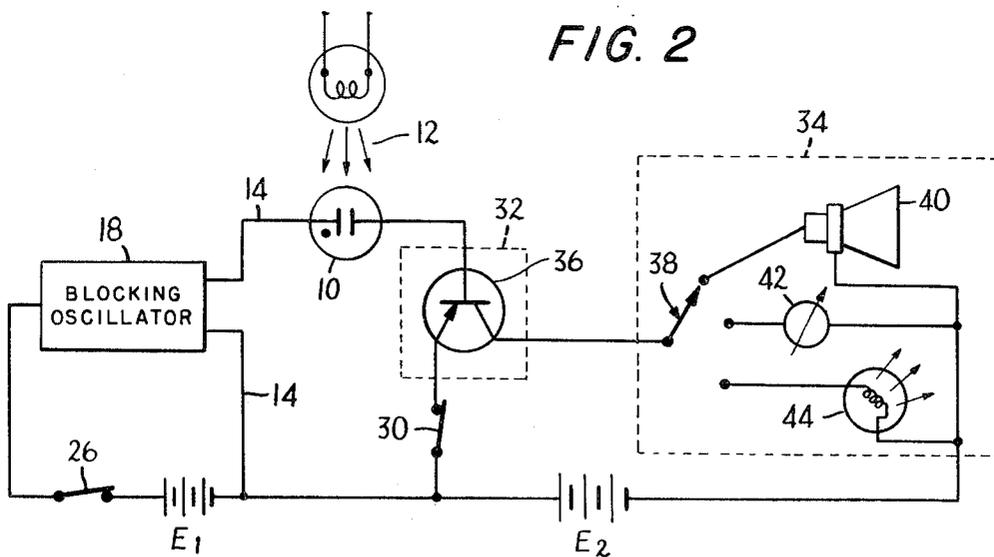
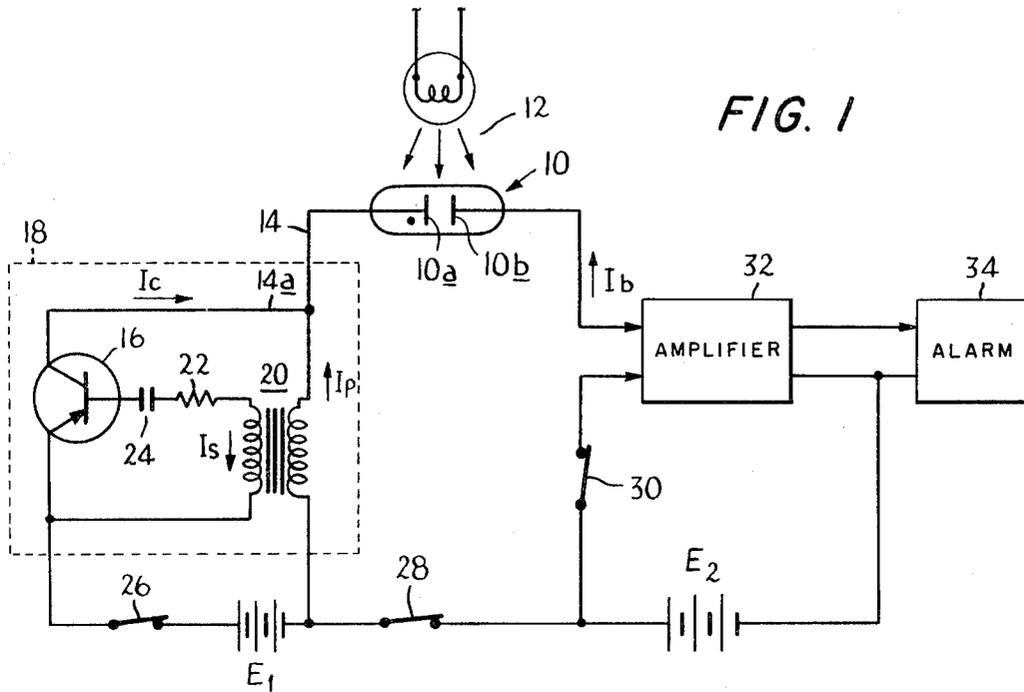
Attorney—Brumbaugh, Graves, Donohue & Raymond

[57] **ABSTRACT**

A light detection monitoring device includes a gaseous discharge tube for converting incident light into an electric signal, and a blocking oscillator. The oscillator, which is coupled to one of the electrodes of the tube and is enabled by the electric signal produced by the discharge tube, supplies short pulses which add to the discharge current to effect cumulative ionization of the gas in the tube and the attendant generation of high frequency waves. The increased discharge current and the high frequency waves are then employed to trigger local and remote alarm devices, respectively.

