

April 8, 1952

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2,591,842

ELECTRON DISCHARGE APPARATUS

Filed July 6, 1949

2 SHEETS—SHEET 1

FIG. 1

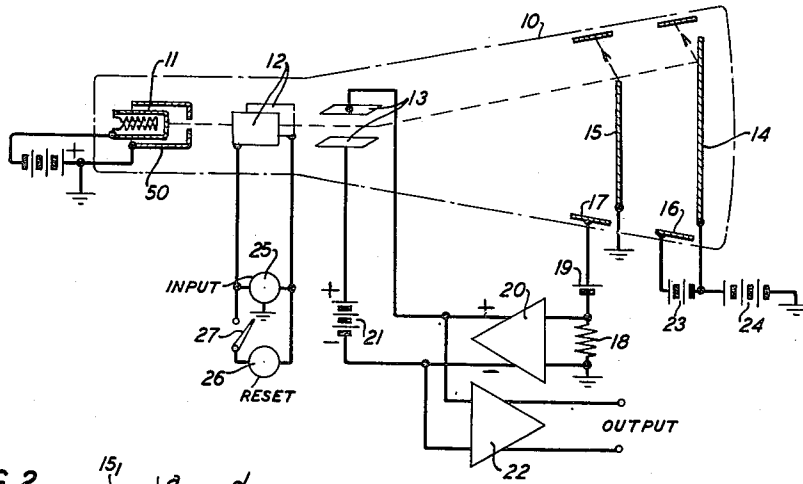


FIG. 2

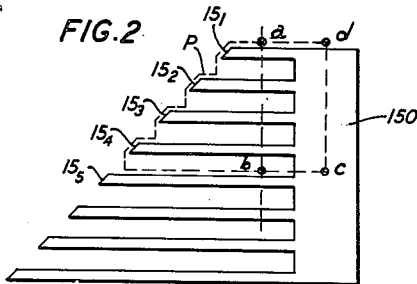


FIG. 4

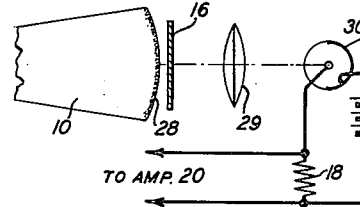
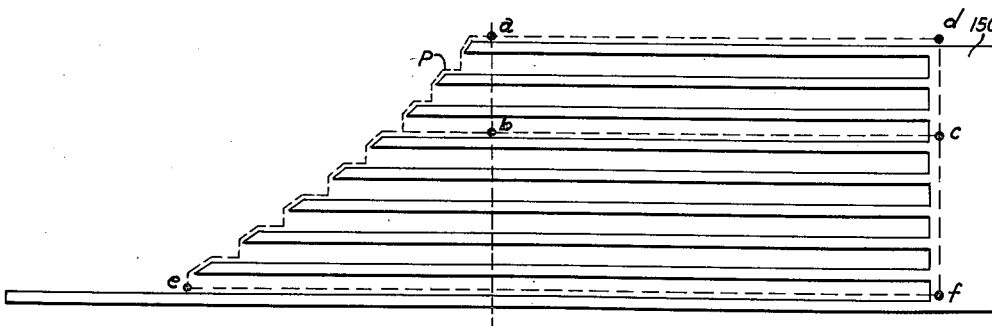


