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[54] ALARM RADIATION DOSIMETER WITH IMPROVED INTEGRATING PULSE IONIZATION CHAMBER AND HIGH VOLTAGE SUPPLY

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[56] **References Cited**

UNITED STATES PATENTS

2,883,551 4/1959 Zito..................................250/83.6 P
2,752,508 6/1956 Zito..................................250/83.6 R
3,675,116 7/1972 Israel..................................328/67

OTHER PUBLICATIONS

"High Voltage Supplies" by Thomas Electronics, December 1948, pages 100–103.

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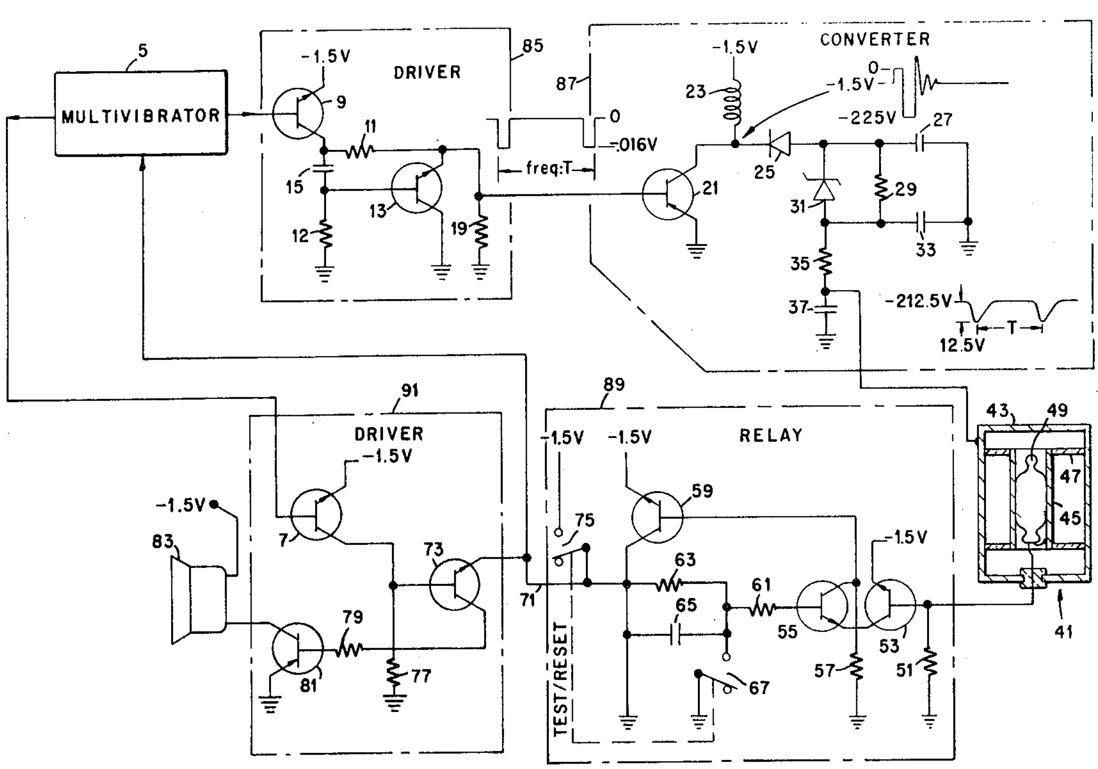
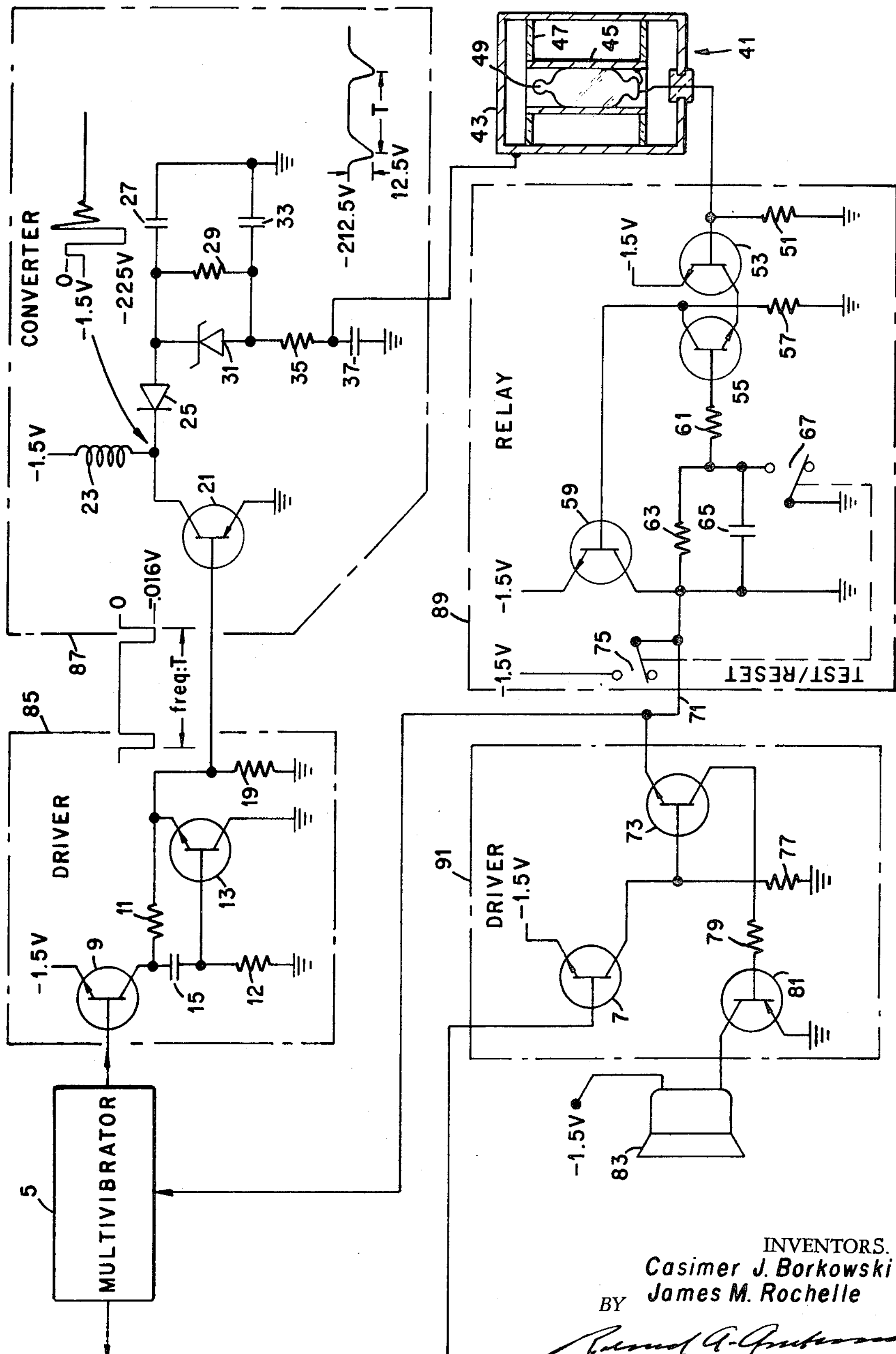
[57] **ABSTRACT**

