

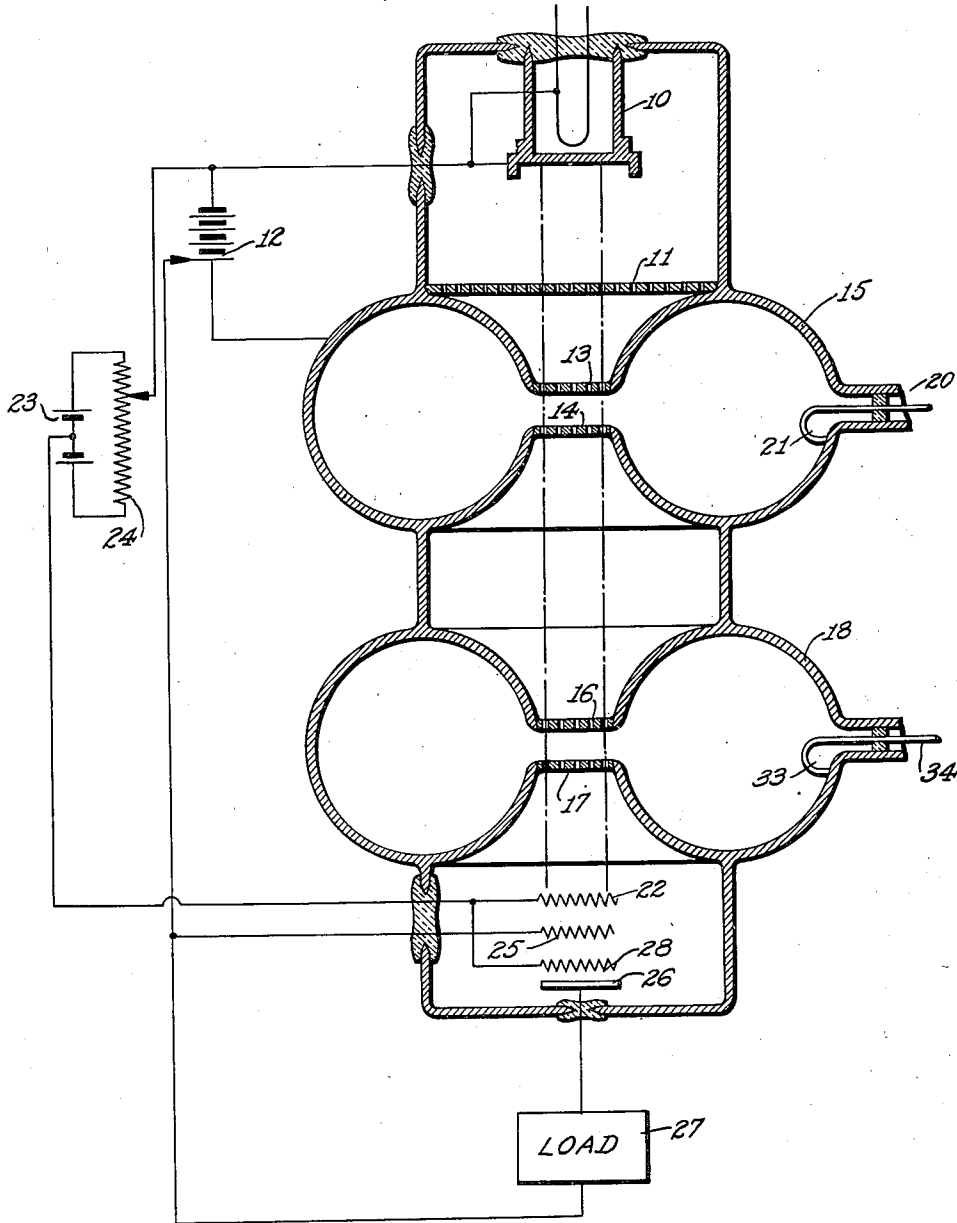
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F. E. TERMAN

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DETECTOR SYSTEM OF THE VELOCITY MODULATION TYPE

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INVENTOR.

FREDERICK E. TERMAN

BY

E. W. Kinney
ATTORNEY

UNITED STATES PATENT OFFICE

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DETECTOR SYSTEM OF THE VELOCITY
MODULATION TYPE

Frederick E. Terman, Stanford University, Calif.,
assignor to International Standard Electric
Corporation, New York, N. Y., a corporation of
Delaware

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This invention relates to a detector arrangement and more particularly to an efficient detector arrangement for use in a tube of the velocity modulation type.

