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TELEVISION SYSTEM

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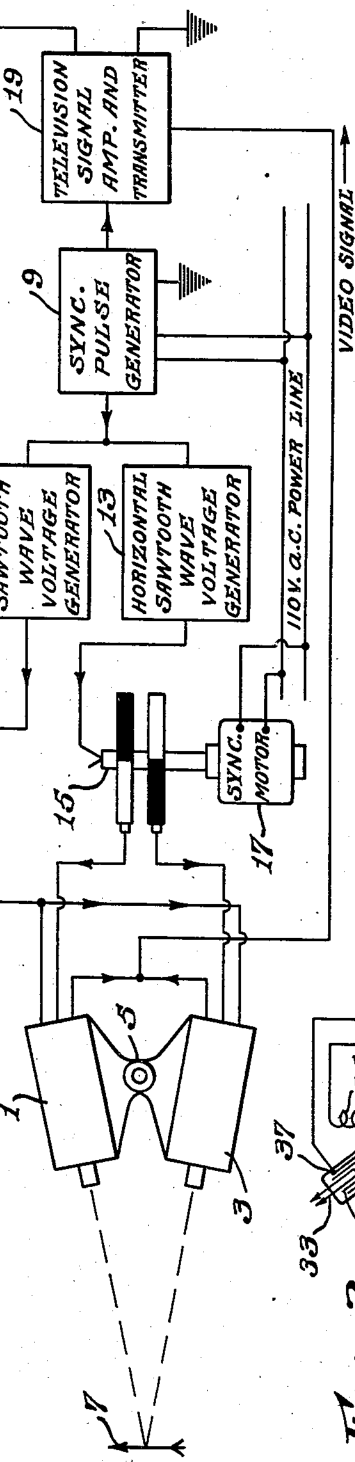

FIG. 1.

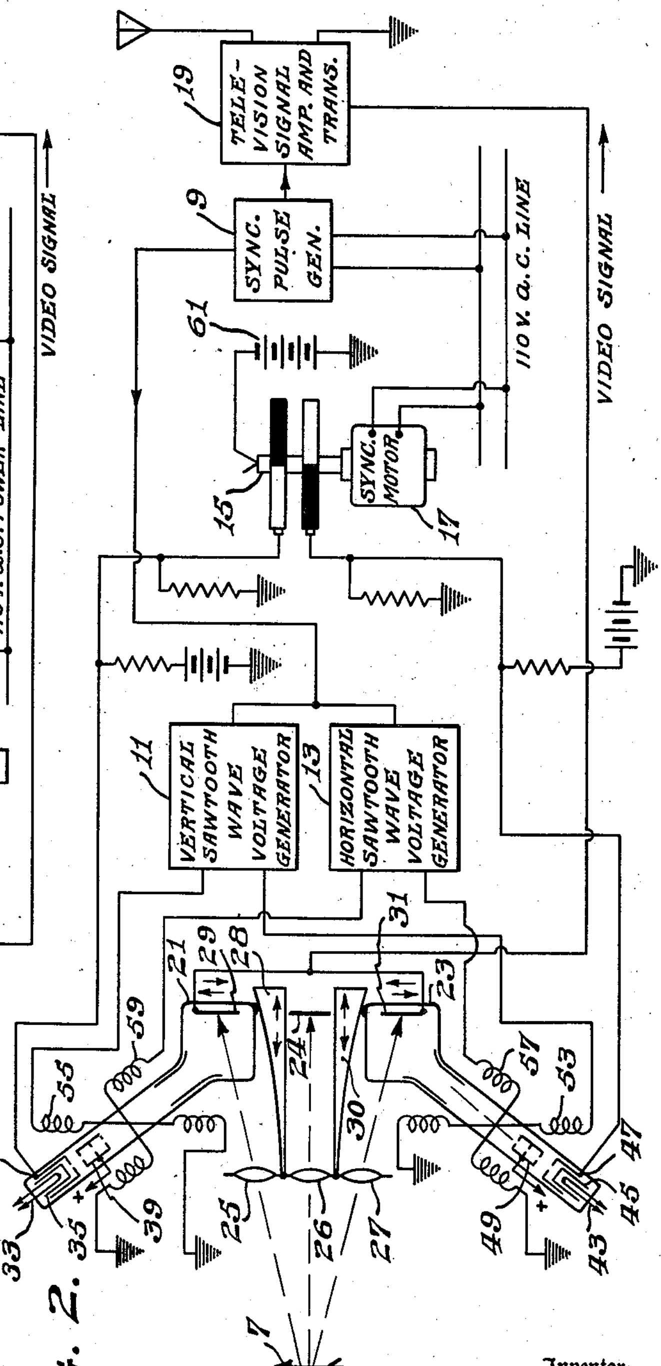

FIG. 2.

