Dec. 24, 1957 M. H. SHAMOS 2,817,768

RADIATION ALARM

Filed Sept. 16, 1954

FIG. 1

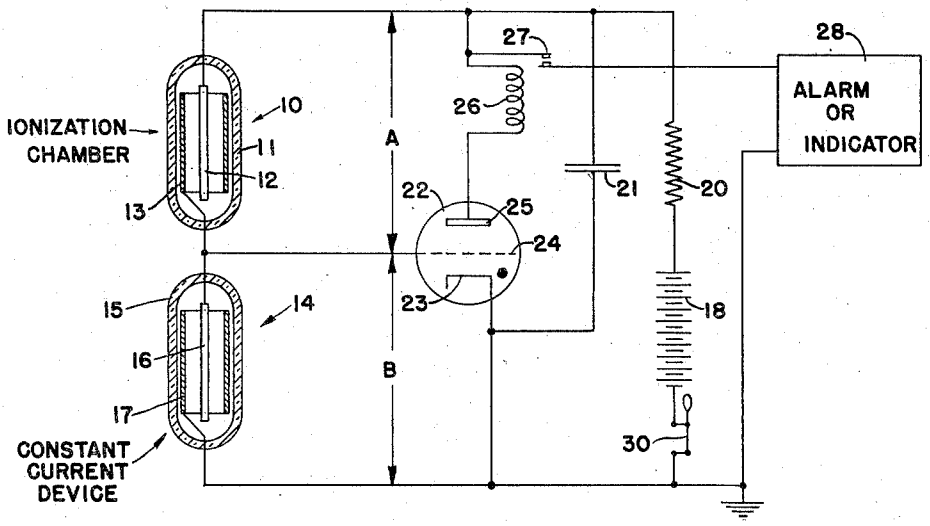


FIG. 2

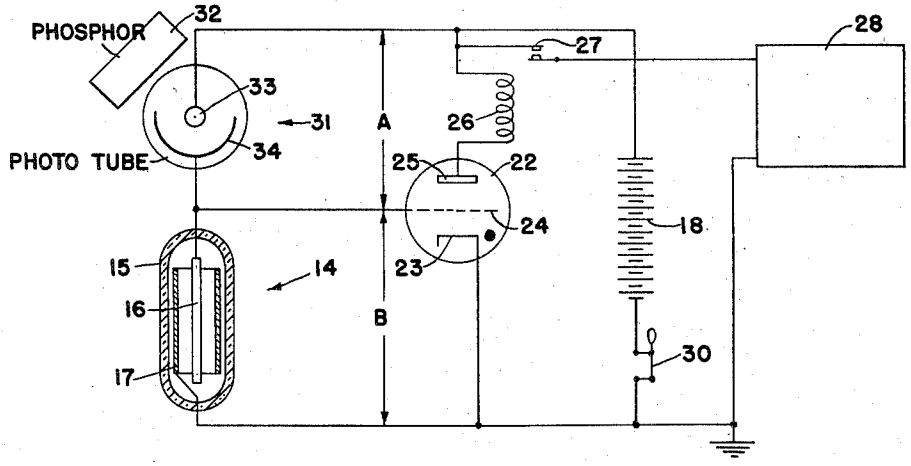
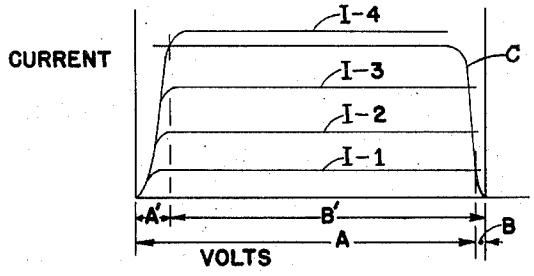


FIG. 3



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RADIATION ALARM

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Application September 16, 1954, Serial No. 456,442

9 Claims. (Cl. 250—83.6)

This invention relates to radiation alarms and has particular reference to an alarm system which will sound a warning or produce a visual indication when gamma ray radiation level exceeds a predetermined tolerance value.

The large increase in the use of radioactive materials during the past few years, coupled with the threat of radiation hazards resulting from atomic warfare make it desirable to have a simple, automatic radiation alarm which will give a signal when the radiation level exceeds a predetermined value. Since such devices should be on duty twenty-four hours a day it is advisable to use a simple dependable arrangement which does not require a continuous supply of electrical energy in the standby condition.

