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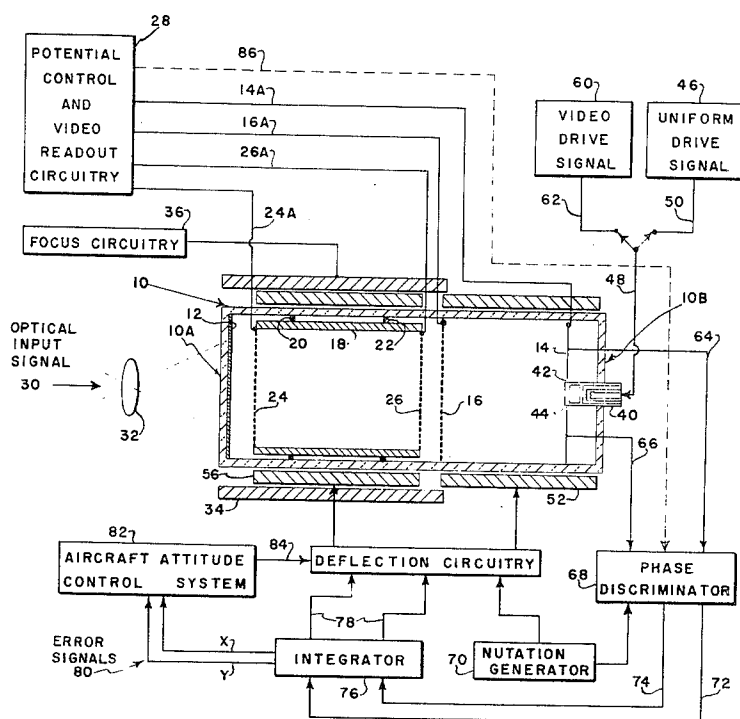
[54] **COMBINED ELECTRON IMAGE TUBE AND VIDICON**
6 Claims, 1 Drawing Fig.

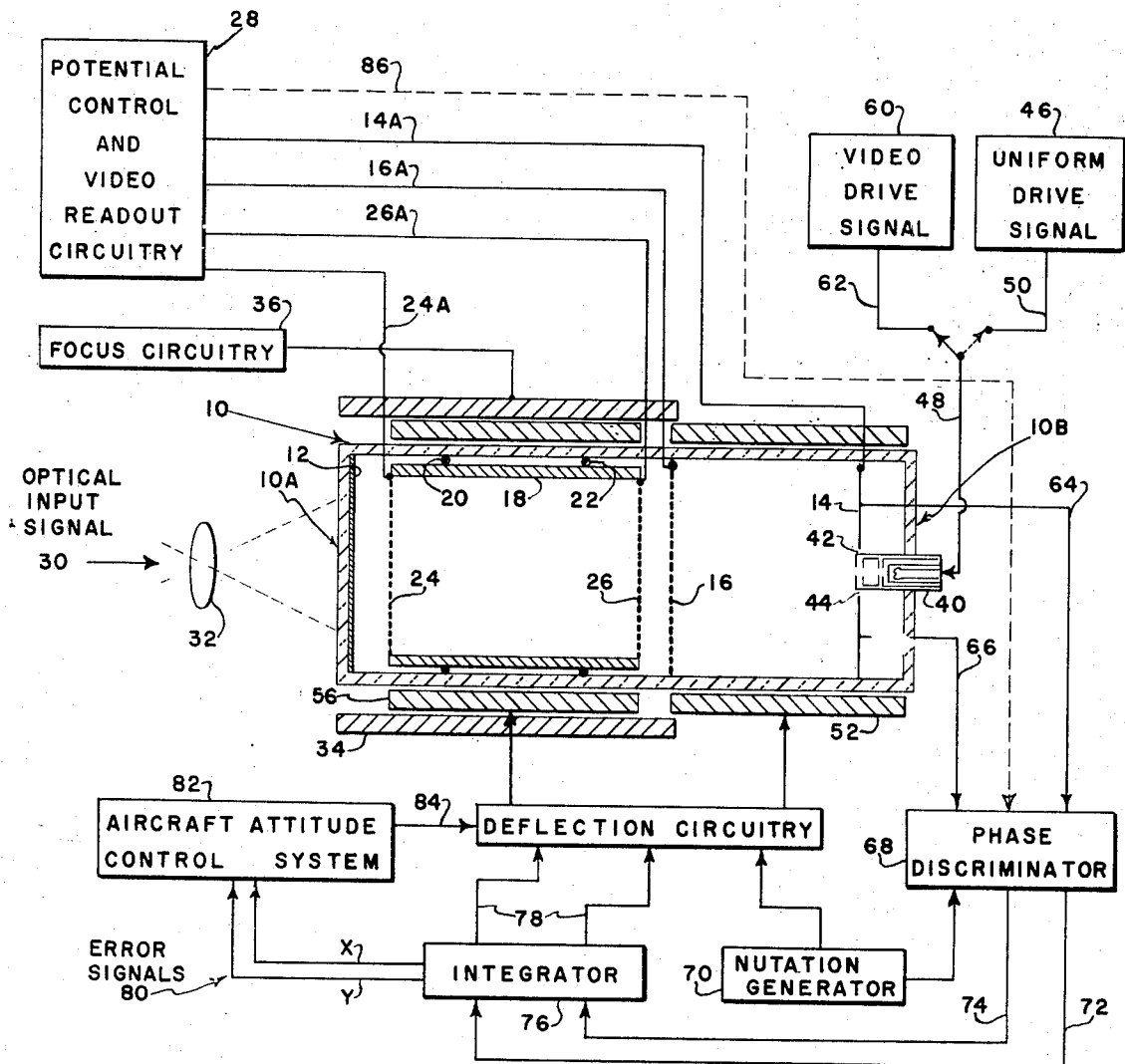
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343/5 (MM), 5 (CM); 178/6.8, 6

