

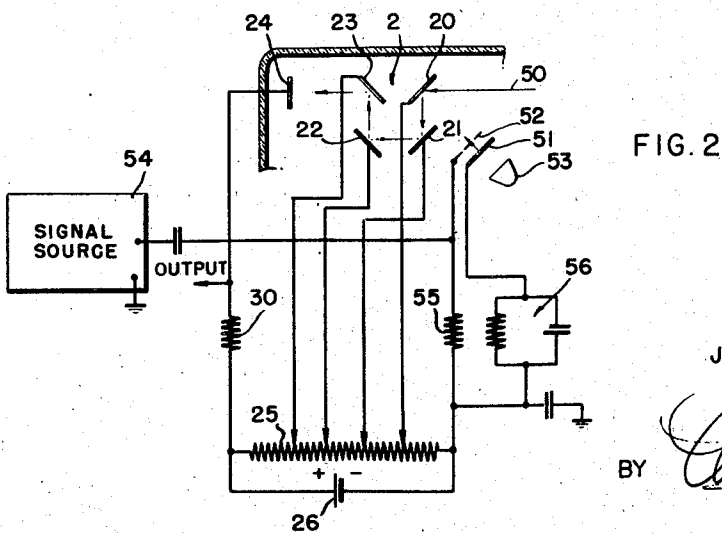
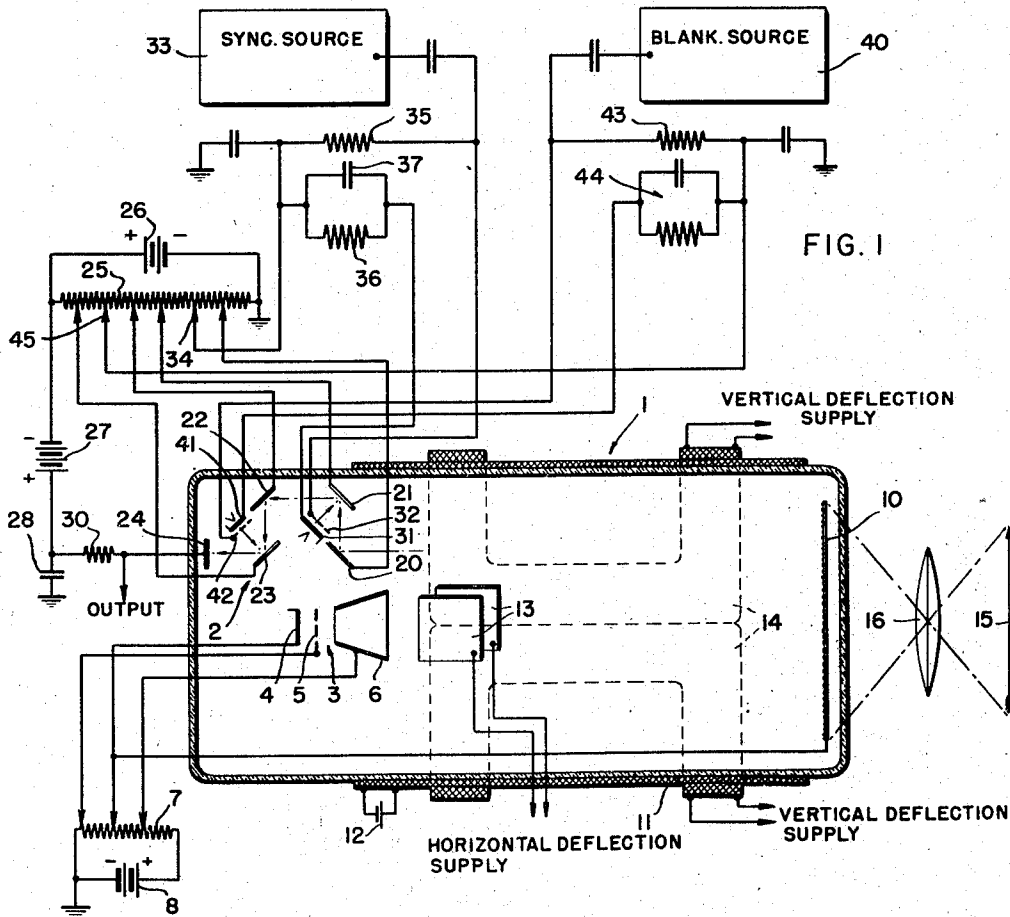
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SIGNAL MIXING ELECTRON MULTIPLIER

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SIGNAL MIXING ELECTRON MULTIPLIER

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This invention relates to electron multipliers, and particularly to a multiplier arranged for mixing two or more signals which may have different mean amplitudes.