The alarms used at present generally consist of ion chambers or Geiger counters coupled to appropriate amplifier circuits to operate preset relays and alarm systems. In any of these devices hot cathode tubes must be used and hence require a continuous supply of heater or filament current in the standby condition. The level for which these alarms are set is usually the presently accepted tolerance level, which is 6.25 milliroentgens per hour.

As used throughout the specification and claims, the term radiation refers to high frequency electromagnetic energy such as X-rays or gamma rays produced by radioactive materials.

One of the objects of this invention is to provide an improved radiation alarm which avoids one or more of the disadvantages and limitations of prior art arrangements.

Another object of the invention is to provide a radiation alarm which consumes virtually no electrical energy in the standby condition.

Another object of the invention is to increase the sensitivity of radiation alarms.

Another object of the invention is to provide a radiation alarm which may be used to detect neutrons or beta radiation as well as gamma radiation.

One feature of the invention includes an ionization chamber in series connection with a constant current device. A gaseous discharge device having a cold cathode is coupled to this circuit with a relay in series with the anode circuit. The relay contacts are connected to an alarm system.

Another feature of the invention includes the use of a photoelectric tube in series with a constant current device, the photoelectric tube being used in combination with a phosphor which gives off light when activated by the radiation which is to be detected.

For a better understanding of the present invention, together with other and further objects thereof, reference is made to the following description taken in connection with the accompanying drawings.

Fig. 1 is a schematic diagram of connections showing one arrangement of the radiation alarm circuit.

Fig. 2 is a schematic diagram of connections showing an alternate circuit.

Fig. 3 is a graph which illustrates the operation of the ionization chamber connected in series with the constant current device.

Referring now to Fig. 1 an ionization chamber **10** includes an envelope **11** which is permeable to the radiation to be measured. Inside envelope **11** is an anode **12** and a cathode **13**. The envelope is filled with an ionizable gas for which the current is reasonably independent of the voltage over a wide range. In series with the ionization chamber is a constant current device **14** which includes an envelope **15** which is opaque to the radiation. The constant current device also includes an anode **16** and a cathode **17** and a small quantity of radium salt which provides constant gas ionization. These two circuit elements are connected in series as shown in the figure and are connected to a source of potential **18** which may be 150 volts although the circuit can be made to work with a voltage supply which varies between a hundred and one hundred seventy-five volts. In series with the source of potential is a high resistor **20**, the use of which is optional as will be described later when the operation is described. A large capacitor **21** is connected across the potential supply and the resistor.

A gaseous discharge device having a cold cathode **23**, a control electrode **24** and an anode **25** is coupled to the ionization chamber and the constant current device as shown in Fig. 1 with a relay winding **26** connected in series with the anode **25** and anode **12**. The relay is supplied with a pair of normally open contacts **27** which are connected between the positive end of the power supply and an alarm or indicator **28**, the other side of which is connected to the negative terminal of the power supply and ground.

The operation of this circuit is as follows: When the ionization chamber does not receive penetrating radiation the resistance between its anode and cathode is quite high and therefore the voltage drop A across it is quite high while the voltage drop B across the constant current device **14** is correspondingly low, thereby maintaining the potential of the control electrode **24** at a value which prohibits conduction through the discharge device **22** and relay **26** is not operated.

When the radiation is strong enough to produce a current in the ionization chamber **10** which is greater than the constant current which normally flows through device **14** voltages A and B change abruptly, voltage A dropping to a comparatively low value and voltage B rising to a value which produces gaseous conduction in tube **22**, thereby actuating the relay **26**, closing contacts **27**, and operating the alarm **28**. Because of the nature of the gaseous discharge device **22** conduction will continue until a reset switch **30** is opened and the anode current through tube **22** is broken. For this reason no holding circuit is required for the relay. In the circuit diagram in Fig. 1 capacitor **21** is added to the circuit in order to supply a large electrical pulse through tube **22** as soon as the tube is fired. This additional power insures the operation of relay **26**. After the relay has been operated the normal current from battery **18** through resistor **20** is strong enough to hold the relay armature in an operated condition.