ABSTRACT: This invention relates to the combination of a vidicon and an electron image tube into one envelope to achieve the best characteristics of both devices which will be much more efficient in cost, weight, volume, and reliability than using two separate devices.





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COMBINED ELECTRON IMAGE TUBE AND VIDICON

Heretofore, it has been known that an electron image tube might be used for correlation technique, as particularly pointed out in Pat. application Ser. No. 232,961, filed Oct. 25, 1962, now U.S. Pat. No. 3,290,546 for Electron Image Correlator, and assigned to Goodyear Aerospace Corporation. A subsequent Pat. application Ser. No. 424,439 filed Jan. 8, 1965 now U.S. Pat. No. 3,424,937 and entitled Electron Image Correlator Tube claims some improvements over the application Ser. No. 232,961. In fact, one of the improvements claimed in application Ser. No. 424,439, and particularly relating to FIG. 3 in the drawings thereof teaches writing image information onto a storage grid by a video signal actuated through an electron gun. However, such technique requires both the electron gun and the photoemissive cathode receiving optical input information to be mounted at the same end of the image tube thereby making registry a considerable problem because the optical input image and the radar input image through the electron gun do not converge on the storage grid at the same angle. An apparatus to overcome this registry deficiency is needed by the art.

It is the general object of the invention to avoid and overcome the foregoing and other difficulties of and objections to prior-art practices and to meet the needs of the art by providing the combination of an electron image tube with a vidicon to allow video input information to be stored on a grid in exact registry to optical input information thereby eliminating distortion and registry problems in achieving correlation between the input image information.

A further object of the invention is to combine the best features of an electron image tube with a vidicon whereby the combination is more efficient in cost, weight, volume, reliability, etc., than using two separate tubes.

A further object of the invention is to provide an electron image tube which may have a video input signal stored on the grid in exact registry with any optical input information where correlation between the image information is possible with either the optical input or video input information stored on the grid, and where correlation readout may be selectively taken from any of several points in the tube.

Another object of the invention is to provide the combination of an image storage device and a vidicon in one envelope which device might be the heart of an optical image tracking or homing guidance system where no mechanical stabilization is required and the device can be rigidly mounted to the airframe with all image stabilization electrically achieved through suitable deflection circuitry associated with the attitude system of the aircraft.