13 Claims, 5 Drawing Figures





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FIG. 3

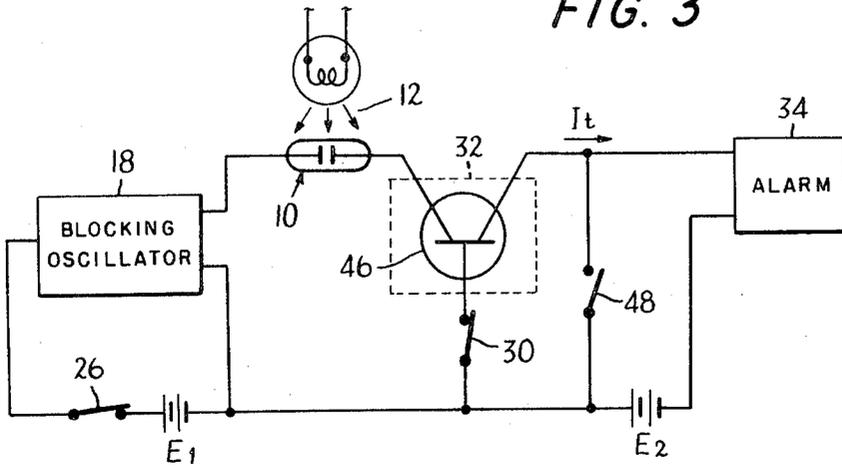


FIG. 4

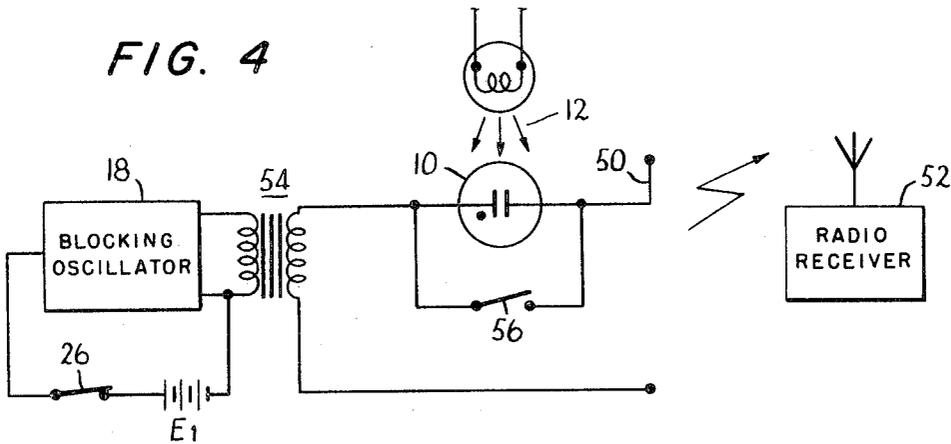
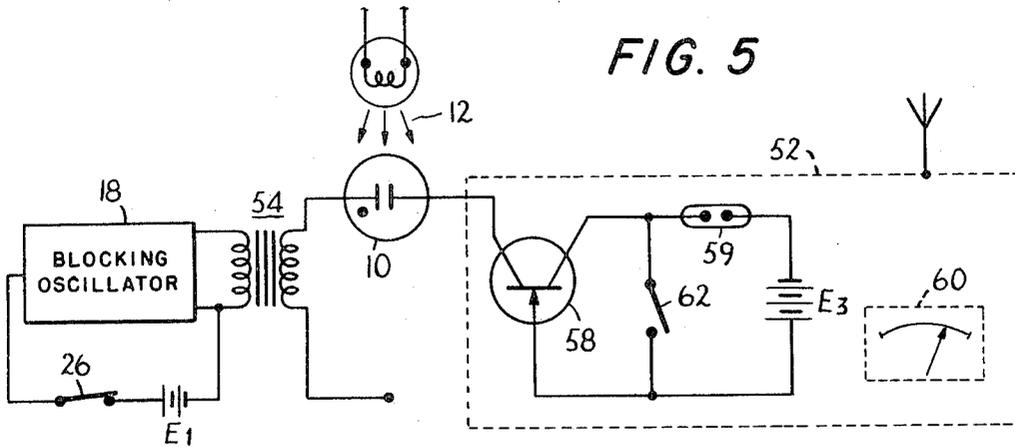


