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E. W. MOLLOY
POCKET RADIATION ALARM

2,596,500

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2 SHEETS—SHEET 1

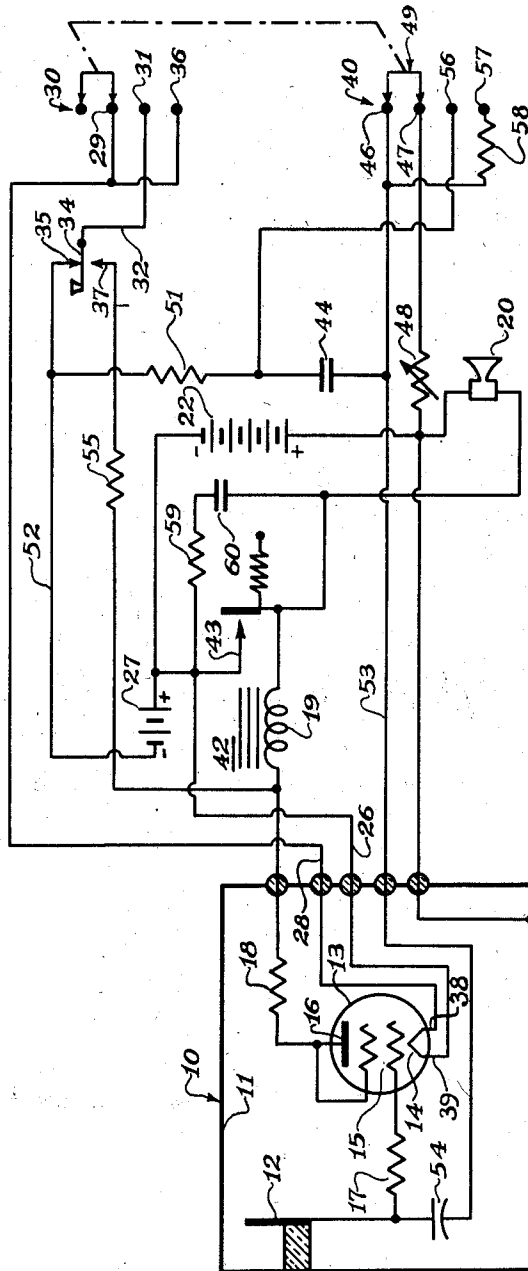


Fig. 1

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2 SHEETS—SHEET 2

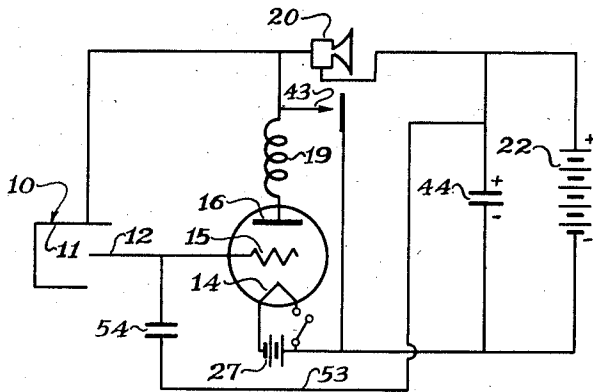


Fig. 2

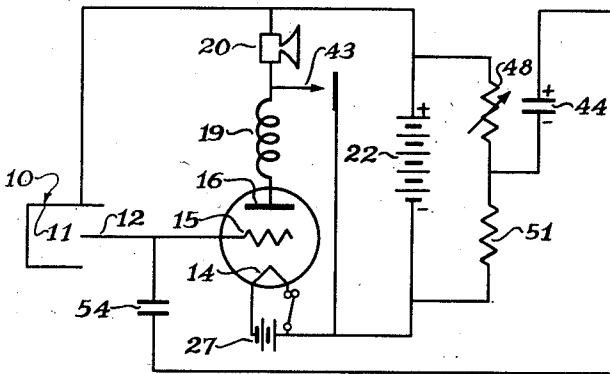


Fig. 3

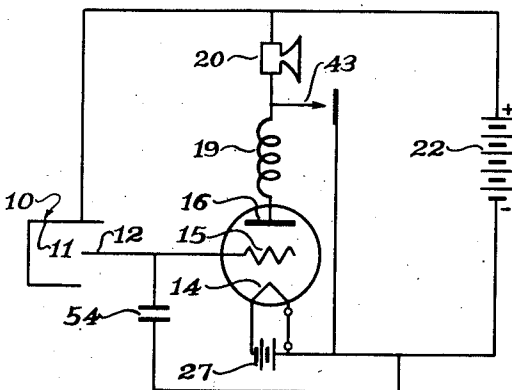


Fig. 4

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UNITED STATES PATENT OFFICE

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POCKET RADIATION ALARM

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This invention relates to a warning device for sounding an alarm if exposed to radioactive energy of a selected cumulative amount. More particularly, it is directed to such a warning device which is sufficiently compact to be carried in a clothing pocket.

Personnel present in the vicinity of radioactive materials must not be subjected to radiation which exceeds the known safe accumulative tolerance dosage. It follows that it is necessary to maintain an integrating radiation exposure indicating device proximate the bodies of such personnel. Therefore, the device must desirably be so compact that it can be carried on the person without causing discomfort or impediment to bodily motion.

In order that personnel to be protected can be warned of the accumulation of tolerance dosage without being distracted by the need for observing the warning device at intervals, it is necessary that the device sound an audible warning.

The radiation alarm of the present invention because of the desired compactness and the necessity for an amply loud warning signal presents a plurality of problems. Compactness requires that the source of operating energy be batteries of small size, with resultant small current capacity. The device, therefore, requires exceptional efficiency in order to sound an appropriate alarm with minute energy.

Further, the limited size of the batteries limits the available potential to a value below that required to actuate the device with reliability. It is therefore necessary that means be provided to obtain a multiplied value of the battery potential and, to this end, this invention teaches a novel and practical system.

The use to which a radiation alarm is put is of such nature that the ascertainment of a continuously operative condition is of utmost importance. To this end, it is necessary that the device be responsive to simple time to time testing. The test must include as many as possible of those circuit elements involved in the radiation detecting and alarm sounding functions.