The aforesaid objects of the invention and other objects which will become apparent as the description proceeds are achieved by providing in combination a vacuum tube, a photocathode at one end of the tube to receive direct optical input images for conversion to electronic image patterns, a storage grid positioned in spaced parallel relation to the cathode to controllably store selected electronic image patterns thereon, coil means surrounding the tube between the cathode and the grid to focus electronic image patterns from the cathode onto the grid, yoke means at spaced relation around the tube to controllably deflect a focused electronic image pattern relative to the grid, an anode electrode output surface at the other end of the tube in spaced parallel relation to the cathode and the grid to sense the number of electrons impinging thereon, an electron gun substantially centrally positioned in the anode electrode, coil means surrounding the tube between the anode electrode and the grid to focus and deflect an electron beam emitted from the electron gun onto the grid, means to modulate the electron beam from the electron gun with a video input signal, and means to selectively control the voltage at the photocathode, the grid, and the anode electrode as necessary to selectively store optical input information from the photocathode onto the grid and video input information from the electron gun onto the grid, and to read out correlation information when the optical input information is stored on the grid and the video input information is nutated relative thereto.

For a better understanding of the invention reference should be had to the single drawing wherein a schematic illustration of the combined image tube and vidicon is illustrated as the preferred embodiment of the invention with suitable block diagram circuitry associated therewith to achieve the desired function thereof.

With reference to the form of the invention illustrated in the drawings, the numeral 10 indicates generally an image tube housing which is generally substantially cylindrically shaped, preferably transparent at one end 10A, and having a photocathode surface 12 at the end 10A with an anode output surface 14 in slightly spaced relationship from the other end 10B of the housing 10. An image storage grid or mesh 16 is mounted substantially midway between the photocathode 12 and the anode 14, and in substantially parallel relationship thereto. A drift tube 18 is mounted substantially concentrically within the housing 10 of substantially uniformly between the storage grid 16 and the photocathode 12. The drift tube 18 is generally cylindrically shaped, and mounted by insulating stabilizing rings 20 and 22, respectively. In order to control potential between the photocathode 12 and the drift tube 18, a field mesh 24 is mounted to one end of the drift tube 18, while the means to control the voltage potential between the other end of the drift tube and the storage grid 18 is achieved by a collector mesh 26. The potential control to each of the field mesh 24, collector mesh 26, storage grid 16, and anode 14 are provided by a potential control circuitry 28 connected through appropriate lines 24A, 26A, 16A, and 14A, respectively to their particular components. The circuitry 28 also functions for correlation readout, as will be more fully explained hereinafter.

In accordance with the usual operation of an optical electron image tube, an optical input signal 30 is provided for focus through a lens 32 through the transparent end 10A of the housing 10 and onto the photocathode 12. This causes the photocathode 12 to emit electrons in proportion to the intensity of the light impinging thereon. Because of the potential existing between the photocathode 12 and the field mesh 24, these electrons are accelerated into the drift tube 18. Then, in order to achieve focus of these electrons onto the storage grid 16, a suitable focus yoke 34 is provided to surround the housing 10 throughout the length of the housing between the photocathode 12 and the storage grid 16. Suitable focus circuitry 36 drives the focus coil 34 to create the desired lines of magnetic flux to effect the desired focus of electrons onto the storage grid 16. In the usual manner, the storage grid 16 will be at no charge so that the electrons impinging thereon will create charges into the usual mesh surface to store an electronic image of the optical input signal 30. It is anticipated that the drift tube 18 will not have any potential difference between the field mesh 24 and collector mesh 26 so that no further acceleration takes place throughout the length of the drift tube 18. The reason for eliminating acceleration of the electrons in the drift tube is to allow deflection of the electrons in the drift tube to achieve a correlation function, as more particularly explained hereinafter.

It is believed that an important distinction of this specific construction over that known in the previous art is achieved by mounting an electron gun 40 substantially in the center of the other end 10B of housing 10 and opposite the photocathode 12, as clearly indicated. The electron gun 40 will preferably extend through the anode 14, although not being in contact therewith, as the gaps 42 and 44 clearly indicate. In essence, the electron gun 40 acts as a vidicon when considered in combination with the storage grid 16. Thus, for example, if a uniform drive signal 46 is sent thereto over line 48 and connected by dotted switch 50, a normal scanning may take place if a suitable deflection yoke 52 is properly driven by suitable and conventional deflection circuitry 54. In the usual vidicon operation a scanning by the electron gun 40 onto the storage grid 16 may be read out by the video readout circuitry 28 from the field mesh 24, collector mesh 26, storage grid 16, or anode 14, by simply appropriately controlling the voltage at these points in the tube. Of course, the usual manner to

operate a vidicon will take the video signal over line 16A connected directly to the storage grid. However, since the normal vidicon operation is a destructive readout mode, it may prove more practical to reflect electrons off the grid 16 back onto the anode 14 for storage grid image readout in a nondestructive manner, as in an image orthicon.