There may be some installations where the alarm is required to be shut off after an initial operation. This condition may be realized by making the capacitor **21** quite large and resistor **20** also quite large so that the normal flow of current from the battery **18** through the resistor is not sufficient to maintain conduction through the tube **22**. Under these circumstances the tube will be fired when the ionization chamber is made conductive, the relay is operated due to the charge stored in capacitor **21**, then the tube is made non-conductive because of the large voltage drop across resistor **20**, and then capacitor

21 is slowly charged and the circuit is ready for the detection of radiation.

The graph shown in Fig. 3 illustrates the voltage division across components 10 and 14. Curve I represents the current-voltage of the ionization chamber 10 while curve C represents the same characteristic of the constant current device plotted in a reverse manner so that the sum of the voltages is equal to the voltage of battery 18. When the ionization chamber is not irradiated by any penetrating radiation its current is quite low (of the order of 10^{-16} ampere or less in the plateau region) and its current characteristic has the form as indicated by curve I—1, the voltage across component 10 is then illustrated by the distance A while the voltage across the constant current device is shown by distance B. As the radiation applied to the ionization chamber increases the characteristic curves go through the changes indicated by I–2 and I–3 until the predetermined limit is exceeded and the characteristic may be represented by curve I–4. It will be evident that as soon as one curve moves above the other a large change in voltage takes place, the final distribution being shown by distances A′ and B′.

A somewhat similar circuit has been described and claimed in application Serial No. 324,525, filed December 6, 1952, by Morris H. Shamos.

It will be obvious that, if gamma rays or X-rays are to be detected, the envelope 11 must be permeable to such radiation. Also the constant current device 14 must have an envelope 15 which is opaque to such radiation or else the device must be enclosed in a shield which eliminates the action of all outside radiation.

If alpha, beta, or neutron radiation is to be detected suitable filters and envelope material must be provided so that the ionization within the envelope 11 is proportional to the desired radiation.

Fig. 2 shows the same circuit as Fig. 1 except that the ionization chamber 10 has been replaced by a photoelectric tube 31 and a phosphor 32. The photoelectric tube includes the usual anode 33 and cathode 34 and is housed in an enclosure (not shown) which eliminates all visible light. The phosphor 32 may comprise any one of the well-known phosphorescent materials which produce light when activated by penetrating radiation. It is well-known that the photoelectric tube 31 has an operating characteristic similar to the ionization chamber 10 shown by the curves I in Fig. 3. The operation of this device is substantially the same as the operation described above. In Fig. 2 the capacitor 21 and resistor 20 have been omitted to illustrate an alternate circuit arrangement.

The phosphor 32 may be a trans-stilbene crystal protected from visible light by a shield of black paper. In this case gamma radiation and X-rays are detected. If the shield is thin enough beta particles will penetrate the shield, cause fluorescence, and actuate the circuit. In order to detect neutrons, a boron containing plastic must be employed, such as polyethylene glycol borate, zinc sulfide compound.

While there have been described and illustrated specific embodiments of the invention, it will be obvious that various changes and modifications can be made therein without departing from the field of the invention which should be limited only by the scope of the appended claims.

I claim:

1. A radiation alarm for indicating the presence of penetrating radiation above a predetermined value comprising; a constant current electron discharge device including an anode and a cathode, said device responsive to penetrating radiation; a constant current device in series with the electron discharge device and a source of potential; a gaseous discharge device coupled to the electron discharge device and said constant current device and responsive to the relative voltage values applied thereon; a relay having a winding in series with the gaseous discharge device; and an alarm means in series with a source of potential and a pair of contacts on said relay.

2. A radiation alarm for indicating the presence of penetrating radiation above a predetermined value comprising, an ionization chamber responsive to penetrating radiation, said chamber passing a constant current in response to a wide range of applied voltages, a constant current device in series with the ionization chamber and a source of potential, a gaseous discharge device coupled to the constant current device and responsive to the voltage existing thereon, a relay having a winding in series with an electrode in said gaseous discharge device, and an alarm means in series with a source of potential and a pair of contacts on said relay.

3. A radiation alarm for indicating the presence of penetrating radiation above a predetermined value comprising, an ionization chamber having an anode and a cathode, said chamber arranged to pass current which is proportional to the intensity of the penetrating radiation incident thereon but passing constant current in response to a wide range of applied voltages, a constant current device in series with the ionization chamber and a source of potential, a gaseous discharge device coupled to the constant current device and responsive to the voltage existing thereon, a relay having a winding in series with an electrode in said gaseous discharge device, and an alarm means in series with a source of potential and a pair of contacts on said relay.