FIG. 5



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LIGHT DETECTION MONITORING DEVICE**BACKGROUND OF THE INVENTION**

The present invention relates to monitoring devices and, more particularly, to a new and improved monitoring device employing a discharge tube as a photosensitive element for producing a distinctive signal when a beam of light illuminates the tube.

The field of monitoring devices for human and property protection is highly developed and complex. One type of monitoring device with which the present invention is related employs a light detector to trigger circuitry for sounding an alarm when the detector is subjected to light. The light detectors now in widespread use will not respond satisfactorily to an incident luminous flux of low intensity. In particular, the sensitivity of the class of photoconductive detectors such as cadmium sulfide and selenium cells is limited by the significant intensity of their darkness current, as well as by the low frequency intrinsic noise accompanying passage of electrons from the valence band to the conduction band.

Other types of detectors presently in use are cathode emission detectors, such as vacuum or gas cells, and photomultipliers. Several factors tend to limit the sensitivity of these detectors. The most significant factors are the statistical character of the electronic flux of cathode emission or secondary emission, the spontaneous emission of parasite electrons not caused by the light signal, and the wide low frequency fluctuations in the supply source, which in the case of photomultipliers, can extend to several milliamperes.

It has also been suggested to use glow tubes for light detection, as well as for signal transmission. However, the sensitivity of these tubes is limited by fluctuations in cathode drop and potential difference at the terminals and by the comparatively high darkness current maintained by a steadily applied internal electric source.

All the foregoing prior art light detectors are limited in sensitivity by low frequency fluctuations and noise, and furthermore, none of such detectors utilizes high frequency oscillations, known as acoustic electrostatic oscillations, that can be generated in ionized gases.

SUMMARY OF THE INVENTION

In order to overcome these disadvantages, the present invention provides a combination of a photosensitive member and a complementary electronic accessory. More specifically, by the novel employment of the special properties of ionized gases in a discharge tube, and the ability of such tubes to generate high frequency oscillations, the device according to the present invention provides a powerful signal even when the incident light intensity is very low. In addition, the device, being free from low frequency fluctuations, remains inoperative both in the absence of illumination and when the tube is short-circuited.

The photosensitive member comprises a gas that readily absorbs photons of light, provides a very low detection threshold, and under suitable conditions of installation, generates and sustains high frequency oscillations. The small electric current supplied by the photosensitive member when illuminated acts upon the electronic accessory which, after processing the signal, reapplies the processed signal to the photosensitive member. The photosensitive member then transmits

the resulting discharge current to following stages to sound an alarm. The photosensitive member utilized in the present invention performs three salient functions: (1) the conversion of incident light quanta into a weak electric current, (2) the reception of the signals processed by the electronic accessory, and (3) the transmission of either its discharge current or the high frequency electromagnetic energy produced therein to sound an alarm. The photosensitive member does not operate with an outside source and, accordingly, is not subjected to low frequency parasite fluctuations.

In closed circuit, the present invention provides both a very low light detection threshold and a very high light-to-electric-signal conversion slope. In open circuit, the combination serves as a high frequency emitter modulated at the frequency determined by the accessory.

In one preferred embodiment of the invention, the monitoring device comprises in combination a photosensitive gas element and an active electronic accessory consisting of passive elements. The gas element comprises a bidirectionally conductive tube having two like cold electrodes free from continuous interference by an outside source and filled with a pure inert gas or mixture of gases, preferably a monatomic gas, such as neon, argon, helium, crypton or xenon. The electronic accessory comprises a blocking oscillator coupled to one electrode of the photosensitive element. The other electrode, when the tube is operated in closed circuit, is connected through a detector to a sensory alarm indicator. According to another feature of the present invention, when the tube is operated in open circuit, the other electrode of the tube is connected to a radio frequency antenna which radiates the high frequency waves produced in the tube.