In an article written by R. H. and S. F. Varian, entitled "A high-frequency oscillator and amplifier," published in the Journal of Applied Physics, May, 1939, vol. 10, page 321, a system utilizing a velocity modulation type tube together with auxiliary electrodes for effecting detection was described. According to the disclosure of this article an electron stream is passed through a first resonator circuit wherein a small difference in velocity is given to electrons in the beam. After traversal of a distance sufficient to allow the electrons to become bunched they are passed between extracting electrodes connected to a second resonator circuit wherein energy is extracted from the bunched electrodes.

The electrons after passing this second resonator are reduced in velocity due to the extraction of the energy. However, since some of the electrons will pass this second resonator at the wrong period of the cycle these electrons will not be greatly slowed down or may even be accelerated. A grid was provided in the path of the electron stream after passing the second resonator, this electrode being maintained at a potential near the cathode potential of the tube. The slower moving electrons were thus repelled by this grid electrode and only electrons of a higher velocity were permitted to pass the grid. Accordingly, the electrons which pass the grid are grouped in accordance with the signal velocity. These electrons were then collected on a plate electrode which was connected through a load to the cathode circuit of the tube.

The detector circuit disclosed in the above application, however, suffers from a number of drawbacks. Since the collector electrode has an impedance in series therewith any voltage across this load impedance alters the potential on the collector electrode. This alters the operating conditions and the optimum relations for detection will not be maintained. A further defect of this arrangement is that it is inherently incapable of handling large rectified currents. This is because before an appreciable voltage can be developed across the load, the collector electrode will depart sufficiently from the cathode potential so that the flow of electrons is interfered with.

According to my invention I overcome these difficulties by providing a means for accelerating electrons which pass a low or negatively biased

grid, termed hereafter the control grid, the voltage of this means and the potential of the space adjacent thereto, being maintained independently of the output or collector voltage. This may be accomplished by arranging a screen grid electrode maintained at a positive potential with respect to the cathode between the collector electrode and the control grid, so that electrons which pass the control grid are accelerated toward the collector electrode and substantially all of those which pass it will, therefore, be impressed upon the collector electrode.

A better understanding of my invention, as well as the objects and advantages thereof may be had from the particular description of an embodiment thereof made in connection with the accompanying drawing, the single figure of which discloses a detector system arrangement in accordance with the features of my invention.

In the drawing is disclosed a tube of the velocity modulating type comprising an electron emitting cathode 10. The electrons emitted from cathode 10 are formed into a stream by any suitable means such as the accelerating electrode 11 which is maintained at a positive potential with respect to the cathode by means of battery 12. The electron beam thus accelerated passes between a pair of grids 13, 14, associated with a first resonator chamber 15. As the electron beam passes between electrodes 13, 14, the electrons are modified in velocity, some of them being slightly accelerated and others slightly decelerated. The electron beam then passes through a space of sufficient length so that the electrons so modified in velocity are permitted to form into bunches or groups the frequency of which depends upon the resonant frequency of resonator 15.

These grouped electrons then pass between a pair of extracting grids 16, 17 associated with a resonator 18 tuned to the same frequency as resonator 15. As the bunches of electrons pass grids 16, 17, energy is extracted therefrom by resonator 18 so that the electrons passing grids 16, 17, are decelerated in average velocity. Energy extracted may be removed for further use by a loop 33 and applied to a line 34. Some of the electrons passing grids 16, 17, may be decelerated to a greater extent than others and some may be actually accelerated since they may not be in proper phase. Associated with resonator 15 is provided a line 20 having a coupling loop 21 through which energy of the frequency to which resonator 15 is resonant, modulated by signals, may be applied. The electrons will thus

be given accelerations modified by the signal potentials by grids 13, 14, and, therefore, the electrons in the beam after passing resonator 18 will be decelerated proportional to the signal envelope of the wave form applied at 20. Accordingly, if the electrons so passed are sorted as to velocity, the modulating envelope may be obtained. In order to provide for this sorting a control grid 22 is arranged in the path of the electrons leaving grid 17. Electrode 22 is maintained at a suitable bias with respect to cathode 10 by means of a battery 23 and a potentiometer arrangement 24.