FIG. 3



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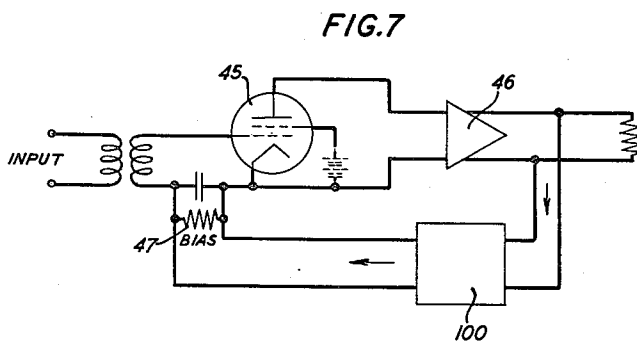
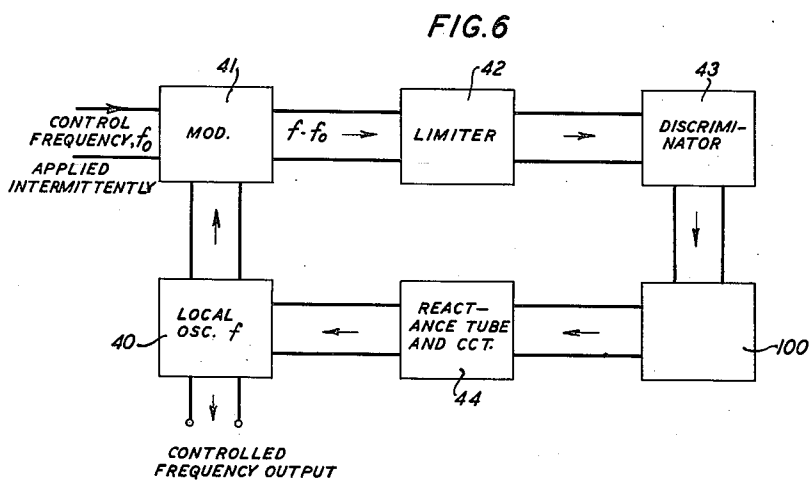
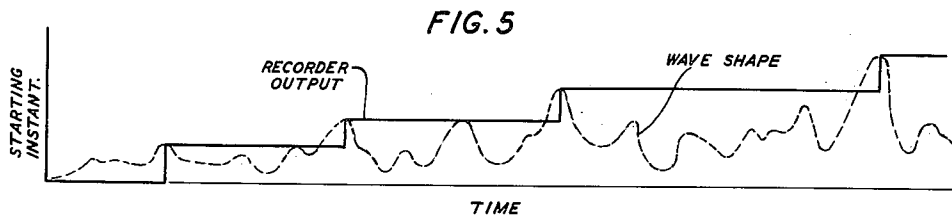
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ELECTRON DISCHARGE APPARATUS

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2 SHEETS—SHEET 2



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ELECTRON DISCHARGE APPARATUS

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9 Claims. (Cl. 315-12)

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This invention relates to electron discharge apparatus and more particularly to such apparatus of the general type disclosed in Patent 2,417,450, granted March 18, 1947, to R. W. Sears and including a cathode ray device wherein control of the beam position in one coordinate direction is effected in part by a feed-back coupling between an auxiliary electrode or mask and the system for deflecting the beam in this direction.

One general object of this invention is to facilitate the conversion of varying signals into an output or control signal of amplitude accurately indicative of the peak amplitude of the varying signals.

More specifically, one object of this invention is to produce a persisting or permanent output or control voltage in apparatus of the type above referred to of amplitude proportional to the peak value of input signals applied in a given period of time.

In general, devices of the type disclosed in the Sears patent, above identified, and to which this invention pertains, comprise a target, an electron gun for projecting a concentrated stream to the target, deflection elements for controlling the position of the beam in two coordinate directions and a mask or auxiliary electrode between the gun and the target and coupled in feedback relation to one of the deflecting elements. The feedback coupling is such that when the beam is incident upon an edge of the mask or auxiliary electrode the deflecting forces acting upon the beam in one direction are balanced whereby the beam is held in equilibrium and in the incident position. The beam may be stepped in this one direction by deflecting it in the second coordinate direction out of impinging relation with the mask or auxiliary electrode.

In accordance with one feature of this invention, in a device of this general construction, the mask or auxiliary electrode is so constructed and arranged that the beam position in one coordinate direction is determined by the maximum amplitude of beam deflection in the second coordinate direction in a prescribed period of time. The beam position in the first direction determines the feedback signal and the latter produces a voltage proportional to the peak amplitude of the signals causing the deflection in the second direction. This voltage may be utilized as the output signal of the apparatus.

