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AUTOMATIC VOLTAGE CONTROL APPARATUS

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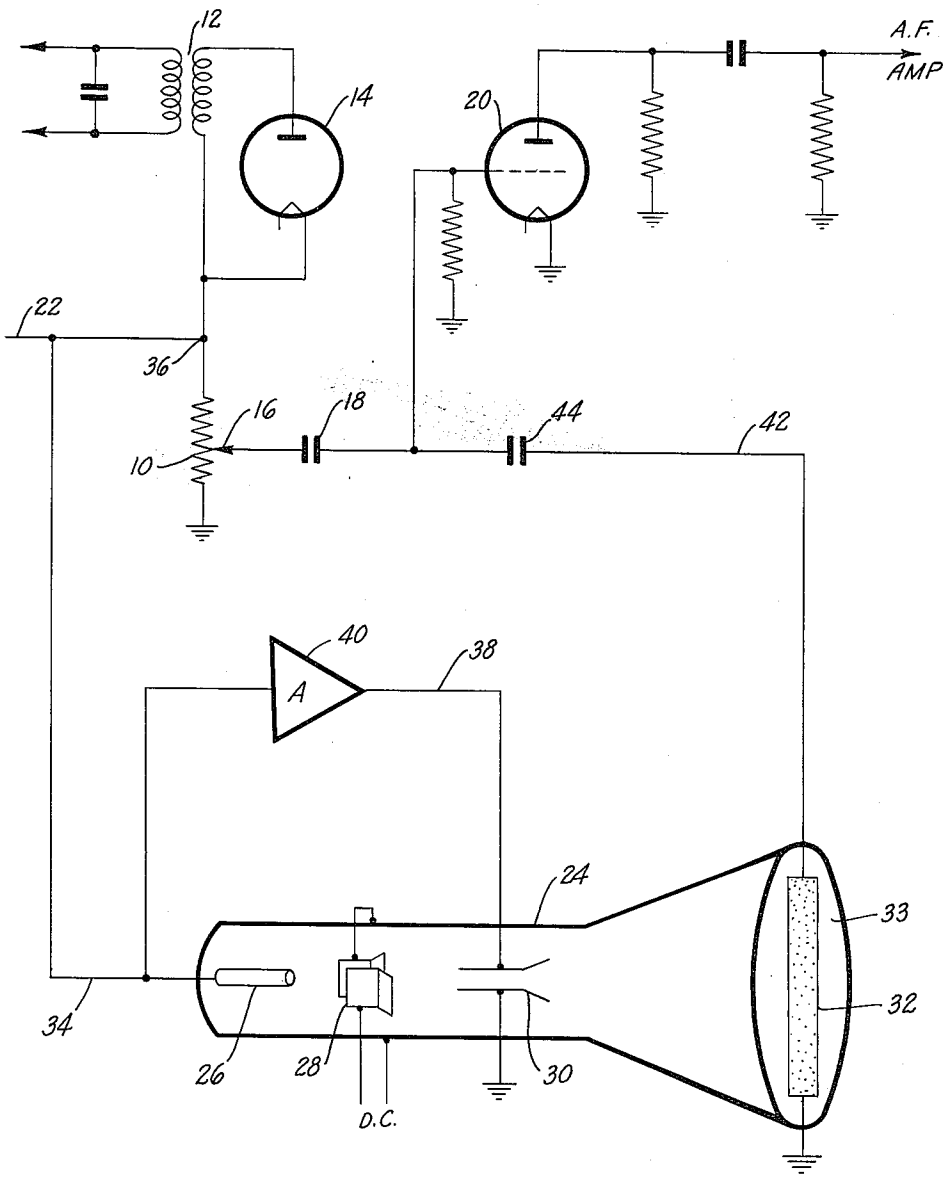

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AUTOMATIC VOLTAGE CONTROL APPARATUS

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This invention may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to electronic apparatus and, more particularly, to apparatus for controlling circuit voltages.

The need for controlling circuit voltages perhaps has been most pronounced and obvious in radio receiver circuits which, unless provided with some automatic volume control (AVC), will respond to the power of the many transmitting stations to successively blast forth the signal or unduly suppress it as the broadcast bands are swept. In addition, there has been much effort expended in providing sufficiently rapid automatic volume control circuits at the transmitting end of the broadcast where variations in human voices or the effect of differing musical instruments and other sounds should be modulated in accordance with a desired noise level. Further, even beyond the broadcast field, there are perhaps even more vital uses for effective and sensitive control circuits, such uses including, for example, the minutely accurate control needed for electronic computers, or counters or scalers such as are used in television.