It follows that a prime objective of the instant application is the provision of a radiation alarm device having the foregoing recited characteristics.

Other features and advantages of this invention will presently become apparent from consideration of the following specification and the drawing included therein.

Referring to the drawing:

Figure 1 is a schematic circuit diagram of a

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preferred embodiment of the radiation alarm of this invention.

Figure 2 is a simplified equivalent circuit diagram of the device of Figure 1 in the "off" condition.

Figure 3 is a simplified equivalent circuit diagram of the radiation alarm of Figure 1 in the "charge and test" condition.

Figure 4 is a simplified equivalent circuit diagram of the radiation alarm in "on" condition.

The modus operandi of the device is based upon a grid controlled thermionic tube which is normally biased beyond cut-off. The electrodes of the ionization chamber shunt the grid and cathode of the thermionic tube so that upon the occurrence of ionization of the gas between the chamber electrodes, the bias potential of the grid leaks off until finally the tube becomes conducting. The anode current of the tube passes through an electro-mechanical sound translation device and a serially connected chopper so that an alarm is sounded. It follows that the intensity of radiation governs the duration of time of radiation exposure which must expire before the alarm sounds. That is, the more intense the radiation, the more ionized the gas becomes between the chamber anode and cathode and the quicker the cut-off bias is dissipated from the thermionic tube grid. Thus the instrument is responsive to the accumulated effects of the radiation field; in other words, it is an alarm which responds to an integration of the impinging field.

Referring to Figure 1, the dependent relationship of the circuit components are shown in schematic form. The radioactive sensitive element is an ionization chamber designated generally by the reference numeral 10. The chamber 10 comprises a box, the sides of which may be entirely of metal or of composition material with a metal liner. The inside surface in either case is the anode of the ionization chamber and is designated by numeral 11. Inside the chamber, a conducting cathode electrode 12 is insulatingly supported.

The grid controlled thermionic tube 13 is provided with at least a cathode 14, a control grid 15 and an anode 16. The grid 15 connects to the ionization chamber cathode 12 through very high resistance 17. Anode 16 is connected through resistance 18, vibrating chopper actuating coil 19, and electro-mechanical transducer 20 to the positive terminal of anode potential source 22.