The invention and the above-noted and other features above will be understood more clearly and fully from the following detailed description

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with reference to the accompanying drawing in which:

Fig. 1 is in part a diagram of a cathode ray device and in part a circuit schematic of electron discharge apparatus illustrative of one embodiment of this invention;

Fig. 2 is a plan or face view of the mask or auxiliary electrode included in the device of Fig. 1;

Fig. 3 is a view similar to Fig. 2 illustrating another form of mask or auxiliary electrode which is particularly suitable for use in devices wherein the input signals are alternating in form;

Fig. 4 is a diagram illustrating a modification of the apparatus illustrated in Fig. 1 wherein the mask is mounted exteriorly of the device and the feedback coupling is by way of a photoelectric cell;

Fig. 5 is a graph showing the form of a typical output signal obtainable with the apparatus of Fig. 1 for a varying input signal of the form indicated;

Fig. 6 is a block diagram showing one manner in which apparatus constructed in accordance with this invention may be utilized to effect automatic frequency control; and

Fig. 7 illustrates one manner in which apparatus constructed in accordance with this invention may be utilized to effect volume control upon a peak signal basis.

Referring now to the drawing, the apparatus illustrated in Fig. 1 includes a cathode ray device comprising an evacuated envelope 10 having therein at one end an electron gun which may be of known construction and for simplicity of illustration is shown as comprising an indirectly heated cathode 11 and an accelerating electrode 50. The electron gun projects a concentrated electron beam between two pairs of deflector plates 12 and 13 mounted in space quadrature, and toward a target or terminal electrode 14 mounted at the opposite end of the envelope 10. Intermediate the deflector plates 12 and 13 and the target electrode 14 is a mask or auxiliary electrode 15 of a construction to be described in detail hereinafter. Advantageously, the mask or auxiliary electrode or the face thereof towards the electron gun is of a material having a secondary electron emission coefficient of greater than unity. Secondary electrons emanating from the mask or auxiliary electrode are drawn to a cylindrical collector electrode 17 which is maintained positive with respect to the mask 15 by a source 19 having in series therewith a resistor 18. Any secondary electrons which emanate from the

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target 14 are collected by a cylindrical collector electrode 15 biased positive with respect to the target by a source 23. The target 14 is maintained positive with respect to the electron gun by a source 24.

The collector electrode 17 is connected in the input circuit of an amplifier 20, the output of which is connected across the deflector plates 13. Included in the circuit between the plates 13 and the amplifier 20 is a source 21 for applying a bias between the plates 13. An output amplifier 22 has its input side connected across the output of the amplifier 20.

A source 25 of input signals, which may be varying direct current or alternating current, is connected across the deflector plates 12. Also connected across these deflector plates is a reset source 26 in series with a switch 27, the function of which will appear presently.

The mask or auxiliary electrode in one form particularly suitable for use in devices when the input signals are varying direct current is illustrated in Fig. 2. It comprises an imperforate base portion 150 extending parallel to the deflecting field between the deflector plates 13 and a plurality of parallel, equally spaced, fingers 151, 152, etc., extending parallel to the deflecting fields between the plates 12. As illustrated in Fig. 2 the fingers are of uniformly increasing length considered from top to bottom of the row of fingers.

In the operation of the device, the normal potential between the deflector plates 13 is made such that in the absence of an input signal from the source 25 the electron beam is in grazing incidence upon the upper edge in Fig. 2 of the uppermost finger of the mask 15 at a position such as indicated at *a* in Fig. 2. The source 21 and amplifier 20 are poled so that the output potential of the amplifier is in opposition to that of the source 21. Thus, for example, in the device illustrated in Fig. 1, the polarities are such that the source 21 tends to move the beam downwardly in this figure and the output voltage of the amplifier 20 is in the sense to tend to deflect the beam upwardly. When the beam is in grazing incidence with an edge of one of the fingers of the mask 15, secondary electrons flow to the collector electrode 17 thereby resulting in an input voltage across the resistor 18. This voltage is such that it results in the amplifier output voltage just balancing the deflecting force due to the source 21 whereby the beam is in equilibrium position. For example, if the beam is in grazing incidence upon the uppermost finger 151 in Fig. 2, the two components of deflecting force between the plates 13 will balance each other and the beam will remain at position *a*.

