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Sato

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[54] HIGH VOLTAGE GENERATING APPARATUS

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[73] Assignee: **Denki Onkyo Company, Ltd.**, Tokyo, Japan

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April 9, 1970 Japan 45/30326

[52] **U.S. Cl.** .....**323/8,** 310/8, 315/27, 321/2 HF, 323/94 R, 338/20

[51] **Int. Cl.**.....**G05f 1/00**

[58] **Field of Search** .....338/13, 20, 21, 31; 323/8, 323/22 Z, 94 R, 95, 96, 97; 321/2 HF; 317/238; 315/27; 310/8

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Primary Examiner—Gerald Goldberg

Attorney—Chittick, Pfund, Birch, Samuels & Gauthier

[57] **ABSTRACT**

A rod shaped varistor having a high breakdown voltage is connected across a source of high voltage so as to maintain the output voltage at a substantially constant value. The varistor is provided with a ring-shaped terminal for deriving an intermediate voltage which is adjustable by moving the ring-shaped terminal along the varistor.

5 Claims, 8 Drawing Figures

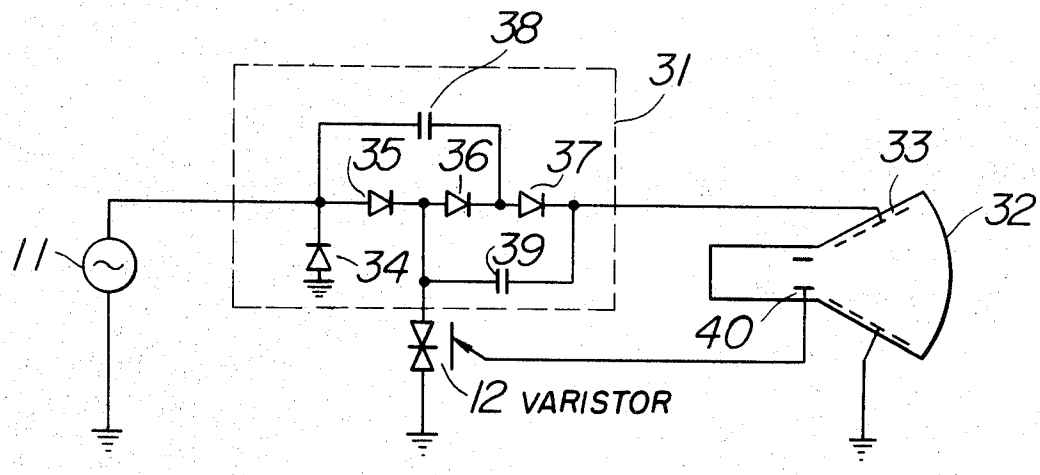


FIG. 1

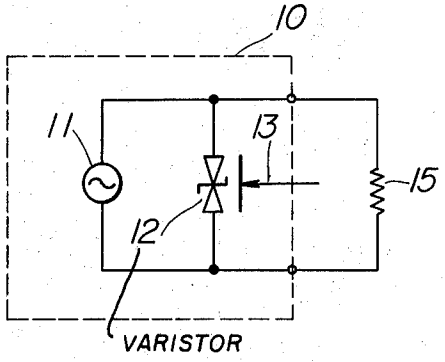


FIG. 2

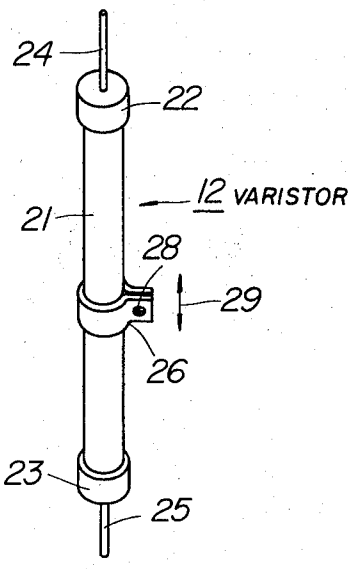


FIG. 3

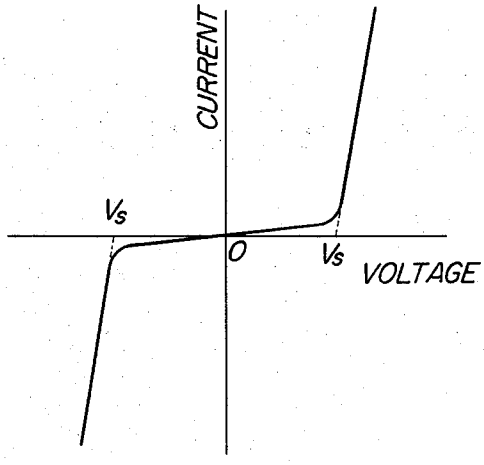
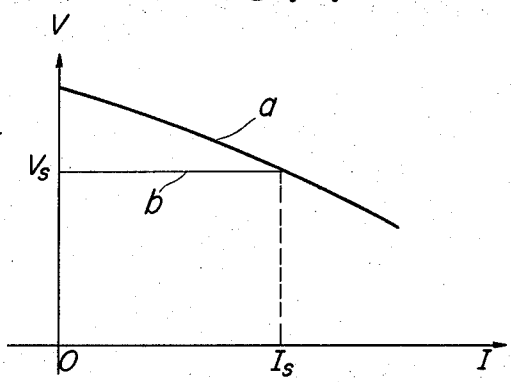


FIG. 4



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FIG. 5

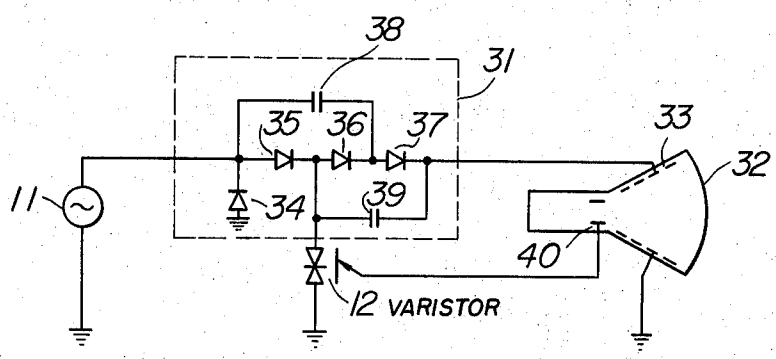
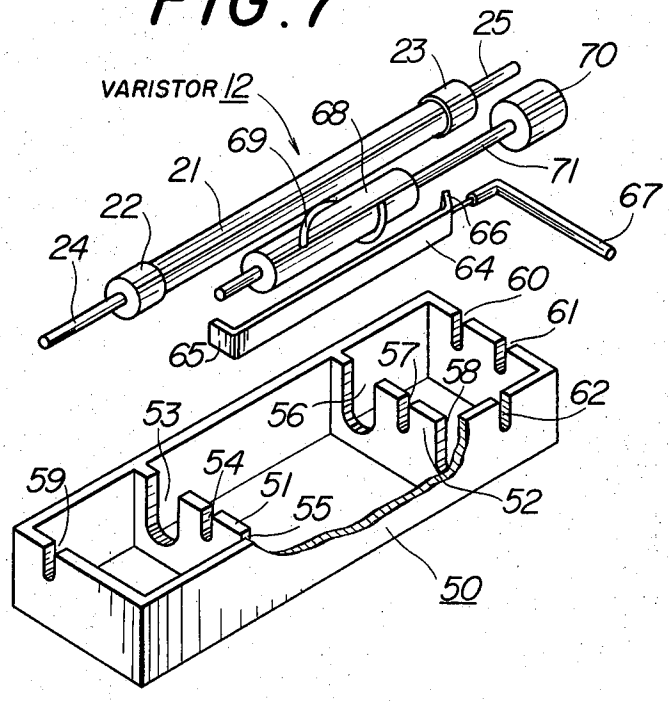