4. A radiation alarm for indicating the presence of penetrating radiation above a predetermined value comprising; an ionization chamber having an anode and a cathode within a permeable envelope; said chamber arranged to pass current which is proportional to the intensity of the penetrating radiation incident thereon but passing constant current in response to a wide range of applied voltages; a constant current device in series with the ionization chamber and a source of potential; said constant current device including an anode, a cathode, and a source of constant ionization within an envelope; a gaseous discharge device coupled to the constant current device and responsive to the voltage existing thereon; a relay having a winding in series with an electrode in said gaseous discharge device; and an alarm means in series with a source of potential and a pair of contacts on said relay.

5. A radiation alarm for indicating the presence of penetrating radiation above a predetermined value comprising; an ionization chamber having an anode and a cathode within a permeable envelope; said chamber arranged to pass current which is proportional to the intensity of the penetrating radiation incident thereon but passing constant current in response to a wide range of applied voltages; a constant current device in series with the ionization chamber and a source of potential; said constant current device including an anode, a cathode, an ionizable gas, and a source of constant ionization within an envelope; a gaseous discharge device coupled to the constant current device and responsive to the voltage existing thereon; said gaseous discharge device comprising an envelope containing an ionizable gas, a cold cathode, a control electrode, and an anode; a relay having a winding in series connection between the anode in said gaseous discharge device and a source of potential; and an alarm means in series with a source of potential and a pair of contacts on said relay.

6. A radiation alarm for indicating the presence of penetrating radiation above a predetermined value comprising; an ionization chamber having an anode and a cathode within an envelope which is permeable to penetrating radiation; said chamber supplied with an external voltage so that the current through the chamber is pro-

portional to the intensity of the penetrating radiation incident thereon but passing current in response to a wide range of applied voltages; a constant current device including an anode, a cathode, an ionizable gas within an envelope, and a source of constant ionization, having its anode connected to the cathode in the ionization chamber; a gaseous discharge device having a cold cathode, an anode, and a control electrode; said control electrode connected to the cathode of the ionization chamber and the anode of the constant current device; a source of potential having its positive terminal connected to the anode in the ionization chamber and its negative terminal connected to the cathode in the constant current device; a relay having a winding in series connection between the anode in said gaseous discharge device and the positive terminal of said source of potential; and an alarm means connected to a pair of contacts on said relay.

7. A radiation alarm for indicating the presence of penetrating radiation above a predetermined value comprising, a light sensitive device associated with a fluorescent screen which is responsive to penetrating radiation, said device passing constant current in response to a wide range of applied voltage values, a constant current device in series with the light sensitive device and a source of potential, a gaseous discharge device coupled to the constant current device and responsive to the voltage existing thereon, a relay having a winding in series with an electrode in said gaseous discharge device, and an alarm means in series with a source of potential and a pair of contacts on said relay.

8. A radiation alarm for indicating the presence of penetrating radiation above a predetermined value comprising, a photoelectric cell mounted adjacent to a fluorescent screen which produces light in response to penetrating radiation, said photoelectric cell passing constant current in response to a wide range of applied voltage values, a constant current device in series with the photoelectric cell and a source of potential, a gaseous discharge device coupled to the constant current device and responsive to the voltage existing thereon, a relay having a winding in series with an electrode in said gaseous discharge device, and an alarm means in series with a source of potential and a pair of contacts on said relay.

9. A radiation alarm for indicating the presence of penetrating radiation above a predetermined value comprising; a first discharge device which passes current which is proportional to penetrating radiation, the current through said first device being independent of voltage changes over a wide range, a second discharge device in series with said first device and a source of potential; said second device also passing current which is independent of penetrating radiation and voltage changes over a wide range; a gaseous discharge device connected to said first and second discharge devices and responsive to the relative voltage values applied thereon, said gaseous discharge device including a cold cathode, an anode, a control electrode, and an ionizable gas in an envelope; a relay having a winding whose terminals are connected between the anode in the gaseous discharge device and a source of potential; and an alarm means in series with a source of potential and a pair of contacts operated by an armature on the relay.

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