An alarm dosimeter has been provided which features an improved integrating pulse ionization chamber of the type containing an hermetically sealed gas diode. Improved operation and miniaturization of the chamber are made possible by a ringing choke converter high voltage supply having a ripple-type output that insures discharge of the gas diode.

7 Claims, 1 Drawing Figure





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ALARM RADIATION DOSIMETER WITH IMPROVED INTEGRATING PULSE IONIZATION CHAMBER AND HIGH VOLTAGE SUPPLY

BACKGROUND OF THE INVENTION

The present invention was made during the course of, or under, a contract with the U. S. Atomic Energy Commission.

This invention relates generally to ionization chamber radiation detectors and more particularly to improvements in integrating pulse ionization chamber dosimeters.

An improved recycling ionization chamber radiation detector has been provided which allows the use of low pressure miniaturized gas chambers even at rather low radiation exposure rates. Such a chamber is disclosed in copending U. S. patent application Ser. No. 196,888 for "Digital Radiation Dosimeter With Improved Integrating Pulse Ionization Chamber" filed Nov. 9, 1971 and having a common assignee with the present invention. A discussion of the problems encountered in miniaturizing a gas discharge ionization chamber may be had by referring to the above-referenced copending application whose disclosure is incorporated herein by reference thereto.

It has been shown that a gas discharge ionization chamber can be miniaturized and remain an accurate and reliable detector by the addition of a strobe pulse modulated bias voltage which periodically raises the chamber voltage above a critical voltage level at which a gas diode connected in series with the charge collecting electrode of the chamber fires, rapidly discharging the chamber. The rate at which the gas diode fires is proportional to the intensity of the radiation field in which the chamber is placed.