FIG. 7



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FIG. 6

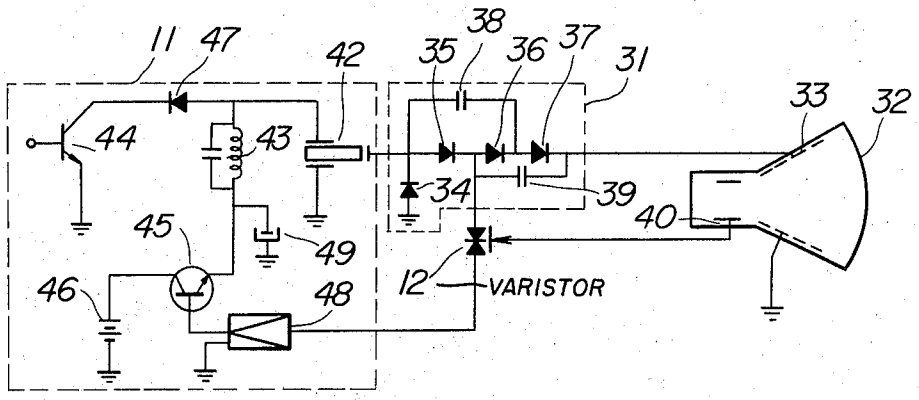
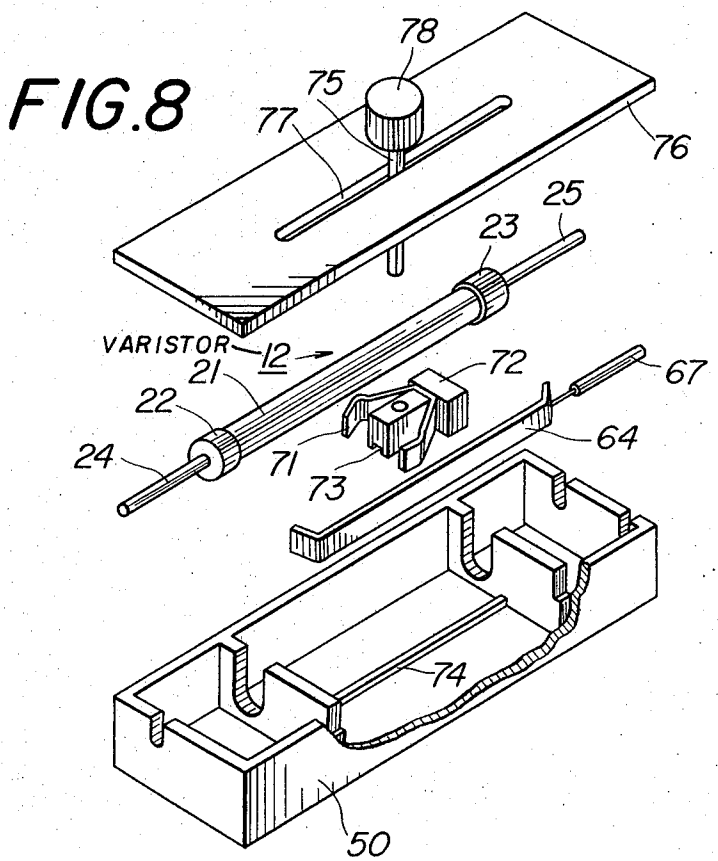


FIG. 8



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HIGH VOLTAGE GENERATING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to high voltage generating apparatus which can be used as a high voltage generating circuit for a television receiving set, for example.

There have been proposed many types of high voltage generating apparatus including those utilizing a transformer or a piezoelectric transducer. However, the voltage regulation of these prior art high voltage generating apparatus is generally poor, in other words, the output voltage varies greatly with variation in the load connected thereto. Accordingly, it is necessary to use an attachment circuit or device which operates to stabilize the output voltage of the high voltage generating apparatus.