Many possible uses of the monitoring device of the present invention are envisioned. The monitoring device is especially useful for fire detection, burglary prevention, alarm or control systems actuated at a distance by a beam of light and the detection of the establishment of an arc in an inaccessible high-tension installation. The monitoring device of the present invention may respond to lasting or transitory illumination of the discharge tube through acoustic means, such as gongs, sirens, loudspeakers, or visual means such as lighting of an incandescent lamp, deviation of a pointer, production of a recording, or in any other manner suited to the particular conditions of service. The novel means according to the invention will likewise serve to provide an uninterrupted warning signal requiring manual intervention to stop the alarm. Finally, the device is compact and light weight and can be installed easily as required for varied applications.

BRIEF DESCRIPTION OF THE DRAWINGS

In the Drawings:

FIG. 1 is a schematic block diagram of the basic embodiment of a monitoring device arranged according to the present invention;

FIG. 2 is a schematic block diagram of a closed circuit embodiment of the present invention which provides an alarm of limited duration;

FIG. 3 is a schematic circuit diagram of a closed circuit embodiment of the present invention that provides a warning signal of extended duration;

FIG. 4 is a schematic block diagram of an open circuit embodiment of the present invention that provides high frequency radiation; and

FIG. 5 is a schematic block diagram of an open circuit embodiment of the present invention that provides an uninterrupted alarm signal.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the description of the preferred embodiments of the light detection monitoring device of the present invention shown in FIGS. 1-5, circuit components which are common to the various embodiments are designated with the same identifying numbers.

Referring now to FIG. 1 which shows a basic embodiment of a light detection monitoring device arranged according to the present invention, the device includes a gaseous discharge tube 10 such as, for example, a neon or xenon tube. Ionization of the gases within the tube 10 is initiated when the tube is illuminated by a beam of light 12. One electrode 10a of the tube 10 is coupled via a conductor 14 and its branch conductor 14a to the collector of a transistor 16 forming an integral part of blocking oscillator 18 and to the primary winding of a transformer 20 also forming an integral part of the oscillator 18. The oppositely poled output or secondary winding of the transformer 20 is coupled across the base and cathode of the transistor 16 through a resistor 22 and a capacitor 24. Completing the input circuitry for the tube 10 are a normally closed switch 26 which couples an enabling DC source E1 concurrently to the cathode of the transistor 16 and to the output winding of the transformer 20. The negative terminal of the source E1 is connected to the primary winding of the transformer 20 and through a normally closed switch 28 to a second normally closed switch 30 and a second DC source E2. The two DC sources E1 and E2 preferably supply equal voltage potentials.

The other electrode 10b of the tube 10 is connected to the output circuitry of the device. The output circuitry includes a detector-amplifier 32 that is enabled by the DC source E2 through the switch 30. An alarm circuit 34 completes the output circuitry of the monitoring device and is enabled by the DC source E2 and is driven into operation to generate an alarm by the amplifier 32. As will be described hereinbelow, the alarm 34 may be located either locally with the discharge tube 10 or remotely therefrom. In view of the foregoing, it will be seen that the switches 26 and 30 enable the operation of the input and output circuitry, respectively, and that the switch 28 serves the function of either coupling or isolating the input and output circuitry of the device.

In the operation of the FIG. 1 monitoring device (switches 26, 28 and 30 closed), the device will energize the alarm 34 as long as the tube 10 is illuminated by the optical electromagnetic energy 12. Specifically, in the initial state of the device and in the absence of any illumination 12, the blocking oscillator 18 and the amplifier 32 are in their quiescent states. The input and output windings of the transformer 20 are not acted upon by any current from the discharge tube 10 whose electrodes 10a and 10b are at the same potential. It necessarily follows that the collector current I_c of the transistor 16 is zero.

When the tube 10 is illuminated by the light 12, the photons of light absorbed by the inert gas of the tube

10 cause the formation of plasma in which neutral atoms, excited atoms, electrons and positive ions coexist. In the absence of a potential difference across the terminals of the tube 10, the electrified particles of the plasma wander in the interelectrode space, with some electrons reaching the electrode 10a and charging it negatively. A discharge current I_p is created in the primary winding of the transformer 20 which, in turn, induces a current I_s in the secondary winding of the transformer. The capacitor 24 discharges through the resistor 22 to reduce the potential of the base of the transistor 16 until the transistor 16 starts to draw collector current I_c and the collector voltage drops. The collector current I_c adds to the discharge current I_p with the result that the potential of the electrode 10a is decreased. An electric field is established in the tube 10 which increases the collisions between electrons and atoms within the tube. The currents I_p , I_c , I_s grow in step with the potential difference across the tube 10 to effect cumulative ionization in the tube and the attendant generation of high frequency waves.