In order to operate the apparatus in a correlation technique, the electron gun 40 may be modulated by a video drive signal 60 connecting with line 48 through a switch 62. In this instance the uniform drive signal 46 is not actuated. By using this technique a reference or present video drive signal 60 is scanned and nutated at the same time over an electron image normally representing optical input information already stored on the grid 16. For correlation readout probably the nondestructive reflective readout operation would be most effective whereby the reflected electrons representing a correlation signal is picked up on the anode 14 by suitable electrical pickup lines 64 and 66, respectively, which in turn feed a phase discriminator 68. The number of electrons reflected from the grid 16 indicates the degree of correlation where maximum reflection will normally represent the highest degree of correlation, although under certain conditions minimum reflection could represent the best correlation. In the usual manner for correlation, the phase discriminator 68 must operate in coordination with a nutation generator 70 which generator also drives the deflection circuitry 54 controlling the nutation to yoke or coil 52 properly nutating the modulated video drive signal 60 scanned through the electron gun 40 onto the grid 16, as described above. Again, in the usual manner, the phase discriminator 68 sends signals over lines 72 and 74 into an integrator 76 which in turn sends correction signals 78 to the deflection circuitry 54. The integrator 76 also sends error signals 80, which are used to appropriately correct the flight path of an aircraft, to a suitable aircraft attitude control system 82.

In order that the entire tube housing 10 might be positioned in fixed relationship to the aircraft frame, even in a tracking situation, the aircraft attitude control system 82 sends a signal over line 84 into the deflection circuitry 54 whereby the deflection yoke or coil 52 correcting the video drive signal 60 and a deflection yoke or coil 56 correcting the optical input signal 30 might be appropriately controlled to reflect and correct all attitude errors in the flight path of the aircraft to maintain the proper images on the storage grid even through the housing 10 is affixed to the aircraft. This electronic signal reference correction as supplied through the attitude control system 82 to the fixed tube housing 10 thus eliminates the equipment and mounting problems of the housing into a suitable gimbaled gyroscopic inertial attitude control system.

Therefore, it should be understood that perhaps the most advantageous operating use of the invention would be in a guidance control capability for a missile where extreme accuracies are important. In this instance, the optical input signal 30 might be obtained from a reference film data, or present optical information. Of course, it should be understood that conventional fiber optics could be utilized in place of the lens 32. In the same manner, the video drive signal 60 might be either present or reference information. Therefore, it should be understood that image information can be stored on the grid 16 from either end of the tube. In other words, the optical input signal 30 or the video drive signal 60 may be stored as an electronic image on the grid 16. If the image stored on the grid 16 is from the video drive signal 60, then the optical input signal 30 will normally be nutated as it passes through the drift tube 18 by appropriate drive from the deflection circuitry 54 into the nutating yoke or coil 56 whereby correlation of the optical input signal 30 with the stored video drive signal 60 will be achieved by sensing the number of electrons impinging onto the anode 14, all in the usual manner in association with the phase discriminator 68 and the integrator 76. Conversely, if the optical input signal 30 is stored onto the grid 16, the video drive signal 60 will be appropriately nutated as it scans the grid 16 by the deflection circuitry 54 appropriately driving

the deflection yoke or coil 52. Again, in this manner, probably the preferable operating mode would be to reflect electrons back onto the anode 14, but correlation signals may be picked up with appropriate voltage control by the video readout circuitry 28 and then presented to the phase discriminator 68 by an appropriate electrical connecting line, indicated by dotted line 86.

Therefore, in summary, with the video drive signal 60 stored on the grid 16, nutation of the entire optical input signal 30 obtains the correlation function. Whereas, with the optical input signal 30 stored on the grid 16, a scan is necessary with the electron gun 40 of the video drive signal 60 so that nutation deflection of the scan is utilized to achieve the correlation function. In one instance, the entire image is nutated for correlation, in the second, the entire scan is nutated. Both will achieve suitable correlation functions, although the full image nutation generally provides a better resolution, and therefore better correlation signals.