It is often necessary to derive intermediate voltages or voltages lower than the rated output voltage from such high voltage generating apparatus. Generally, a resistance potentiometer is used for this purpose. However, where the impedance of the intermediate voltage generating circuit is high such measure scarcely affects the output voltage, whereas where the impedance is low, a substantially large current flows through the intermediate voltage generating circuit. Accordingly, variation in the intermediate voltage causes the output voltage to vary, and variation in the load also reflects in the variation of the intermediate voltage.

It is an object of this invention to provide new and improved high voltage generating apparatus which can produce a stable output voltage as well a stable intermediate voltage lower than the output voltage.

Another object of this invention is to provide an improved high voltage generating apparatus of simplified construction.

Yet another object of this invention is to provide a novel high voltage generating apparatus in which high source voltage is prevented from varying the output voltage of the apparatus as the load varies, thus stabilizing the output voltage and by which it is possible to derive out voltages lower than the output voltage without affecting the stability of the output voltage.

A further object of this invention is to provide a novel high voltage generating apparatus which can provide an intermediate voltage without the necessity of using any additional device.

According to this invention there is provided high voltage generating apparatus comprising a source of high voltage, and a rod shaped nonlinear element of high breakdown voltage, the nonlinear element being connected across the source and being provided with means for deriving an intermediate voltage lower than the output voltage of the high voltage generating apparatus whereby to maintain the output voltage at a substantially constant value.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawing :

FIG. 1 shows a fundamental connection diagram of a high voltage generating apparatus embodying the invention ;

FIG. 2 is a perspective view of a high breakdown voltage nonlinear element utilized in the circuit shown in FIG. 1 ;

FIG. 3 is a plot of a voltage-current characteristic of the nonlinear element shown in FIG. 2 ;

FIG. 4 shows load current-load voltage characteristics of a circuit with and without the nonlinear element ;

FIG. 5 shows a connection diagram of a modified high voltage generating apparatus especially suitable for use in a television receiving set ;

FIG. 6 shows a connection diagram of another embodiment of this invention including means for controlling the source voltage in response to the voltage variation in the output of the source ;

FIG. 7 is an exploded perspective view of essential elements of the novel high voltage generating apparatus ; and

FIG. 8 shows a view similar to FIG. 7 but illustrating a modified sliding contact for deriving the intermediate voltage.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference first to FIG. 1, the high voltage generating apparatus 10 shown therein comprises a source of high AC voltage 11 and a nonlinear element 12 connected across the source 11. As will be described later in more detail, the nonlinear element 12 is provided with a tap 13 for deriving an intermediate voltage. As shown, a load 15 is connected across nonlinear element 12.

As the nonlinear element 12 is used a rod shaped symmetrical varistor of high breakdown voltage prepared by sintering silicon carbide powder, for example. As shown FIG. 2, the nonlinear element 12 comprises a rod shaped body 21 of uniform cross-section, terminals 22 and 23 secured to the opposite ends of the body, lead wires 24 and 25 connected to terminals 22 and 23 and a ring shaped terminal 26 secured at an intermediate position of the body for deriving out an intermediate voltage. The position of the intermediate terminal 26 is adjustable along the length of the body 21 as shown by a double headed arrow 29 by loosening a screw 28.

As shown in FIG. 3, the voltage-current characteristic of this nonlinear element is symmetrical with respect to the origin of a rectangular coordinate. Below a threshold value V_s, the current increases gradually with the increase in voltage but beyond the threshold value the current increases abruptly. In other words, as the voltage impressed upon the nonlinear element increases beyond the threshold value the element becomes conductive thus greatly decreasing its resistance.

In the circuit shown in FIG. 1 so long as the crest value of the voltage of source 11 is lower than the threshold value V_s of the nonlinear element 12, all output of the source is supplied to load 15 but as the crest value increases beyond the threshold value V_s the output from the source will be shunted by the nonlinear element, thus limiting to V_s the maximum value of the voltage supplied to load 15.