The problem frequently arises of mixing in an electron multiplier a plurality of signals which may have different amplitudes. Thus, in a picture signal generating tube of the type where a mosaic electrode is scanned by a low velocity electron beam, a primary electron beam is developed which is modulated in accordance with the video signal. In this type of light storage tube which is usually referred to as an orthicon, the intensity of the returned electron beam is inversely proportional to the light intensity so that the beam intensity has a maximum where the area under scansion is black. This modulated primary electron beam is conventionally amplified in an orthicon by an electron multiplier which inherently has a low noise contribution. However, the television signal as transmitted further comprises synchronizing and blanking signals which have a larger amplitude than the maximum amplitude of the video signal. According to the television standards adopted by the Radio Manufacturers Association, the synchronizing and blanking signals extend into the so-called blacker-than-black region of the video signal. Accordingly, the synchronizing and blanking signals cannot be mixed with the video signal in a conventional electron multiplier of an orthicon because this would necessitate an increase of the current passing through the multiplier during the synchronizing periods which cannot be effected by conventional means. It is furthermore desirable to provide an electron multiplier wherein two or more signals having different mean amplitudes may be mixed.

It is conventional practice to mix two input signals of equal amplitude in an electron multiplier. Thus, it has been suggested to provide a multiplier wherein two components of an input signal which are in phase opposition, are amplified in the manner of a push-pull amplifier. A conventional push-pull multiplier comprises two collector electrodes and either one or two sets of multiplying stages. In an electron multiplier comprising only one set of multiplying stages, two electron beams may be developed which are passed through the multiplying stages separated in space. Since the combined intensity of the two electron beams, which are modulated by two signals in phase opposition, is always constant, the voltage of the multiplying stages is stabilized. Another type of electron multiplier which has

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previously been proposed comprises two sets of multiplying stages and a common collector electrode. One electron beam traverses each set of multiplying electrodes, each beam being modulated in accordance with an input signal, the two signals being in phase opposition. However, these prior multipliers are not adapted for mixing or superimposing a plurality of signals of different mean amplitudes.

It is an object of the present invention, therefore, to provide an electron multiplier arranged for mixing or adding two or more signals having different mean amplitudes.

A further object of the invention is to provide an electron multiplier wherein the synchronizing and blanking signals may be superimposed on the video signal which may be derived, for example, from a picture analyzing tube of the type having a mosaic electrode that is scanned by a low velocity electron beam.

In accordance with the present invention there is provided an electron multiplier comprising means for developing a first primary electron beam modulated in accordance with a first signal and a plurality of secondary electron emissive stages arranged for receiving and multiplying the first primary electron beam. Means are further provided for developing a second primary electron beam modulated in accordance with a second signal and for directing it onto one of the secondary electron emissive stages. There is finally provided a collector electrode arranged for receiving the electrons liberated from the last one of the secondary electron emissive stages. The mean intensity of the two primary electron beams may be different, whereby two signals of different mean amplitudes may be mixed.

For a better understanding of the invention, together with other and further objects thereof, reference is made to the following description, taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the accompanying drawing, Fig. 1 is a schematic representation of an orthicon including an electron multiplier embodying the present invention and arranged for mixing the video signal with the synchronizing and blanking signals, while Fig. 2 illustrates a modified electron multiplier in accordance with the present invention.