A cloud of positive ions forms and increases around the electrode 10b to attract electrons and thereby reduce the number of electrons reaching the electrode 10a. The electric field, as well as the currents I_c and I_p , will then be reduced. At a certain time, the directions of the currents are reversed, and a secondary discharge current I_b in the output circuit is produced. The discharge current I_b drives the detector-amplifier 32 into conduction which, in turn, drives the alarm circuit 34 to generate a sensory alarm indication. At this time, the capacitor 24 of the blocking oscillator charges to reverse bias the transistor 16. Then, the positive ions collect at electrode 10a to diminish the reverse electric field and the cycle repeats itself for as long as the discharge tube 10 remains illuminated.

The timing is maintained by the discharge tube 10. The critical features of the present invention are the interdependence of the blocking oscillator 18 and the discharge tube 10, the monatomic gas of the tube 10 and the omission of any permanent triggering source for the tube 10.

Referring now to FIG. 2, there is shown a closed circuit monitoring device of the type illustrated in FIG. 1, with the exception that one form of amplifier 32 is diagrammatically illustrated and several alarm indicators which may be used as the local alarm 34 are illustrated. In particular, the amplifier 32 is shown as including a pnp transistor 36 and the alarm circuit 34 is shown as including a stepping switch 28 for coupling the collector of the transistor 36 to either a loudspeaker 40, a meter 42 or a light bulb 44. It will be understood that in actual practice only one of the alarms 40, 42 and 44 would be coupled directly to the output of the amplifier 32 and any particular location.

Referring now to FIG. 3, there is shown a closed circuit embodiment of the present invention which provides an uninterrupted warning signal even when the incident luminous flux 12 lasts for only a short time. For this purpose the amplifier 32 includes a silicon thyristor 46 having its control electrode coupled to the electrode 10b of the discharge tube 10. A signal, even a brief one, furnished by electrode 10b triggers the thyristor 46 which will then supply a continuous current I_t to the alarm circuit 34 which may comprise for example, an incandescent bulb, a pointer instrument, an acoustic alarm or any other constant current signaling

device. An additional switch 48 serves to stop the current It to the alarm circuit 34. A thyatron may be used in place of the thyristor 46 to produce a constant warning signal, as will be understood in the art.

The diagram of FIG. 4 illustrates an open circuit embodiment of the present invention which radiates high frequency waves into the surrounding space. An antenna 50, which may consist of a single wire, is connected to electrode 10b of the discharge tube 10. Since the potentials of electrodes 10a and 10b are not fixed when the tube 10 is illuminated, the ionized particles wander from one electrode to the other, undergoing collisions, recombinations and reionizations. These frequent interactions, as well as the dislocations of the positive ions, produce a band of high frequency waves modulated by the low frequency oscillations of the blocked oscillator 18.

For suitable ionic density of the plasma, the waves generated fall within the band of conventional radio frequencies. A remotely located radio receiver 52 having an antenna will detect these waves generated by the discharge tube 10 and make the vibrations of the blocked oscillator 18 audible through its speaker. To isolate electrode 10a of the tube 10, a second transformer 54 is interposed between the transformer 20 operating the oscillator 18 (FIG. 1) and electrode 10a. The primary windings of transformers 54 and 20 are connected in parallel.

The antenna 50 may be long, so that the receiver 52 may be placed at a very great distance and, more specifically, in a different location from that of the monitoring device. It is possible, however, to place the tube 10 and the oscillator 18 inside the cabinet of receiver 52 without interfering in any way with normal radio operation. To listen to ordinary voice transmission, the discharge tube 10 need merely be short-circuited with a switch 56, thereby eliminating the monitoring mode.