Turning now to FIG. 4, in the absence of the nonlinear element 12, the load current (I) - load voltage (V) characteristic will be shown by a curve *a* whereas with the nonlinear element the characteristic will be shown by curve *b*. For a small load current I in a range of from zero to I_s, even when the source voltage is higher than the threshold voltage V_s of the nonlinear

element, the load voltage V will be limited to the threshold voltage V_z. Thus, within a prescribed range of the load, it is possible to obtain a constant output voltage across the opposite terminals of the nonlinear element, thus applying the stabilized constant voltage along the length thereof. For this reason it is also possible to derive a stable constant intermediate voltage from the tap or lead **13** which can be varied according to the position of the ring shaped electrode **26** along the length of the nonlinear element **12**.

FIG. **5** illustrates a modified embodiment of this invention suitable for use in a television receiving set. In this embodiment, the output from the source of high voltage AC **11** is supplied to a rectifier circuit **31** and the rectified output thereof is supplied to the anode electrode **33** of a cathode ray tube **32** of the television receiver. Rectifier circuit **31** comprises four diodes **34** to **37** and two capacitors **38** and **39** connected as shown and is constructed to multiply the voltage by a factor of 4. The nonlinear element **12** is connected between the juncture between diodes **34** and **35** of the rectifier circuit **31** and the ground. The intermediate voltage taken out of the nonlinear element **12** is supplied to the focusing electrode **40** of the cathode ray tube.

Although the nonlinear element **12** may be positioned on either the load side or the input side of the rectifier circuit **31**, where the element is disposed on the load side, as a high voltage is impressed across the element it is necessary to increase the length thereof and hence the physical size of the high voltage generating apparatus. On the other hand, where the nonlinear element is connected to the load side as the voltage impressed across the element is low it is possible to decrease the length thereof. In any case, the use of the nonlinear element provides a stable constant load voltage over a prescribed range of the load current.

FIG. **6** shows another embodiment of the novel high voltage generating apparatus comprising means for controlling the source **11** in accordance with the variation in the output voltage thereof. A piezoelectric transducer is herein used as the source **11**. Elements corresponding to those shown in FIGS. **1** and **3** are designated by the same reference numerals.

The source of high voltage **11** comprises a piezoelectric transducer **42**, a parallel resonance circuit **43** including an inductance and a capacitance, a transistor **44** on the input side of the source **11**, a transistor **45** with its emitter electrode connected to resonance circuit **43**, a source of DC connected to the collector electrode of transistor **45**, a diode **47** connected between the resonance circuit **43** and the collector electrode of transistor **44**, and a DC amplifier **48** connected to a suitable point of the rectifier circuit **31** via nonlinear element **12**. The output of DC amplifier **48** is connected to the base electrode of transistor **45**. Thus, the output voltage of source **11** controls the current flowing through the resonance circuit **43** through the action of the nonlinear element **12** to control the driving input to the piezoelectric transducer thereby varying the output voltage of the piezoelectric transducer to compensate for any variation in the source voltage.

FIG. **7** shows an exploded view of essential elements of the novel high voltage generating apparatus. The interior of a casing **50** of a synthetic resin, polypropyrene resin, for example, is divided into three compartments by insulating partition walls **51** and **52**. The shorter side walls of the casing are formed with notched **59**, **60** and **61** whereas partition walls **51** and **52** are formed with notches **53** to **58**. One of the longer side wall is provided with a notch **62**. A strip shaped terminal **64** has bent ends and a lead wire **67** is connected to one of the ends. A conductor **69** is helically wound about a rotary body **68** having an operating knob **70** connected thereto by means of a shaft **71**.