One of the most common automatic volume control systems utilizes a rectified D. C. voltage developed by the received input signal voltage to vary the bias on the grids of the R. F. or I. F. amplifier tubes. Other automatic volume controls utilize a diode crystal bleeder system to partially short to ground the excess signal voltage. However, it has been found that although the above systems operate effectively at a given setting of voltage, they are limited in flexibility to the extent of being unable to operate accurately over wide ranges of voltage variations such as may be encountered in sudden static discharges and quick voltage changes. For these reasons, as well as others, these simpler AVC arrangements have not been found adequate for automatically controlling or modulating speaker systems and, instead, where fine control is considered of sufficient importance, the art has been forced to turn to a complicated plurality of circuits provided with manual controls intended to permit a broadcast monitor to achieve whatever effect he may desire. Such means, it will be recognized, are not automatic in the sense of eliminating manual controls and, of course, a great deal of their effectiveness depends upon the personal skill of the monitor.

Accordingly, a principal object of this invention is to provide simple and inexpensive apparatus which will control instantly and automatically wide variations in the power input of a circuit.

Another object is to provide such a control at a preselected and adjustable level.

A further object is to provide an automatic voltage control that is sufficiently sensitive to effectively maintain a minutely accurate voltage in an instrument circuit, such as a computer, as well as control that is sufficiently

rapid in its automatic response to modulate wide variations in voltage ranges.

Other objects will become apparent from the detailed description and the accompanying drawing.

In accordance with the invention, the apparatus includes a resistance element arranged in the path of an electron beam, the beam, in turn, being variable in response to input power variations so as to modify the effective value of the resistance and consequently the effective voltage flowing out of the circuit. In the preferred embodiment the apparatus is used to control the volume in a radio receiver for preventing any voltage variations from reaching the A. F. amplifying circuits, and, most suitably, the beam resistance is supplemented by the use of another resistance which is the conventional manually adjustable volume control employed in most AVC circuits, while the beam itself is produced by a common cathode ray tube. The two resistance elements preferably are connected in a parallel grounded circuit while the electron beam gun with its conventional beam deflector plates both are connected to the negative side of the manual volume control, which is the manual adjusable resistor. Any variations in the signal voltage from a predetermined selected level will change the position of beam impingement and vary the resistance value in the tube resistance element. It is obvious that the amount of resistance between the impingement point and ground will determine the total resistance in the circuit. When the signal voltage increases above a selected value for any cause, electron beam impingement is moved instantly from its normal location on the tube resistance element toward the ground end to reduce the resistance value and permit the excess current in the circuit to be bled to ground, thereby restoring the signal voltage to the selected value. Conversely, when the signal voltage falls below the selected value, beam impingement is moved in an opposite direction from its normal location on the resistance element to increase the resistance, reduce the current being bled to ground, and maintain the signal voltage level. This type of apparatus for varying the resistance in the circuit by an electron beam may be aptly referred to as an electronic potentiometer.

In the drawing the only figure is a perspective view diagrammatically illustrating the control apparatus of this invention.

Referring to the figure, reference character **10** designates a conventional manually adjustable volume control of a radio receiver, one end of the volume control being grounded and the other joined to one side of an I. F. or R. F. signal transformer **12**. The transformer is connected across a diode tube **14** which rectifies the I. F. or R. T. signal voltage for A. F. application. A tap **16** of volume control **10** is connected through an isolation condenser **18** to the grid of a triode tube **20**, which tube represents the first stage of A. F. amplification. In some conventional circuits an automatic volume control is obtained by a feed-back of the signal in the conductor **22** to the I. F. or R. F. signal amplifier tubes through a time-delay circuit, not shown. The above circuit is well known in the art and is illustrative of only one type of circuit in which a voltage can be regulated by the apparatus of this invention.

The novel voltage regulating apparatus includes a cathode-ray tube **24** having an electron gun **26**, a beam control means such as sets of horizontal and vertical beam deflecting plates **28** and **30** respectively, and a resistance element **32** arranged as a target in the path of the electron beam. Electron gun **26** may be of a common design connected by conductor **34** to the negative end of volume control **10** at point **36**. Horizontal deflecting plates **28** are connected across a constant D. C.

voltage to confine the electron beam within horizontal limits, and vertical deflecting plates **30** are connected by conductor **38** to the signal voltage. An amplifier **40** may be provided in the vertical plate circuit if additional signal voltage amplification is needed for proper cathode tube operation. Thus, variations in signal voltages applied to the vertical deflecting plates will cause the generated electron beam to move longitudinally along resistance element **32** and the changing impinging point to the beam will vary the resistance in the circuit, as well as the signal voltage in a manner presently to be described. Resistance element **32** may be in the shape of a rectangular or elongate strip formed of a thin coating or layer of suitable resistance material, and applied to the interior surface of the tube front wall **33**, with or without the screen, or otherwise mounted on a suitable support within tube **24**. The ends of resistance element **32** are provided with terminals on the exterior of the tube, one terminal may be connected to ground and the other terminal may be connected by conductor **42** to the grid of amplifier tube **20** through an isolation condenser **44**. Conductor **42** is desirable at least to prevent the build up of static charges at the ungrounded end of the resistance and condenser **44** also is most desirable to prevent thumping noises which otherwise might be attributed to a bleeding-off from the grid of the A. F. amplifier through the grounded resistance.