Although the problems of miniaturizing a gas discharge ionization chamber have been overcome by the addition of strobe pulses to the DC bias voltage, it is further desirable to reduce the size, weight and cost of a dosimeter utilizing the improved gas discharge ionization chamber. It has been the practice in the past to use high voltage power supplies in the form of DC-to-DC converters employing a blocking oscillator type circuit which requires a relatively bulky and expensive transformer having three or four windings, depending upon the particular dosimeter application. Therefore, it will be seen that there is a need for a transformerless converter for converting low DC voltages (1.5 V DC) to higher DC voltages in the range of from 150–250 volts.

SUMMARY OF THE INVENTION

In view of the above need, it is an object of this invention to provide a DC-to-DC converter which does not require the use of a transformer.

Further, it is an object of this invention to provide a transformerless DC-to-DC converter for use with a miniaturized gas discharge ionization chamber which provides strobe pulses superimposed on the high voltage output of the converter without the use of an additional oscillator circuit.

Yet another object of this invention is to provide a miniaturized alarm radiation dosimeter utilizing an integrating pulse ionization chamber.

Briefly, this invention comprises an oscillator in the form of an astable multivibrator, the output of which is formed into pulses in a driver circuit and presented to a

ringing choke converter to thereby provide a high DC voltage from a low voltage cell connected to the choke. Strobe pulses in the form of ripple on the high DC bias voltage are provided by means of a novel filter and pulse shaping circuit connected to the output of the choke. The detection of a predetermined accumulated radiation dose in the chamber, as indicated by an output pulse from the chamber, activates a solid state relay which, in turn, latches in a speaker alarm. The chamber output also increases the frequency of the multivibrator into the audio range which through an output to the speaker maintains the audible alarm until the relay is manually reset.

Other objects and many of the attendant advantages of the invention will be obvious from the following detailed description of the invention taken in conjunction with the accompanying drawing wherein the single FIGURE is a schematic diagram of an alarm dosimeter according to the present invention.

DETAILED DESCRIPTION

Referring now to the drawing, a free-running astable multivibrator 5 that has an input for increasing the frequency has a first output connected to the base of a transistor 7 and a second output connected to the base of another transistor 9. The emitter of transistor 9 is biased with a negative 1.5 V DC. The collector of transistor 9 is connected through a biasing resistor 11 to the emitter of a grounded collector driver transistor 13 and through a pull-up capacitor 15 to the base of transistor 13. The base of transistor 13 is further connected through a biasing resistor 12 to ground and its emitter is further connected jointly to ground through a biasing resistor 19 and to the base of a grounded emitter high voltage switching transistor 21. The collector of transistor 21 is connected jointly to a negative 1.5 V through a miniature choke 23 and to the cathode of a rectifier diode 25. The anode of diode 25 is connected to ground through a filter capacitor 27, to a filter resistor 29, and to the cathode of a first pulse-forming zener diode 31. The anode of diode 31 is connected to the other lead of resistor 29, to ground through a filter capacitor 33, and to one lead of a filter resistor 35. The other lead of resistor 35 is connected jointly to ground through a filter capacitor 37 and to the electrically conductive housing 43 (cathode) of an ionization chamber 41.

The ionization chamber 41 is identical to that disclosed in the above-referenced copending application. Briefly, the chamber 41 consists of an outer electrically conductive gas-tight housing 43 forming the cathode which is filled with an ionizable gas. The electrically conductive anode 45 is co-axially disposed within the housing 43 and held in position by means of insulators 47. A hermetically sealed gas diode 49 is preferably disposed within the chamber environment and may conveniently be placed within a copper tube forming the anode 45.

One lead of the gas diode 49 is connected to the chamber anode and the other lead connects jointly to ground through a load resistor 51 and to the base of an amplifying transistor 53. The emitter of transistor 53 is connected to the negative 1.5 V supply and the collector of transistor 53 is connected to the emitter of a switching transistor 55. The collector of transistor 55 is connected jointly to ground through the biasing resistor **57** and to the base of another switching transistor **59**. The base of transistor **55** is connected through a biasing resistor **61** to one lead of a biasing resistor **63**, a noise suppression capacitor **65** and to the normally open contacts of a switch **67** that is connected to ground. The emitter of transistor **59** is connected to the negative 1.5 V supply and the collector is connected jointly to resistor **63**, capacitor **65**, grounded resistor **69** and an electrical lead **71**. Lead **71** is connected jointly to the frequency increase input of multivibrator **5** and to the emitter of a gating transistor **73** and is further connected to the negative 1.5 V through normally open contacts of a switch **75**. Switches **67** and **75** are mechanically ganged so that they close or open together. The base of transistor **73** is connected jointly to ground through a biasing resistor **77** and to the collector of transistor **7**. Transistor **7** is connected to the negative 1.5 V supply at its emitter. The collector of transistor **73** is connected through a biasing resistor **79** to the base of a grounded emitter speaker driver transistor **81**. A small PM speaker **83** connected between the negative 1.5 V supply and the collector of transistor **81** completes the circuit connection.