An open circuit embodiment of the present invention that provides an uninterrupted signal is schematically shown in FIG. 5. The connection between the oscillator 18 and the transformer 54 leading to electrode 10a of discharge tube 10 is the same as in FIG. 4. For monitoring, a thyristor 58, located inside a radio receiver 52, is inserted between the positive terminal of a supply source E3 and the positive tab of a supply bar 59 which, when energized, supplies current to the radio circuitry (not shown). The electrode 10b of the discharge tube 10 is connected directly to the control electrode of the thyristor 58, the emitter of which is connected to the positive terminal of the source E3 and the collector which supplies the positive tab of the bar 59 of the receiver. The thyristor 58 serves as a switch, open in the absence of the luminous flux 12 and closed when the light appears. In order to generate a loud sound in case of intrusion, it is desirable to take the precaution of raising the volume control potentiometer 60 of the radio receiver all the way and setting the wavelength of the receiver to a powerful broadcast transmitter.

Since one end of the transformer 54 is isolated, the potential of electrode 10a of the tube 10 is not fixed, and hence the high frequency oscillations of the plasma are reinforced when the discharge tube is illuminated. These oscillations act on the control electrode of the thyristor 58 to thereby fire the thyristor which will then close the circuit comprising the battery E3 and the bar 59 and enable energizing current to be supplied to the circuitry of the receiver 52. The speaker (not shown)

in the receiver will then loudly reproduce the voice transmission being detected. A switch 62, connected between the collector and the emitter of the thyristor 58 serves to stop the thyristor, but off the receiver 52 and restore the monitoring mode of the device as a whole. In darkness, the receiver, having no supply, remains silent.

In this embodiment, in order not to render the tube 10 conspicuous, the tube 10 may be covered by a filter. Of course, when monitoring is not required, normal radio listening modes may be restored. It then suffices to disconnect the wire coupling the electrode 10b to the control electrode of the thyristor 58 and make a direct connection joining the positive terminals of the source E3 and bar 59.

Although the invention has been described herein with reference to specific embodiments, many modifications and variations therein will readily be apparent to those skilled in the art. Accordingly, all such variations and modifications are included within the intended scope of the invention as defined by the following claims.

I claim:

1. A light detection monitoring system comprising a gaseous discharge tube filled with a monatomic gas for producing high frequency electromagnetic waves and a discharge current in the presence of light, signal generating means coupled to the gaseous discharge tube and responsive to the discharge current produced by the tube for generating periodic signals which add to the discharge signal to effect cumulative ionization of the gas in the tube and the reinforcement of the high frequency electromagnetic waves produced by the tube and means operatively coupled to the tube for producing a detectable alarm in response to the ionization of the gas within the discharge tube.
2. Apparatus according to claim 1 wherein the alarm producing means comprises means responsive to the discharge current for producing a sensory alarm.
3. Apparatus according to claim 2 wherein the alarm producing means comprises a loudspeaker.
4. Apparatus according to claim 2 wherein the alarm producing means comprises a light producing means.
5. Apparatus according to claim 2 wherein the alarm producing means comprises a meter.
6. Apparatus according to claim 1 wherein the alarm producing means comprises means responsive to the high frequency electromagnetic energy for providing a sensory alarm indication.
7. Apparatus according to claim 6 wherein the alarm producing means comprises means for radiating the high frequency electromagnetic energy and radio receiver means tuned to the frequency of the radiated high frequency energy.
8. Apparatus according to claim 1 wherein the signal generating means comprises a blocking oscillator having a transistor and a pulse transformer coupled across the terminals of the transistor and to one of the electrodes of the gaseous discharge device.
9. Apparatus according to claim 8 wherein the alarm producing means comprises an amplifier means responsive to the discharge current produced in the tube and a sensory alarm indicator responsive to the signals amplified by the detector amplifier for providing a sensory alarm indication.
10. Apparatus according to claim 9 wherein the amplifier means comprises a thyristor.

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11. Apparatus according to claim 1 wherein the alarm producing means comprises a radiating wire coupled to one of the electrodes of the tube for radiating the electromagnetic energy and radio receiver means responsive to the radiated electromagnetic energy for providing a sensory alarm indication.

12. Apparatus according to claim 1 wherein the alarm producing means comprises a radio receiver, said receiver comprising circuit energizing means responsive to the discharge current produced in the tube for

energizing said receiver.

13. Apparatus according to claim 12 wherein the circuit energizing means comprises a source of potential, a receiver energizing supply bar and a thyristor coupled between the source and the supply bar and responsive to the high frequency electromagnetic energy produced by the tube for closing a circuit between the source and the supply bar to thereby energize the supply bar.

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