One leg 33 of the filamentary cathode 14 is connected through conductor 25 to the positive

pole of filament energization source 27, and the other leg 38 is connected through conductor 28, to switch contact 29 of the switch designated generally by the numeral 30. From contact 31 of the switch, the filament circuit continues through conductor 32 to a single pole, double throw switch 34, through switch contact 35 to the negative pole of filament energization source 27.

Switch 30 is shown in Figure 1 in the "off" position and as having two other positions. The middle position is the "charge and test" condition, and the third position is the "on" or vigilant position.

In order to enable the transducer 20 to emit a distinct, audible tone, the vibrating relay or chopper 42 is provided. When the instrument is activated by the occurrence of a conducting condition of tube 13, contact 43 is closed. This condition connects the transducer directly across anode potential source 22 and connects the anode 15 of tube 13 to the negative terminal of the source 22 thereby de-energizing tube 13 and chopper actuating coil 19. The de-energization of the chopper actuating coil releases the relay armature thus opening the contacts and reducing the current through the transducer. This chain of events continues to cycle thereby impressing a square wave of potential on transducer 20. The application of a square wave of potential on the transducer has been found to be exceptionally effective in producing a particularly distinctive tone of sufficient loudness.

From the foregoing description, it is seen that in the "off" position, the filament circuit of tube 13 is open so that the tube does not function. However, in order to produce sufficient potential from the small anode energization source to effectively operate the ionization chamber and the tube when in the "on" position, a first step in increasing the available potential is obtained in the first switch position. Referring again to Figure 1, the cathode 12 of the ionization chamber is connected to one terminal of a small capacitor 54. This capacitor has a value in the neighborhood of 100 micromicrofarads. The remaining terminal of capacitor 54 is connected through conductor 53 to contact 46 in the first position on switch 40. A capacitor 44 also has one terminal connected to contact 45 of switch 43. The second contact 47 of switch 40 is connected through resistor 48 to the positive side of anode potential source 22. The slider 49 of switch 40 in the first position joins contacts 46 and 47 so that the capacitor terminal is connected to the positive terminal of potential source 22. The remaining terminal of capacitor 44 is connected through resistor 51, conductor 52, and low potential source 27 to the negative terminal of anode potential source 22. Switches 30 and 40 are mechanically coupled so that the sliders in each are always in corresponding positions.

The condition of the circuit in the "off" position is shown in simplified form in Figure 2. Capacitor 44 is shown connected directly across anode potential source 22 for the reason that resistors 48 and 51 may be disregarded when the capacitor is charged. Capacitor 44 has a value in the neighborhood of 0.1 microfarad for reasons later to become apparent and is charged to the nominal potential of the anode potential source 22. That side of the capacitor 44 which is charged positively is connected through conductor 53 to one terminal of capacitor 54. The other terminal of capacitor 54 is connected to

grid 15 of tube 13 and cathode 12 of the ionization chamber.

In the "off" position, the tube filament is not energized so that no other action takes place.

In the second position of switches 30 and 40, which is the "charge and test" position, the circuit of Figure 1 is rearranged as shown in Figure 3. Referring to Figures 1 and 3, it is seen that the bridging of contacts 29 and 31 of switch 30 causes the filament of tube 13 to be energized.

The bridging of contacts 47 and 56 of switch 40 results in conditioning the grid of tube 13 to a low bias potential. It is to be noticed that resistors 51 and 48 are effectively serially connected with each other and in shunt with potential source 22. The circuit now takes the condition shown in Figure 3. Capacitor 44 connects in series with the junction of resistors 48 and 51 and capacitor 54. Thus the potential present at the junction of resistors 48 and 51 is combined additively with the charge on capacitor 44. The total potential thus obtained is impressed on capacitor 54 which, being small compared to capacitor 44, impresses substantially the total potential on grid 15. The filament is energized at this time so that by grid rectification, a negative potential accumulates on the grid which is equal very nearly to the peak potential impressed on capacitor 54. The anode current first increases to a high value for a short duration and then decreases to a lower steady value. The alarm therefore sounds continually for the second switch position.