Referring now to Fig. 1, there is illustrated picture signal generating tube 1 which is of the orthicon type and is provided with electron multiplier 2 embodying the present invention. Tube 1

comprises electron gun 3 which may include cathode 4, control grid 5 and anode 6 which are supplied with operating potentials from voltage divider 7 connected across the terminals of a suitable voltage source such, for example, as battery 8. The electron beam developed by electron gun 3 is directed toward mosaic electrode 10 which may be transparent. Mosaic electrode 10 carries a multiplicity of electrically insulated photosensitive islands and is electrically connected to cathode 4 so that the electron beam impinges on mosaic electrode 10 with substantially zero velocity.

Magnetic focusing coil 11 is supplied from a direct current source such, for example, as battery 12 and serves for producing an axial magnetic field in order to focus the electron beam developed by electron gun 3 on mosaic electrode 10. Horizontal deflection of the electron scanning beam is effected by deflecting plates 13, 13 which may be curved as is conventional in an orthicon and which are connected with the horizontal deflection supply, as indicated. Two magnetic deflecting coils 14, 14 are arranged opposite each other and surround picture analyzing tube 1 to generate a transverse magnetic field. Deflecting coils 14, 14 are fed from the vertical deflection supply for imparting the vertical deflection to the electron scanning beam.

The scene or object to be transmitted is indicated diagrammatically by arrow 15 and is projected by lens system 16 on mosaic electrode 10. Each island of mosaic electrode 10 will lose a number of photoelectrons depending upon the amount of light projected thereon. Thus, each island acquires a positive charge representative of the brightness value of an associated area of the object to be transmitted. The low velocity electron beam developed by electron gun 3 serves for successively neutralizing these positive charges or for returning each island to a normal predetermined electric potential. The electrons returning from mosaic electrode 10 are accordingly representative at any instant of the brightness value of a selected elemental area of object 15. Since the number of the returned electrons is reduced in accordance with the amount of light projected on the mosaic area under scan, it will be seen that the beam intensity is inversely proportional to the light intensity. In other words, an increase in light projected on the mosaic area under scan corresponds to a decrease in intensity of the return electron beam. Thus, black corresponds to a maximum beam current, while white corresponds to a minimum beam current.

The electrons returning from mosaic electrode 10 are directed toward electron multiplier 2, wherein they are multiplied as is conventional in an orthicon. Electron multiplier 2 comprises successive multiplying stages 20, 21, 22 and 23 and collector electrode 24. Multiplying stages 20 to 23 and collector electrode 24 are maintained at increasing positive potentials by means of taps connected to voltage divider 25 connected across the terminals of battery 26. The first multiplying stage 20 should have a potential that is positive with respect to that of mosaic electrode 10 to attract the electrons returned from electrode 10. Collector electrode 24 may be connected to a separate voltage source such as battery 27, which may be grounded for alternating potentials through bypass condenser 28. The output signal is developed across a load impedance, such as re-

sistor 30 connected between collector electrode 24 and battery 27.

Electron multiplier 2 should be arranged in such a manner as to collect substantially all electrons returned from mosaic electrode 10. To this end a conventional orthicon tube may be utilized where the path of the return electrons is different from those directed toward mosaic electrode 10 so that substantially all return electrons may be attracted by and fed through multiplier 2.

In accordance with the present invention means are provided for developing a second and a third primary modulated electron beam and for directing each beam onto one of the multiplying stages 20 to 23 of electron multiplier 2. Thus, there may be provided cathode 31 which may be indirectly heated, as indicated, and an associated control grid 32 positioned to direct a primary modulated electron beam onto multiplying stage 21. The primary electron beam developed by cathode 31 may be modulated in accordance with the synchronizing signals developed by synchronizing signal source 33 having its output connected to control grid 32. By means of tap 34 on voltage divider 25 cathode 31 and control grid 32 are maintained at a potential that is negative with respect to that of multiplying stage 21 so that the electrons developed by cathode 31 are attracted by multiplying stage 21. Control grid 32 may be provided with a grid leak resistor 35 while cathode 31 may be connected through a self-bias network including resistor 36 and condenser 37 arranged in parallel to tap 34.

During the horizontal and vertical synchronizing periods, an electron current developed by cathode 31 is directed onto multiplying stage 21. In this manner the synchronizing signals may be superimposed on the video signal. It will be understood that the mean intensity of the synchronizing signals is higher than that of the video signal because the synchronizing signals extend into the blacker-than-black region of the video signal.