It should be understood that one of the important assets of this particular structural concept is that registry of the images onto the storage grid 16 is easily achieved because everything is presented substantially through the centerline and axis of the tube 10. This eliminates the registration problems inherent where the electron gun is mounted in offset relationship in the same face as the photocathode, as shown in above-identified Pat. application Ser. No. 424,439.

Further, since the photoemissive surface of the photocathode 12 is not resolution limited like a vidicon, magnification of the optical input can readily be accomplished by appropriately controlling the focus circuitry 36 to thereby facilitate registry problems in correlating to a video drive signal 60 presented through the electron gun 40. Further, the field of view of the optical input signal is large as compared to the normal vidicon utilized to obtain the video drive signal 60, and hence if the optical input signal 30 is utilized for present information, it gives a great deal of flexibility to the tracking capabilities of the apparatus.

If, it is desirable to have two or more correlation signals, to better enhance the resolution and capabilities for detecting accurate error signals, the anode 14 may be split into two or four equal sectors, which would require additional pickoff circuitry to detect the required correlation functions. Naturally, as is well known in the art, light intensity amplifiers may be appropriately positioned between the photocathode 12 and the storage grid 16, as well as between the storage grid 16 and the anode 14 to increase the intensity of the signals and enhance the signal to noise ratios.

While in accordance with the patent statutes only one best known embodiment of the invention has been illustrated and described in detail, it is to be particularly understood that the invention is not limited thereto or thereby, but that the inventive scope is defined in the appended claims.

We claim:

1. An electron image tube which comprises a vacuum tube, a photocathode at one end of the tube to receive direct optical input images for conversion to electron image patterns, a storage grid positioned in spaced parallel relation to the cathode to controllably store selected electronic image patterns thereon, coil means surrounding the tube between the cathode and the grid to focus electron image patterns from the cathode onto the grid, yoke means at spaced relation around the tube to controllably deflect a focused electron image pattern relative to the grid, an anode electrode output surface at the other end of the tube in spaced parallel relation to the cathode and the grid to sense the number of electrons impinging thereon, an electron gun substantially centrally positioned in and insulated from the anode electrode, coil means surrounding the tube between the anode electrode and the grid to focus and deflect an electron beam scanned from the electron gun onto the grid, means to modulate the electron beam from the electron gun with a video input signal, means to nutate the video input signal as it is scanned in an electron beam from the electron gun when an optical input image is stored on the

storage grid and to control the voltage along the tube whereby the number of electrons in the electron beam reflected from the storage grid back to the anode is an indication of the correlation between the video input signal and the optical input signal, and means to selectively actuate the electron gun with a uniform drive signal or the video drive signal to operate the tube selectively as an image orthicon or a correlation tube.

2. An electron image tube according to claim 1 where means are provided to nutate the optical input signal as it is focused as an electron image pattern onto the storage grid when a video input signal is stored on the storage grid and to control the voltage along the tube whereby the number of electrons in the electron image pattern passing through the storage grid and received by the anode is an indication of the correlation between the video input signal and the nutated optical input signal.

3. An apparatus according to claim 1 where a plurality of electron multipliers are placed between the photocathode and the anode to amplify the electron image stored on the storage grid, and the electrons reflected onto the anode representing the correlation function.

4. An apparatus according to claim 1 where the means for storing the optical image as an electron image on the storage grid include means for focusing and changing the scale factor of the optical image presented onto the photocathode to insure that the electron image pattern representing the present image display information is of the same scale as the electron image pattern scanned by the electron gun representing the video drive signal.

5. An apparatus according to claim 1 where nutation yoke means surround the housing between the storage grid and the photocathode and between the storage grid and the anode with suitable nutation drive means to deflect the electrons passing through the tube whereby registration of the optical image and the video drive signal on the storage grid may be obtained.

6. An apparatus according to claim 1 which is mounted in fixed relation to an aircraft where the optical image represents the present image information and is electronically controlled in image pickup by signals received by an attitude control system for the aircraft.

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