Beyond grid 22 is arranged a screen grid 25 preferably maintained at a positive potential by tapping it at a suitable point on a battery 12. The bias on control grid 22 is so arranged with respect to the electrostatic potential in the space intermediate resonator 18 and the screen grid as to give the desired type of velocity sorting. Thus, electrons which are below a predetermined velocity are repelled by grid 22 and only those electrons above this predetermined velocity are allowed to pass. The electrons which pass grid 22 are accelerated by screen grid 25 and most of them will pass through the mesh of this grid on to collector electrode 26 which is preferably maintained at a positive bias with respect to cathode 10 and which may be connected through a load impedance 27.

The fraction of electrons passing grid 22 is independent of the potential on anode electrode 26, since this electrode has no effect on the electrostatic fields of the resonator 18 because of the screen grid interposed therebetween. Also, since the screen grid 25 and electrode 26 are always considerably more positive than the cathode, all the electrons which pass control electrode 22 go on toward the plate and none are returned back to control grid 22 by a variation in potential in the anode or collector electrode 26 produced by the rectified voltage developed across load 27.

Further, by making collector electrode 26 relatively positive, a large voltage drop may be developed across load 27 by the rectifier output without any effect upon operation of the detector. The only limitation in the output voltage is that the instantaneous potential of 26 with respect to cathode 10 must always be sufficiently great to prevent formation of a virtual cathode in front of electrode 26.

If desired a further electrode 28 may be provided which serves as a suppressor grid. This suppressor grid prevents the exchange of secondary electrons between screen-grid 25 and collector 26.

It can be seen that the detector system of my invention has a number of distinct advantages. This may be briefly summarized as follows: (1) the detecting action of this arrangement is not affected by the voltage developed across the output load impedance; (2) the output electrode has substantially infinite equivalent internal impedance as far as the load is concerned (that is, the output circuit has a screen-grid or pentode characteristic); (3) a large output voltage can be developed so that the system can operate as a power detector.

While I have disclosed the principles of my invention in connection with a single preferred embodiment thereof, it is clear that various modifications thereof may be provided without departure from the spirit thereof. It is clear that

various types of velocity modulated tube arrangements may be used in place of the particular type disclosed in this drawing. Furthermore, the potential applied to the various electrodes may be modified somewhat and still retain the operating characteristics of the system. What I consider to be my invention and desire to secure protection upon is embodied in the accompanying claims.

What is claimed is:

1. In a detector system of the type comprising means for producing a stream of electrons, means for modifying the velocity of electrons in accordance with a signal voltage, control means in the path of said electron stream for passing such of said electrons as are above a predetermined minimum speed, a collector electrode maintained at a positive potential with respect to said means for producing a stream of electrons for collecting electrons which pass said control means, a load connected to the collector electrode producing variations in the potential thereof, the improvement which comprises means interposed between said control means and said collecting electrode of such form and at such potential as to shield the latter and for accelerating the passed electrons toward said collector electrode independent of the potential of the latter.

2. A detector system comprising means for producing a stream of electrons, means for modifying the velocity of electrons in said stream in accordance with a signal voltage, a control grid in the path of said electron stream biased to a low potential for repelling such of said electrons as are below a predetermined potential velocity, characterized in this that there is further provided a screen grid biased to a positive potential with respect to said control grid for accelerating said electrons which pass said control grid, and a collector electrode maintained at a positive potential for collecting said accelerated electrons.

3. A detector system according to claim 1 characterized in this that there is further provided an output load connected to said collector electrode.

4. A detector comprising a source of electrons, means for accelerating electrons from said source to produce an electron beam, a first resonator circuit, means for applying a signal modulated wave to said first resonator circuit, a pair of electrodes connected to said first resonator circuit for modifying the velocity of electrons in said beam, a second resonator resonant to the frequency of said first resonator, a pair of electrodes connected to said second resonator for extracting energy from said velocity modified electron beam, whereby electrons passing said second pair of electrodes are reduced to a lower average velocity, a grid electrode maintained at a potential near that of said electron source arranged in the path of said reduced velocity electrons, so that only electrons above a predetermined velocity are passed by said grid electrode, a collector electrode maintained at a positive potential with respect to said source for collecting said passed electrons, characterized in this that there is further provided a screen grid interposed between said collector and said grid electrode for accelerating said passed electrons toward said collector electrode, and screening the electrostatic effect of said collector electrode from the remainder of said system.

FREDERICK E. TERMAN.