It is also feasible to superimpose the blanking signals which may be developed by a blanking signal source 40 on the video signal. To this end there may be provided a further thermionic cathode 41 having associated therewith a control grid 42 and positioned to develop an electron beam and direct it onto multiplying stage 23. The output of blanking signal source 40 is connected to control grid 42 which is also connected to grid leak resistor 43. Cathode 41 may again be connected to a self-bias network 44. By means of tap 45 cathode 41 and control grid 42 may be maintained at a potential that is negative with respect to that of multiplying stage 23 so that the electrons developed by cathode 41 are attracted by multiplying stage 23.

The three modulated electron beams, that is, the electron beam returned from mosaic electrode 10 and the two modulated electron beams developed by cathodes 31 and 41 are concurrently multiplied by secondary electron emission in electron multiplier 2. The total multiplied electron beam is collected by collector electrode 24. The output signal developed across load resistor 30 is accordingly a composite video signal including the video signal, the synchronizing signals and the blanking signals.

The electron beam developed by cathode 31 and modulated by control grid 32 should have such an intensity with respect to that of the video signal as represented by the secondary electrons liberated from multiplying stage 20

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that the amplitudes of the video and synchronizing signals will have the required values. Similarly the intensity of the electron beam developed by cathode 41 and modulated in accordance with the blanking signals by control grid 42 should be such that at the collector electrode 24 the blanking and video signals will have the required amplitude, although the blanking signals are multiplied only once by multiplying stage 23.

Referring now to Fig. 2, in which like components are designated by the same reference numerals as were used in Fig. 1, there is illustrated electron multiplier 2 which may form part of picture analyzing tube 1. Electron multiplier 2 comprises successive multiplying stages 20 to 23 and collector electrode 24. The output signal may be developed across load resistor 30 connected between voltage divider 25 and collector electrode 24. A primary modulated electron beam indicated diagrammatically at 50 is directed toward the first multiplying stage 20. Primary modulated electron beam 50 may be the return electron beam of an orthicon as explained in connection with Fig. 1. Alternatively, primary modulated electron beam 50 may be a primary beam of photoelectrons which may be developed, for example, in a photocell multiplier. In certain applications it may be preferred to develop the additional modulated electron beam by a photocathode. Accordingly in the embodiment of the invention of Fig. 2, a second primary electron beam is developed by photocathode 51 having associated therewith control grid 52. The photoelectrons may be liberated from photocathode 51 by the action of light which may, for example, be projected thereon by light source 53. Light source 53 may be provided at any suitable point either inside or outside of the tube.

The electron beam developed by photocathode 51 may be modulated in accordance with a signal developed by signal source 54 having its output connected to control grid 52. Control grid 52 is connected to the negative terminal of battery 26 through grid leak resistor 55 while cathode 51 is connected to battery 26 through self-bias network 56. The first multiplying stage 20 is maintained at a potential that is positive with respect to that of photocathode 51 by a suitable tap on voltage divider 25. The electron multiplier of Fig. 2 operates in the same manner as that of Fig. 1.

The electron multiplier of Fig. 2 may be utilized for mixing two signals of different amplitudes. Primary electron beam 50 may be modulated in accordance with any desired signal as may be the electron beam developed by photocathode 51. It is to be understood that a further primary modulated electron beam may be developed and directed toward another one of the multiplying stages 20 to 23 in the embodiment of the invention illustrated in Fig. 2.

While there has been described what is at present considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An electron multiplier comprising means for developing a first primary electron beam

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modulated in accordance with a first signal, a plurality of secondary electron emissive stages arranged for receiving and multiplying said first beam, means for developing a second primary electron beam modulated in accordance with a second signal and for directing it onto one of said stages, means for developing a third primary electron beam modulated in accordance with a third signal and for directing it onto another one of said stages, and a collector electrode arranged for receiving the electrons liberated from the last one of said stages, the mean intensity of said first beam being different from that of said second and third beams.