It will be noted at this point that the circuit may be broken down into specific functions or parts as depicted by the dotted line enclosed portions. These specific parts will now be pointed out in conjunction with the explanation of the operation of the circuit.

The circuit is activated by the insertion of a 1.5 V battery (not shown) causing the multivibrator **5** to oscillate at a very low frequency below the audio range. These low frequency pulses are applied to a choke switch driver **85** comprised of transistors **9** and **13**. The choke switch driver **85** transforms the multivibrator output into a train of 0.15 msec. duration, 0.6 V negative-going pulses that are applied to the base of transistor **21** included in a ringing choke DC-to-DC converter circuit **87**. Transistor **21** is turned "On" for the duration of the driver pulses allowing energy to be stored in the ringing choke **23**. Transistor **21** is quickly turned "off" with the active pull-up of transistor **13** resulting in the production of a large negative going pulse (~ −225 V) at the collector of transistor **21**.

These negative pulses are then rectified, filtered and regulated to obtain a −200 V chamber bias at the output of the converter **87**. Regulation of the converter output voltage is maintained by the series connected diode **25**. At this point the converter could be used as a 200 V supply for a conventional radiation detector. However, since it is desired to provide strobe pulses superimposed on the chamber bias to enhance the operation of the miniaturized ionization chamber **41**, the strobe pulses may be added by means of the action of zener diode **31**. Assume the reverse breakdown of diode **25** is 200 volts, the reverse breakdown of diode **31** is 25 volts, and the sequence beginning with the cutoff of transistor **21** causing the fast rising negative pulse applied to the cathode of diode **25** to forward bias diode **25** allowing it to conduct the pulse. When the pulse voltage exceeds the voltages on capacitors **27** and **33**, diode **31** also becomes forward biased and the energy stored in choke **23** is transferred to the capacitors raising their voltage to a non-critical maximum which must exceed −225 volts. Now when the collector voltage returns to zero, both diodes break down in the reverse direction and the voltage on capacitor **27** quickly recovers to −200 volts and the voltage on capacitor **33** to −225 volts. Capacitors **27** and **33** are equal in capacitance and are connected by the resistor **29** thereby causing their voltages to come to an equilibrium of −212.5 volts with a time constant of 1 msec. determined by the resistor **29** and capacitors **27** and **33**. The voltage across capacitor **33** thus has the appearance of −212.5 V DC with an additional −12.5 V slowly decaying pulses superimposed (strobe pulses). The final RC filter consisting of resistor **35** and capacitor **37** acts to slow down the pulse rise times and suppress the switching spike. The nominal strobe pulse frequency is 25 to 50 Hz.

This strobed bias supply is applied to the cathode **43** of the gas discharge ionization chamber **41**. When the chamber is placed in a radiation field, the gas diode **49** breaks down or fires at a rate depending upon the intensity of the radiation field as pointed out in the above-referenced copending application. As pointed out therein, the additional strobe pulses insure that the diode **49** fires even though the radiation field intensity is not sufficient to provide an ionization current large enough to deposit charge on the chamber anode to fire the diode **49**. It will be appreciated from a study of the referenced application that the system could come to a point of equilibrium in low strength radiation fields of interest due to miniaturization of the active gas volume of the chamber **41**. In such fields the ionization current or chamber charging current would be equal to the diode current preventing the diode from firing. The strobe pulses periodically raise the voltage to a level that will insure a discharge even under these conditions, thereby making it possible to provide a miniaturized gas discharge ionization chamber which is accurate and reliable for use as a fallout shelter or pocket dosimeter, for example.

When the gas diode **49** breaks down forming the glow discharge, an output pulse is formed that is applied to the base of transistor **53** which is part of a solid state relay circuit **89**. Both transistors **53** and **55** are turned "On" applying the −1.5 V to the base of transistor **59** turning it "On" also. Relay **89** is a latching circuit that applies a negative 1.5 V to lead **71** via transistor **59** when activated. This voltage is held on lead **71** until reset by momentarily closing the test/reset switches **67** and **75**.