In the illustrated embodiment, resistance element **32**, preferably, is connected in parallel with volume control **10** so that the effective resistance of such a circuit becomes the product of the resistances divided by their sum. Thus, by varying the resistance value of resistance element **32** by means of the electron beam, the effective resistance of the circuit may be varied automatically in accordance with changes of signal voltage. After the control apparatus is set by the operator, it will instantly and automatically adjust itself to hold the voltage value selected. When a delayed correction action is desired, usually necessary in audio frequency amplifying units as in the preferred embodiment, a conventional delay system, not shown, may be incorporated to prevent the instantaneous action of the regulator from smoothing out the audio modulation voltages. By using a visual screen in conjunction with the resistance strip in the cathode-ray tube, or by use of meters, the initial position of the electron beam may be set and adjusted by the operator with reference to resistance strip **32**. Since the beam may necessarily remain in one position on resistance strip **32** for extended periods of time, the beam preferably should be adjusted to be out of focus so as to spread the beam contact point over a greater area of the resistance strip to prevent resistance disintegration.

In operation, after the apparatus is adjusted by the operator to a selected signal voltage, the rectified D. C. audio signal voltage is applied to the cathode-ray tube where any signal voltage is regulated before it reaches the audio amplifier circuit, and finally, in the case of a receiver installation the usual speaker or headphones. As long as the signal voltage across volume control **10** does not fluctuate, the electron beam impinges at the same point on the resistance strip and the effective resistance of the circuit remains at a fixed valve with a certain portion of the current being bled to ground. When the signal voltage increases above the pre-selected level for any reason, the electron beam in the cathode-ray tube is deflected downward (toward the ground connection) to reduce the resistance in resistance strip **32** between the impinging beam and ground. This decrease in resistance, which reduces the effective resistance of the circuit, enables the excess current in the increased signal

to bleed off to ground through resistance strip **32** and instantly restores the signal voltage to the selected value. The position of the beam will remain in the deflected position to regulate the increased signal voltage until the cause for the increased signal is no longer present, at which time the apparatus is restored to its normal position. When the signal voltage falls below the preset level, the electron beam is deflected upward on resistance strip **32** from the normal position of the beam (in a direction away from the ground connection) to increase the resistance and reduce the current being bled to the ground, which increases the current in the circuit to restore the signal voltage to the predetermined level. Upon restoration of the signal voltage, the beam returns to its normal position and remains in such condition until the next voltage fluctuation. In this manner, the apparatus functions as an electronic potentiometer and operates automatically to counter-act variations in the audio signal voltage to provide an automatic volume control.

The electronic potentiometer or control apparatus is not to be construed as being limited in use to an automatic volume control circuit for it is apparent that the apparatus may be used to regulate the output voltage of any power supply. The use of such an electronic potentiometer would be valuable for controlling voltages in computer and counting circuits. In addition, the corrective action of the electronic potentiometer is sufficiently fast to correct the voltage fluctuations in television tube circuits caused by static, auto ignition and other disturbing changes.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

1. Apparatus for automatically controlling circuit input power, the apparatus including an elongate resistance element, and electron gun disposed to direct an electron beam onto said element, deflector plates for sweeping said beam along said element, and a second manually-variable resistance element electrically connected to said circuit input, said gun and deflector plates being electrically coupled to said variable resistance element and said variable resistance element being connected in parallel with said first resistance element, whereby said deflector plates sweep said beam along said first resistance element in conformity with said circuit input for varying the effective resistance in said apparatus.

2. Apparatus for automatically controlling an audio signal voltage, the apparatus including an elongate resistance element, an amplifier tube electrically connected to said element, an electron gun disposed to direct an electron beam onto said element, deflector plates for sweeping said beam along said element, and a second manually-variable resistance element electrically connected to said circuit input, said gun and deflector plates being electrically coupled to said variable resistance element and said variable resistance element being connected in parallel with said first resistance element, whereby said deflector plates sweep said beam along said first resistance element in conformity with said audio signal voltage for varying the effective resistance in said apparatus.

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