2. In a television transmitting system, an electron multiplier comprising a plurality of secondary electron emissive stages and a collector electrode, means for developing a first primary modulated electron beam representative at any instant of the brightness value of a selected elemental area of a scene to be transmitted, means for directing said first beam onto successive ones of said stages for multiplying it, a source of synchronizing signals, a source of blanking signals, a second source of electrons arranged for directing a second primary electron beam onto one of said stages, means for modulating the intensity of said second beam in accordance with said synchronizing signals, a third source of electrons arranged for directing a third primary electron beam onto another one of said stages, and means for modulating the intensity of said third beam in accordance with said blanking signals, thereby to derive a composite video signal from said collector electrode.

3. In a television transmitting system, an electron multiplier comprising a plurality of secondary electron emissive stages and a collector electrode, means for developing a first primary modulated electron beam representative at any instant of the brightness value of a selected elemental area of a scene to be transmitted, means for directing said first beam onto successive ones of said stages for multiplying it, a source of synchronizing signals, a source of blanking signals, means for developing a second beam of photoelectrons and for directing it onto one of said stages, means for modulating the intensity of said second beam in accordance with said synchronizing signals, means for developing a third beam of photoelectrons and for directing it onto another one of said stages, and means for modulating the intensity of said third beam in accordance with said blanking signals, thereby to derive a composite video signal from said collector electrode.

4. In a television transmitting system, an electron multiplier comprising a plurality of secondary electron emissive stages and a collector electrode, means for developing a first primary electron beam modulated at any instant in accordance with the brightness value of a selected elemental area of a scene to be transmitted in such a manner that an increase in light of said area corresponds to a decrease in intensity of said first beam, means for directing said first beam onto successive ones of said stages for multiplying it, a signal source, a further source of electrons arranged for directing a second primary electron beam onto one of said stages, and means for modulating the intensity of said second beam in accordance with said signals from said signal source.

5. In a television transmitting system, an electron multiplier comprising a plurality of second-

any electron emissive stages and a collector electrode, means for developing a first primary electron beam modulated at any instant in accordance with the brightness value of a selected elemental area of a scene to be transmitted in such a manner that an increase in light of said area corresponds to a decrease in intensity of said first beam, means for directing said first beam onto successive ones of said stages for multiplying it, a source of synchronizing signals, a source of blanking signals, a second source of electrons arranged for directing a second primary electron beam onto one of said stages, means for modulating the intensity of said second beam in accordance with said synchronizing signals, a third source of electrons arranged for directing a third primary electron beam onto another one of said stages, and means for modulating the intensity of said third beam in accordance with said blanking signals, thereby to derive a composite video signal from said collector electrode.

6. The method of developing a composite video signal which comprises developing a first primary modulated electron beam representative at any instant of the brightness value of a selected elemental area of a scene to be transmitted, multiplying said first beam by secondary electron emission, developing a second primary electron beam and modulating it in accordance with a synchronizing signal, developing a third primary electron beam and modulating it in accordance with a blanking signal, multiplying said second and said third beam by secondary electron emission concurrently with said first beam, and collecting the total multiplied electron beam representative of said scene and of said synchronizing and blanking signals.

7. The method of developing a composite signal which comprises developing a first primary electron beam modulated at any instant in accordance with the brightness value of a selected elemental area of a scene to be transmitted in such a manner that an increase in light of said area corresponds to a decrease in intensity of said first beam, multiplying said first beam by

secondary electron emission, developing a second primary electron beam and modulating it in accordance with a signal at a higher mean intensity than that of said first beam, multiplying said second beam by secondary electron emission concurrently with said first beam, and collecting the total multiplied electron beam representative of said scene and of said signal.

8. The method of developing a composite video signal which comprises developing a first primary electron beam modulated at any instant in accordance with the brightness value of a selected elemental area of a scene to be transmitted in such a manner that an increase in light of said area corresponds to a decrease in intensity of said first beam, multiplying said first beam by secondary electron emission, developing a second primary electron beam and modulating it in accordance with a synchronizing signal, developing a third primary electron beam and modulating it in accordance with a blanking signal, multiplying said second and said third beam by secondary electron emission concurrently with said first beam, and collecting the total multiplied electron beam representative of said scene and of said synchronizing and blanking signals.

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