If, now, a signal potential is applied between the deflector plates 12 in the sense to deflect the beam to the left in Fig. 2, the beam will pass beyond the left-hand edge of the finger 151 and out of contact with the mask 15. The equilibrium condition is thus disturbed and the beam will fall to the next lower finger 152, the beam path being indicated by the dotted line *P*. The finger to which the beam will fall will be dependent, of course, upon the amplitude of the input signal. For example, if the amplitude of this signal is such that the beam is deflected beyond the left-hand end of the finger 154 it will fall to the upper edge of the finger 155. Upon the cessation of the input pulse the beam will move to the right in grazing incidence with the upper edge of finger 155 and come to rest at position *b*, which is directly below position *a*.

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Now, if a succeeding pulse of amplitude less than the first pulse, that is the one resulting in shifting of the beam from position *a* to position *b*, is applied between the deflector plates 12, the beam will move along the upper edge of the finger 155 first to the left in Fig. 2 and then to the right returning to the equilibrium position at *b* upon cessation of this pulse. If, however, a subsequent pulse is of amplitude sufficient to drive the beam beyond the left-hand edge of the finger 155, the beam will fall to a lower finger and finally reach an equilibrium position directly below positions *a* and *b*. Thus, once the beam has been deflected to an equilibrium position by an input pulse, it will remain at that position until a second pulse of greater amplitude than the first is applied between the deflector plates 12. The output of the amplifier 22, therefore, is a voltage proportional to the peak amplitude of the input signals applied to the deflector plates 12 in any prescribed period of time.

If it is desired to reset the apparatus at any time, that is, to return the beam to its initial position *a*, a reset pulse from the source 26 is applied between the deflector plates 12 by closing the key 27, the pulse polarity being such as to deflect the beam to the right in Fig. 2 so that it passes to the base portion 150, for example, to the position *c* indicated in Fig. 2. When the beam impinges upon the base portion 150 the secondary electron current from mask 15 to collector 17 is sufficient to result in an output voltage of the amplifier 20 adequate to override the deflecting force due to the source 21. Consequently, the beam rises, say from *c* to *d* in Fig. 2, until it is in grazing incidence upon the upper edge of the mask. Upon termination of the reset pulse the beam returns to its initial equilibrium position at *a*.

In devices particularly suitable in cases where the input signals are alternating current, that is, are substantially symmetrical about a zero axis, the mask 15 may take the form illustrated in Fig. 3. As is evident, the construction illustrated in Fig. 3 is similar to that illustrated in Fig. 2 with one difference that the fingers are longer to allow swinging of the beam to the right without impinging upon the imperforate base portion 150. Assume that an alternating current signal of sufficient amplitude to deflect the beam to the left in Fig. 3 beyond the left-hand end of the third finger from the top is applied between the deflector plates 12. On the positive half-cycle the beam will be moved from position *a* to position *b*. On the negative half-cycle of the signal, the beam will ride along the upper edge of the fourth from the top finger, first to the right and then back to position *b*. The beam will remain upon the upper edge of the fourth finger from the top for any other applied signals of lesser amplitude than the first one. If, however, a succeeding signal is of greater amplitude sufficient to drive the beam to the left beyond the left-hand end of the fourth finger from the top in Fig. 3, the beam will move downwardly to a lower finger and come to an equilibrium position on the upper edge of this finger at a position below and aligned with positions *a* and *b*.

The beam may be reset to position *a* in one way by applying between the deflector plates 12 a pulse sufficient to drive it into impinging relation upon the base portion 150. For example, the beam may be reset from position *b* to position *a* by applying a direct current pulse to the plates 12 sufficient to deflect the beam from *b* to

c whereupon it will rise to position d in grazing incidence on the upper edge of the uppermost finger and return to position a. It may be reset also in another way by applying between the plates 12 an alternating current pulse sufficient to drive the beam to the left so that it drops to position to the left of e on one half-cycle of the pulse and on the other half-cycle moves to position f, thence upward to d and back to the initial position a.