When assembling the element, terminal strip **64** is disposed in notches **55** and **58**, shaft **71** of the rotary body in notches **54** and **57** and nonlinear element **12** in notches **53** and **60** in such a manner that helical conductor **69** engages the periphery of the nonlinear element and the terminal strip at the same time, and that the rotary body can be moved in the longitudinal direction while maintaining electrical contacts between it and the nonlinear element and the terminal strip.

When the knob **70** on the outside of casing **50** is rotated the contact points between rotary body **68** and nonlinear element **12** are varied gradually to vary the intermediate voltage appearing at lead wire **67**. When desired a suitable lid may be provided for the casing **50**.

FIG. **8** shows a perspective exploded view of another example of the novel high voltage generating apparatus. Elements identical to or functioning similarly to those shown in FIG. **3** are designated by the same reference numerals. This embodiment is different from that shown in FIG. **7** in that a sliding mechanism is used to derive out the intermediate voltage. More particularly a longitudinal rib **74** is provided on the inner bottom wall of the casing **50** to receive a guide groove **73** on the lower surface of a movable block **72** disposed to move between nonlinear element **12** and terminal strip **64**. A generally U shaped sliding contact **71** is secured to the movable block **72** to engage its legs against nonlinear element **12** and terminal strip **64**. The block **72** and hence the sliding contact **71** are moved longitudinally of the casing by means of a knob **78** secured to the upper end of a rod **75** extending through a longitudinal slot **77** of a lid **76**, the slot **77** being formed above rib **74**. Thus, by moving knob **78** along slot **77**, the intermediate voltage appearing at lead wire **67** can be varied to any desired value. With this construction, since the movable block **72** is guided by the rib **74**, the relative position between the movable block, the nonlinear element and the terminal strip **64** can be always assured without any lateral movement.

It is to be understood that the invention is not limited to the particular embodiments illustrated and that many changes and modifications will be obvious to one skilled in the art. Thus, for example, where direct current is to be supplied to the load the nonlinear element may have an anasymmetical characteristic.

What is claimed is:

1. High voltage generating apparatus comprising a source of high AC voltage, a voltage step-up rectifier circuit connected across said source and comprising a plurality of serially-connected diodes, and a rod shaped nonlinear element of high breakdown voltage, said nonlinear element being connected to said rectifier circuit at a junction between two adjacent ones of said diodes, and having means for deriving an intermediate voltage lower than the output voltage of said rectifier circuit, said deriving means being adapted to be ad-

justable positioned and fixed along said rod-shaped element to variably set said intermediate voltage.

2. The high voltage generating apparatus according to claim 1 wherein the output voltage of said rectifier circuit is supplied to the anode electrode of a cathode ray tube of a television receiving set and said intermediate voltage derived out from said nonlinear element is supplied to the focusing electrode of said cathode ray tube.

3. High voltage generating apparatus comprising a voltage controllable source of high voltage, and a rod shaped nonlinear element connected to said source to detect the variation in the output voltage of said source and, in response, to provide an output voltage for controlling said source, said nonlinear element being provided with means for deriving out an intermediate voltage which is lower than the voltage impressed across said nonlinear element, and means, responsive to the output voltage of said nonlinear element, for controlling said source to maintain said output voltage at a substantially constant value.

4. The high voltage generating apparatus according to claim 3 wherein said source includes a piezoelectric transducer, a parallel resonance circuit for driving said piezoelectric transducer, and a transistor energized by said nonlinear element for controlling the current flowing through said parallel resonance circuit.

5. High voltage generating apparatus comprising a source of high voltage, and a rod shaped nonlinear element having high breakdown voltage, said nonlinear element being connected across said source and being provided with means for deriving out an intermediate voltage lower than the output voltage of said source, said deriving means comprising a terminal strip disposed in parallel with said nonlinear element, a rotatable cylindrical body, a conductor helically wrapped about the periphery of said cylindrical body, said conductor electrically bridging said nonlinear element and said terminal strip, and means for rotating said cylindrical body to move said helically wrapped conductor in the longitudinal direction along said nonlinear element so as to vary said intermediate voltage.

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