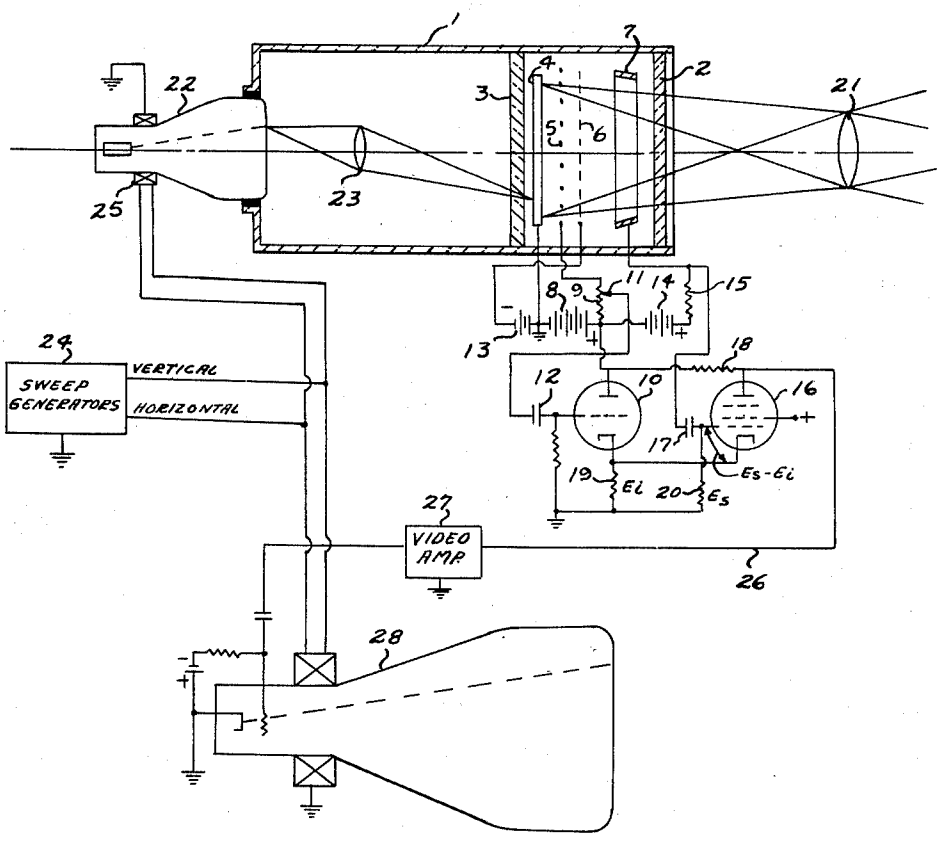
Jan. 20, 1959 M. GARBUNY ET AL 2,870,370

PHOTOTHERMIONIC SPECTRUM CONVERTER

Filed March 26, 1957



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United States Patent Office 2,870,370
Patented Jan. 20, 1959

2,870,370

PHOTOTHERMIONIC SPECTRUM CONVERTER

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Application March 26, 1957, Serial No. 648,753

2 Claims. (Cl. 315—10)

This invention relates to apparatus for converting an image into a video signal. The invention is particularly concerned with the conversion of a thermal image into a video signal which may be applied to a kinescope for the production of a visible image.

In photothermionic image converters the photoemissive material upon which the thermal image is formed and also the phosphor producing the flying scanning spot have nonuniformities which cause variations in the generated video signal during the scanning process. The presence of this spurious signal reduces the resolving power of the converter and the contrast in the visible image produced from the generated video signal. It is the object of the invention to reduce this undesirable component of the video signal to negligible proportions so as to enable the production of a visible image comparable to the original thermal image in resolution and contrast.

In the proposed solution to this problem advantage is taken of the fact that, while the emission of all photoelectrons produced in the converter is sensitive to nonuniformities in the photoemitter and the scanning phosphor, the photoemission of only those electrons in the upper part of the energy spectrum is influenced by the temperature distribution in the thermal image. The total photocurrent therefore consists of thermally sensitive and thermally insensitive parts which may be separated by a retarding field technique due to the greater energy of the electrons forming the thermally sensitive part. Consequently, by adjusting the amplitude of the signal due to the thermally insensitive part and subtracting it from the signal due to the thermally sensitive part, the spurious signal due to the above mentioned nonuniformities may be largely canceleld out leaving a signal corresponding almost entirely to the temperature variations in the thermal image.

A more detailed description of the invention will be given in connection with the specific embodiment thereof shown schematically in the single figure of the accompanying drawing.

Referring to the drawing, 1 is a tube of metal or other suitable material having an infrared transparent window 2 at one end and a glass window 3 at an intermediate position. The space between the two windows is evacuated and contains a semipermeable photocathode 4, made of a suitable photoemissive material, a fine grid of relatively open mesh 5, a fine grid of relatively close mesh 6 and a collector electrode 7. Grid 5 is maintained at a positive potential with respect to photocathode 4 by voltage source 8 acting through resistor 9. Photoelectrons flowing to grid 5 flow through this resistor producing a signal voltage a variable portion of which may be applied to the grid of tube 10 through adjustable contact 11 and condenser 12. Grid 6 is held at a slight negative potential relative to the photocathode by voltage source 13 and consequently no photoelectrons flow to this grid. Collector electrode 7 is held at a positive potential relative to photocathode 4 by voltage sources

8 and 14 acting through resistor 15. Photoelectrons reaching this electrode produce a signal voltage across resistor 15 which is applied to the control grid of pentode 16 through condenser 17. Resistor 18 serves as the anode load impedance for this tube.