It is to be noted that a variety of relations between input pulses applied between the deflector plates 12 and output voltages obtained from the amplifier 22 may be realized. For example, if, as in the form illustrated in Fig. 2, the increase in length of successive fingers is linear, a linear relation will obtain between the input and output voltages. However if, as illustrated in Fig. 3, the lengths of the fingers as measured from the line passing through a and b, for example, are in other than linear relation, the relation between the input and output voltages similarly will be other than linear. For example, the lengths of the fingers may be made such that a logarithmic ratio between input and output voltages obtains.

The invention may be embodied also in devices wherein the mask 15 is exterior to the envelope 10. For example, as illustrated in Fig. 4, the mask 15 may be opposite or on the end wall of the envelope and the latter may have a fluorescent coating 28 thereon. Light from this coating when impinged by the beam, passes by the mask and is focused by a lens 29 upon a photoelectric cell 30. The cell 30 is connected across the input resistor 18 for the amplifier 20. The potential developed across the resistor 18 will be dependent upon the position of the beam relative to the fingers of the mask 15 so that the beam will be directed to and held in equilibrium position in the same manner as in the device illustrated in Fig. 1 and described heretofore.

In the devices thus far described it will be appreciated that input signals of varying amplitudes are converted into an output signal proportional to or indicative of the peak amplitude of the input signal in a prescribed period of time. Thus, the devices are particularly suitable for use as peak voltmeters and in other applications wherein a constant, persistent voltage over a long period of time is desired.

The device may be utilized advantageously in signal level distribution recorders, the output of amplifier 22 being applied to the recorder. Illustrative of the record obtained in such case is the solid line shown in Fig. 5. As is clear from this figure, the recorder output registers only the peak amplitudes of signals, one form of which is illustrated by the dotted curve in the figure, in prescribed time periods.

The devices may be utilized also to provide automatic frequency control, for example of oscillators of radio transmitters and receivers. The general arrangement for such a system is illustrated in Fig. 6. The control frequency is applied intermittently to a modulator 41, the output of which is passed to a limiter 42 and thence through a discriminator 43 to the control device 100, which may be of the organization illustrated in Fig. 1 and heretofore described. The device 100 produces an output voltage of amplitude proportional to the control frequency. This output is passed through a reactance tube and circuit 44 to the local oscillator 40. As has been pointed out hereinabove, the output voltage of the device 100 remains constant so that the frequency of the

local oscillator 40 likewise is maintained constant.

The invention may be utilized also in volume control circuits for adjusting systems, such as a radio transmitter or a telephone system, to prevent overloading by peak signals. As illustrated in Fig. 7, the output from the amplifier 45 is passed to the device 100 through an amplifier 46 and the output of the device controls the potential across the bias resistor 47 for the amplifier 45. The device 100 may be preset in a manner which will be apparent from the description hereinabove from the apparatus of Fig. 1 so that the bias upon the amplifier 45 corresponds to the anticipated or preassigned peak amplitude of the input signals applied to the amplifier 45. Signals of amplitudes below this prescribed peak amplitude will not affect the bias whereas for signals of greater than this amplitude the bias will be adjusted correspondingly to prevent overloading of the amplifier 45.

Although the invention has been described with particular reference to the conversion of input signals into an output voltage indicative of or proportional to the peak amplitude of the input signals, it will be understood that by proper control of the polarity of the input signals the output voltage may be made indicative of or proportional to the minimum value of input signals. Such measure is desirable, for example, in field strength recording systems.

Further, although specific embodiments of this invention have been shown and described, it will be understood that they are but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention.