Lead **71** is normally at zero volts but the negative 1.5 V potential initiates two actions. First, the voltage is applied to the frequency increase input of multivibrator **5** causing it to be raised to a higher frequency, into the audio range. Second, the −1.5 V gates transistor **73** "On" allowing it to pass the increased frequency via transistor **7** connected to the first output of multivibrator **5**. Transistor **81** is turned on and drives speaker **83** at the audio frequency. An audible alarm is sounded until the switches (**67** and **75**) are manually actuated to the test/reset position and returned to the operating position to deactivate relay **89**. This procedure does not reset the chamber itself, and therefore, an operating cycle can only begin immediately following the completion of the previous cycle (discharge of the chamber). Normally, the chamber would be calibrated to produce a pulse every 50 mR.

Since the chamber output pulse rate is directly proportional to the dose rate and is equivalent to the repetition rate of the sound bursts, an individual would simply search for the quietest location in a given radiation fallout shelter in order to find the safest location in that shelter. Also, a wrist watch with a sweep second hand can be used to determine the absolute dose rate.

Therefore, it will be seen that an alarm dosimeter with an improved miniaturized integrating pulse ionization chamber has been provided which by means of a novel transformerless DC-to-DC converter is more compact and reliable than prior radiation dosimeters.

What is claimed is:

1. In combination with a radiation dosimeter including a gas discharge ionization chamber of the type having a gas diode connected in series with a charge collecting electrode which discharges each time said charge collecting electrode reaches a critical diode firing voltage to provide output pulses which vary in repetition rate depending upon the intensity of the detected radiation field, a strobe pulse modulated DC voltage biasing means, comprising:

- an astable multivibrator for producing fixed amplitude pulses at an output thereof having a predetermined repetition rate;
- a switching means connected to the output of said multivibrator and switched "On" and "Off" in response to the output of said multivibrator;
- a source of DC voltage of substantially lower magnitude than said chamber bias voltage;
- an inductive energy storage means connected in series with said DC voltage source and said switching means for storing energy from said DC source each time said switching means is "On" and providing a voltage surge greater than said chamber bias voltage each time said switching means turns "Off;"
- a capacitance storage means having a time constant substantially larger than that of said inductive storage means;
- a diode connected between said inductive storage means and said capacitive storage means for conducting said inductive voltage surge into said capacitive storage means and having a predetermined reverse breakdown voltage so that a predetermined voltage is stored by said capacitive storage means each time said inductive voltage surge is applied to said capacitance storage means;
- circuit means connecting said capacitive storage means to said ionization chamber; and, a strobe pulse modulating means responsive to said inductive voltage surge applied to said capacitive storage means for providing a predetermined amplitude strobe pulse superimposed on said DC bias voltage each time said inductive device charges said capacitive storage means.

2. The combination of claim 1 wherein said capacitive storage means, said strobe pulse modulating means and said circuit means include a first capacitor connected between ground potential and said diode, a second capacitor having one lead connected to ground potential, a first resistor connected between the ungrounded leads of said first and second capacitors; a zener diode connected in parallel with said first resistor, having a predetermined reverse breakdown voltage value so that said second capacitor is held at a voltage greater than that of said first capacitor following each of said inductive voltage surges so that when said zener diode is nonconductive current flows through said first resistor to equalize the voltages across said first and second capacitors, thereby generating a strobe pulse; and a second resistor connected between the ungrounded lead of said second capacitor and said chamber.

3. The combination of claim 2 wherein said inductive energy storage device is a ringing choke.

4. The combination of claim 2 further including means connected to the output of said chamber and responsive to the output pulses from said chamber for indicating the detection of radiation by said chamber.

5. The combination of claim 4 wherein said indicating means is a resetable audio signaling means which is triggered by each output pulse from said chamber.

6. The combination of claim 5 wherein said astable multivibrator is operable in at least two frequency states, the first state being below the audio frequency range and the other within the audio range and having an output connected to said audio signaling means and a frequency input coupled to the output of said chamber for switching said multivibrator from said first state into a second state in the audio frequency range in response to an output pulse from said chamber, thereby providing an audio frequency signal to said audio signaling means.

7. The combination of claim 6 wherein said audio signaling means includes a solid state relay connected to the output of said chamber and having an output connected to the frequency increase input of said multivibrator for applying a signal thereto following a pulse from the output of said chamber, said relay having a manual reset means for resetting said relay;

- an audio speaker;
- a transistor switching means connected in series with the output of said multivibrator and said speaker and having a control input connected to the output of said relay, whereby each time said chamber generates a pulse indicating a predetermined radiation dose accumulated in said chamber, said speaker is activated at said audio frequency of said multivibrator until said relay is reset.

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