Tube 10 operates as a cathode follower so that its entire output signal E_t, due to the photoelectron flow to grid 5, appears across resistor 19. The signal E_s, due to the photoelectron flow to collector electrode 7, is developed across resistor 20. Since the similar components of these two signals are inherently of the same phase, the difference between the two signals, $E_s - E_t$, appears between the grid and cathode of tube 16.

An infrared image of the field to be scanned is formed on photocathode 4 by lens 21. The opposite side of the cathode is scanned by a small high intensity spot of light produced by scanning cathode ray tube 22 and lens 23 which forms an image of the fluorescent screen of tube 22 on the photocathode through window 3. Any type scanning pattern may be used, however, conventional line scannig as used in television is illustrated, suitable horizontal and vertical sweep voltages from sweep generators 24 being applied to magnetic deflection yoke 25 for this purpose.

The operation of the device is as follows: As the scanning spot passes over photocathode 4 photoelectrons are emitted and flow toward the more positive grid 5. This photocurrent contains photoelectrons from all levels in the electron energy spectrum, the electrons from the higher levels leaving the photocathode and travelling toward grid 5 with greater velocity than the electrons from the lower end of the energy spectrum. Because of the fineness and wide spacing of grid 5 all of the photoelectrons initially pass through this grid, however, once through they encounter a retarding field due to the negative fine mesh grid 6. This causes electrons having velocities below a certain minimum, determined by the relative potentials of grids 5 and 6, to return to grid 5 without penetrating grid 6. The remainder have sufficient velocity to pass through grid 6 to the more positive collector electrode 7. The current flowing through resistor 9 therefore is composed of photoelectrons derived from the lower portion of the energy spectrum and that flowing through resistor 15 is composed of photoelectrons derived from the upper portion of the energy spectrum.

As already stated, the emission of photoelectrons throughout the energy spectrum is influenced during the scanning process by nonuniformities in the photocathode 4 and by variations in scanning spot intensity due to nonuniformities in the phosphor of scanning tube 22. However, only in the case of electrons having energies above a certain minimum, depending upon photocathode material and scanning spot intensity and wavelength, is the photoemission influenced by the temperature of the photocathode. By proper selection of the potential difference between grids 5 and 6 the thermally sensitive photocurrent, which varies as a function of photocathode temperature as well as photocathode and scanning phosphor nonuniformities, is restricted to resistor 15 and the thermally insensitive photocurrent, which varies as a function of photocathode and phopshor nonuniformities only and is insensitive to photocathode temperature, is restricted to resistor 9. The former current produces the thermally sensitive signal E_s across resistor 20 and the latter produces the thermally insensitive signal E_t across resistor 19.

By proper adjustment of the amplitude of E_t through variable contact 11 this signal may be made to cancel the component of E_s due to photocathode and scanning phosphor nonuniformities so that the output signal on the anode of tube 18 represents only the variations in photoemission from the cathode due to temperature varia-

tions in the thermal image on the cathode. This video signal may be converted into a visible image by applying it over conductor **26** to video amplifier **27** and thence to the beam intensity control electrode of kinescope **28**, the scanning operation of which is synchronized with that of tube **22**.

We claim:

1. Apparatus for converting a thermal image into a representative video signal comprising: an image converter tube having a photocathode; means for forming a thermal image on said photocathode; means for scanning said photocathode with an elemental area of light for the liberation of photoelectrons from the elemental areas of the photocathode in succession; means separating those of said liberated photoelectrons having velocities above a predetermined level from those having velocities below said level, said predetermined level being such that photoelectrons having velocities above said level are derived from those photocathode electrons of sufficient energy that the photoemission thereof is a direct function of temperature; means for collecting the photoelectrons of higher velocity and producing a first voltage proportional to the resulting current; means for collecting the photoelectrons of lower velocity and producing a second voltage proportional to the resulting current; and means for subtracting said second voltage from said first voltage to produce said video signal.

2. Apparatus for converting a thermal image into a representative video signal comprising: an image converter tube having a photocathode with an image receiving surface; means for forming a thermal image on said surface; means for scanning said photo cathode over the extent of said image with an elemental area of light for the liberation of photoelectrons from the elemental areas of said surface in succession; a first grid commensurate with said surface and in parallel spaced relation thereto; a second grid commensurate with said surface, parallel thereto and spaced therefrom by a greater distance than said first grid; means maintaining said first grid at a positive potential relative to said photocathode; means maintaining said second grid at a negative potential relative to said photocathode; said potentials being such that only the photoelectrons that are derived from those electrons of the photocathode having a sufficiently high energy level that their photoemission is a direct function of photocathode temperature will penetrate said second grid, the remaining photoelectrons having their directions reversed by the retarding field produced by the negative second grid and flowing to said first grid; an electrode for collecting the photoelectrons penetrating said second grid; means deriving a first signal voltage from the photoelectron flow to said first grid; means for deriving a second signal voltage from the photoelectron flow to said collector electrode; and means for subtracting said first signal from said second signal to produce said video signal.

No references cited.