What is claimed is:

1. Electron discharge apparatus comprising means for projecting an electron beam along a path, a first means adjacent said path for deflecting said beam in one coordinate direction, a second means adjacent said path for deflecting said beam in a second coordinate direction, means for applying signals of varying amplitude to said first deflecting means, a pair of output terminals connected to said second deflecting means, and means for resolving deflection of said beam in response to said signals into a voltage at said terminals proportional to the peak amplitude of said signals, said resolving means comprising a mask extending transversely with respect to said path and having a plurality of spaced portions, in a row, of lengths increasing progressively along said row and extending in said first direction and a feedback coupling between said mask and said second deflecting means, one set of corresponding edges of said spaced portions being parallel.

2. Electron discharge apparatus in accordance with claim 1 wherein said portions increase linearly in length along said row.

3. Electron discharge apparatus in accordance with claim 1 wherein said portions increase exponentially in length along said row.

4. Electron discharge apparatus in accordance with claim 1 wherein the face of said mask toward said beam projecting means has a secondary electron emission coefficient greater than unity and said feedback coupling includes a collector electrode opposite said face.

5. Electron discharge apparatus comprising a mask having a plurality of parallel fingers extending in one direction from a reference plane normal thereto, successive fingers increasing in length from said plane in accordance with a pre-

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scribed relation, means opposite said mask for projecting an electron beam toward it, a first deflection means between said beam projecting means and said mask for deflecting said beam in said one direction, and a second deflection means between said beam projecting means and said mask for deflecting said beam in the direction normal to said one direction.

6. Electron discharge apparatus comprising an electrode having a plurality of parallel fingers extending in one direction from a reference plane normal thereto, successive fingers increasing in length from said plane in accordance with a prescribed relation, electron gun means opposite said electrode for projecting an electron beam thereto, a first pair of deflector plates between said gun means and said electrode, effective when energized to deflect said beam in said one direction, and a second pair of deflector plates between said gun means and said electrode effective when energized to deflect said beam in the direction normal to said one direction.

7. Electron discharge apparatus comprising means for projecting an electron beam along a path, a pair of deflection means adjacent said path for deflecting said beam in first and second coordinate directions respectively, circuit means having input terminals for controlling the energization of one of said deflection means, means for impressing energizing signals upon the other of said deflection means, and means defining a feedback coupling between said beam and said input terminals for applying between said terminals a potential varying with the amplitude of said energizing signals, said coupling defining means including a resistance connected across said terminals, a source in series with said resistance and a mask for controlling the current through said resistance in accordance with the position of said beam with respect to said mask, said mask having a plurality of parallel fingers extending transversely with respect to said beam path and parallel to the coordinate direction corresponding to said other deflection means, and successive fingers increasing in length in accordance with a prescribed relation.

8. Electron discharge apparatus comprising means for projecting an electron beam, a first deflection means for deflecting said beam in one coordinate direction, means for applying signals to said first deflection means, a second deflection means for deflecting said beam in a second coordi-

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nate direction, a pair of output terminals coupled to said second deflection means, and means for resolving deflection of said beam in said first direction into a signal, at said terminals, proportional to the maximum amplitude of signal applied to said first means, said resolving means comprising means for applying a fixed bias to said second deflection means, means opposite said beam projecting means to receive said beam and having a plurality of spaced elements mounted in a row parallel to said second direction and extending parallel to one another in said first direction, said elements increasing in length in said first direction, along the row, and means including a feedback coupling between said target means and said second deflection means for applying to said second deflection means a signal in opposition to said bias and of magnitude proportional to the beam current received by said target means.

9. Electron discharge apparatus comprising an enclosing vessel having a transparent wall and a fluorescent screen upon said wall, an electron gun opposite said wall for projecting an electron beam thereto, a first deflection means for deflecting said beam in one coordinate direction, a second deflection means for deflecting said beam in a second coordinate direction, and means for applying to said second deflection means a voltage component proportional to the amplitude of signals applied to said first deflection means, said voltage applying means comprising a photoelectric cell opposite said wall and coupled to said second deflection means and a mask between said wall and said cell, said mask having a plurality of fingers extending parallel to one another in said one coordinate direction, successive fingers increasing in length in accordance with a prescribed relation.

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