The adjustability of resistor 48 provides a calibration function for the reason that its setting determines the value of negative bias accumulated on grid 15 and ionization chamber anode 12. The magnitude of bias determines the amount of charge which must leak off through the chamber electrodes due to the integrated effects of impinging radiation. Under some circumstances, the adjustability feature may not be necessary in which case capacitor 44 would be directly connected in series with potential source 22.

The warning device is in vigilant condition for the third switch position. Referring to Figure 1, it is seen that contacts 31 and 36 of switch 30 are bridged by the slider. Because contact 36 is connected to contact 29, this circuit remains the same as for Figure 2. Contacts 56 and 57 of switch 40 are bridged by the switch slider 49. The effect of this is to connect the upper terminal of capacitor 44 to its lower terminal through low value resistor 58. Therefore, capacitor 44 is short circuited. The negative side of energy source 22 is now connected to capacitor 54 thus depressing the potential of grid 15 and ionization electrode 12 to a below cut-off value for the tube 13. This condition is more easily seen by reference to the simplified diagram of Figure 4. Resistors 58 and 18 are not shown in Figure 3 for the reason that they function for decoupling purposes and to prevent excitation of other parts of the circuit due to sparking when switches are shifted. Resistor 59 and capacitor 60 shown shunted across the relay contacts in Figure 1 are not shown in Figure 4 again for the reason that they are for sparking radiation elimination purposes.

Figure 4 shows the negative side of battery 22 connected to the filament and to capacitor 54. Comparison of Figures 2 and 4 leads to the observation that the combined positive potentials of the battery 22 and capacitor 44 impressed on

grid 15 through capacitor 54 which are obtained in the second position of the switches effects a negative potential on grid 15 due to grid rectification, and that the change in circuit as shown in Figure 4 causes battery 22 to be reversed with respect to capacitor 54, grid 15 and ionization cathode 11. The anode of the ionization chamber remains connected to the battery 22 positive terminal. Therefore, the final potential on the grid 15 of tube 13 and ionization chamber cathode 12 with respect to the filament of tube 13 is a negative value of several times the available potential across battery 22. Since the anode of the ionization chamber is connected to the positive terminal of battery 22, the ionization chamber anode is at a considerably higher value of positive potential with respect to the chamber cathode than the original value of the potential of battery 22.

The tube 13 anode current thus is reduced to a very low value or is cut off so that no signal can sound until the accumulative effect of radiation on ionization chamber 10 is such as to provide a leakage path between the chamber cathode and anode. When the grid potential rises to about the cut-off value, the tube starts to conduct and sound alarm 20. The alarm persists in sounding until the circuit is switched off by switches 30 and 40.

Reference is now made to the test switch 34 shown in Figure 1. In the vigilant position of switch 30, the test switch blade is seen to be connected to one leg of filament 14. The upper or normal contact of switch 34 connects the filament leg 38 to filament energization source 27. In test position the blade of switch 34 connects to contact 37 thereby disconnecting filament leg 38 from filament energization source 27. Contact 37 is connected through resistance 55 to the anode end of chopper energization coil 19. The value of resistance 55 is selected to result in a current through the chopper and transducer equal to the minimum alarm tube current. Thus resistor 55, tube filament 14, anode energization source 22, the alarm device 20, the chopper actuating coil 19 and contact 43 are in series thereby causing the alarm to sound. The process of testing the circuit does not alter the charges on the grid of tube 13 or the cathode 12 of the ionization chamber.

A practical table of values for the parts shown schematically in Figure 1 for sounding an alarm at approximately 100 milliroentgens is as follows.

Part Reference No.:

Tube 13	Raytheon type CK571AX
Capacitor 54	.0001 ufd.
Capacitor 44	.1 ufd.
Capacitor 60	.003 ufd.
Resistor 17	22 megohms.
Resistor 18	1 kilohm
Resistor 59	100 ohms
Resistor 51	1 megohm
Resistor 55	43 kilohms
Resistor 58	27 kilohms
Battery 27	1.3 volts
Battery 22	30 volts

It is thus seen that a simple, compact and reliable radiation alarm has been described. Variations are possible without departing from the spirit of the invention and therefore the invention is intended to be restricted only by the appended claims as interpreted in view of the prior art.

What is claimed is:

1. A compact radioactive alarm device comprising an ionization chamber, a thermionic tube, and a source of potential, said ionization chamber having an anode and a cathode, said thermionic tube having a cathode, control grid and anode, means electrically connecting the chamber cathode to the thermionic tube control grid, means electrically connecting the negative pole of the source of potential to the thermionic tube filament, means electrically connecting the positive pole of said source of potential to the ionization chamber anode and the thermionic tube anode, a first capacitor and a second capacitor each having first and second terminals, means electrically connecting the first terminal of the first capacitor to the thermionic tube grid, first switch means for connecting the second capacitor first terminal to the negative pole of said source of potential and the second terminal of the second capacitor and the second terminal of the first capacitor to the positive pole of the potential source, second switch means disconnecting said first switch means and connecting the first terminal of the second capacitor to a positive portion of the source of potential and the second terminal of the second capacitor to the second terminal of the first capacitor, third switch means for disconnecting the second switch means and connecting the second terminal of the first capacitor to the thermionic tube cathode, whereby the thermionic tube grid is conditioned to a below cut-off negative bias with respect to the cathode, and the ionization chamber cathode is impressed with a negative potential.
2. In a compact radioactive radiation alarm, an ionization chamber having a cathode and an anode, a thermionic tube having at least a cathode, a grid and an anode, means electrically connecting the thermionic tube grid and the ionization chamber cathode, a capacitor having a pair of terminals one of which is electrically connected to the ionization chamber cathode and the thermionic tube grid, a source of potential and a second capacitor, switch means for sequentially connecting said second capacitor first in shunt with said source of potential, second in series with at least a part of said source of potential, said first capacitor and the interelectrode space between the cathode and grid of said thermionic tube, and third, connecting the first capacitor across the thermionic grid and cathode interelectrode space whereby a charge is accumulated on said thermionic tube grid and ionization chamber due to grid rectification in the switch means second position of value exceeding that of the source of potential, and said charge is rendered further negative in the switch means third position, whereby said thermionic tube anode cathode circuit is blocked by said charge, and becomes unblocked only by the dissipation of said charge through conduction of the ionization medium in the ionization chamber by the impingement thereon of ionization radiation.
3. A radiation alarm comprising an ionization chamber, a grid controlled thermionic tube, a source of anode potential and a switch; said ionization chamber having a hollow anode and an internally supported cathode, means connecting the positive pole of the anode potential source to the ionization chamber anode and means connecting the ionization chamber cathode to the grid of said tube, a first capacitor connected to

said ionization chamber cathode, said switch having a first, second, and third position, a second capacitor, means connecting said second capacitor in parallel with said anode potential source in the switch first position, means connecting said capacitor in series with the potential of at least part of said anode potential source with polarities adding and impressing the positive polarity of the combined potential on said first capacitor and through the same on said thermionic tube grid, and the negative polarity of the combined potential on the thermionic tube filament in the switch second position whereby the thermionic tube grid and ionization chamber electrode collects a negative charge due to grid rectification, and means for short circuiting said second capacitor and impressing the potential of said anode potential source with negative polarity of the filament of said grid controlled thermionic tube in the switch third position whereby said thermionic tube is in a state of cut-off due to the negative bound charge on said grid, and conduction of said tube cannot occur unless a leakage path is established between the ionization chamber cathode and anode due to radioactive impingement.

4. A radiation alarm device comprising a thermionic tube, a chopper, a transducer and a source of potential, said thermionic tube having at least cathode, grid and anode, said chopper having an actuating coil and a pair of contacts, means serially connecting the thermionic tube

anode to the chopper actuating coil, the transducer and the positive pole of the source of potential; means electrically connecting the cathode of the thermionic tube to the negative pole of the source of potential; means for impressing a cut-off bias on the grid of the thermionic tube; said chopper contacts being open in the absence of energization of the actuating coil and being connected across the thermionic tube interelectrode space and chopper actuating coil; manual test means including a switch for connecting the anode end of the actuating coil to the negative pole of said source of potential and for connecting the chopper contacts across the actuating coil, whereby excitation of said transducer is evidence of operability of the device.

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