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TELEVISION SYSTEM

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4 Claims. (Cl. 178—7.2)

This invention relates to television transmission systems and more particularly to the arrangement of television cameras.

In the transmission of television signals, one of the most difficult problems, particularly in attempting the transmission of outside distance scenes resides in the difficulty brought about by the need of introducing sufficient light into the image scanning tube to fall within the range of photosensitivity thereof in order to convert the optical images into electric currents by scanning operation. The photosensitivity of present scanning tubes is not equal to that of the usual photoelectric cells and, consequently, to energize the photosensitive electrode of image scanning tubes of the storage type such as the iconoscope, it is desirable that provision be made whereby the storage period may be effectually lengthened.

The actual sensitivity of the tube sets a limit in the obtainable depth of focus of a television camera because it is only by large aperture lenses that enough light can be caused to reach the photosensitive mosaic. However, the larger the lens aperture, the shallower the depth of focus which, of course, limits the range of distance over which objects in a scene can be reproduced faithfully.

The limit of sensitivity of the transmission tube also sets a limit upon the least amount of light that can be employed without having the reproduced image spoiled by interference caused by spurious signal generated in the coupling circuits and first tubes of the associated signal amplifier. Even the minimum amount of light required for the satisfactory transmission of television images is sometimes so great that subjects are required to endure intense light and a great deal of heat resulting in objectionable discomfort.

It has been demonstrated that the amount of charge accumulated by elemental areas of the photosensitive electrode in a transmitter tube increases with the amount of time which light of any predetermined intensity is allowed to fall on the mosaic element, providing complete saturation has not taken place.

According to this invention, advantage is taken of this phenomenon by using a camera having a plurality of lenses and transmitter tubes, or by using a plurality of complete television cameras, and causing the photosensitive electrode in each transmitter tube to be scanned alternately so that the light image on the mosaic electrode is allowed twice as much, or more, time in which to build up its electrical charge. If two cameras are used, there is obtained approximately twice the time interval for storing a charge image on the mosaic of each transmitter tube. If three transmitter tubes are used three times as much time is obtained for the charge and so on. Therefore, in each iconoscope or transmitter tube less incident light is needed in order to build up an electrical image intense enough to satisfactorily overcome the objectionable interference noise level. Consequently, a scene having less incident and reflected light may be successfully televised or, for a given intensity of light, a smaller lens opening the television camera may be used, resulting in a desirable greater depth of focus.

When a plurality of cameras are used to transmit the same image, it is necessary that each camera be focused precisely on the same image. In the practice of this invention, any of the well-known parallax correction methods may be used, such as, for example, the method shown in Burns Patent 1,931,890, patented October 24, 1933.

In order that corresponding points on the photosensitive screens of the two cameras may always contain the same element of the scene to be televised, the lens and camera element mountings may be made to move in grooves to control their lateral displacement and angle simultaneously with their focusing adjustment in order to maintain the correct condition for superposition of images. The British "Emitron" television cameras have such an arrangement to overcome the effects of parallax between camera lens and viewing lens when the focus is varied. This method may be applied for overcoming parallax between the two camera elements as well as between the camera elements and view finder.

From another point of view it may be noted that if two television cameras are operated in synchronism to reproduce substantially identical scenes, then the useful output currents from the two cameras may be combined in a manner to add them together in a single circuit. At the same time the spurious noise currents due to thermal agitation, shot effect and similar sources are also combined in the circuit but do not add so well. The wave forms of the useful signal currents are identical so that, in effect, all signal component frequency currents are added together in the same phase while the wave forms of noise currents are not identical, taking into account timing and amplitude, so that all noise component frequency currents are added together in random phase. The result of adding signal component currents in like phase is to produce new currents with amplitudes equal to the sum of the amplitudes of the component currents while the result of adding noise component currents in random phase is to produce new currents having total power equal to the sum of the powers of the component currents. For this reason, each time we double the number of cameras, we provide a gain of 2 to 1 in useful signal to noise power.

In practicing this second method utilizing a plurality of lenses and photosensitive tubes, care should be taken that any noises arising in the equipment, from similar sources such as ripples in power supply potential, induction from single sources, or synchronous sources, vibration, etc., do not tend to add in the same manner as the signal so that the noise cannot be suppressed.

Accordingly, the principal object of this invention is to provide a television system having greater light sensitivity.

Another object of this invention is to provide a television system having an increased depth of focus.

Other and incidental objects of the invention will be apparent to those skilled in the art from a reading of the following specification and an inspection of the accompanying drawing in which:

Figure 1 is a block diagram showing one form of this invention, and

Figure 2 is a block diagram showing another form of this invention.

Referring now in more detail to Fig. 1, a plurality of television cameras 1 and 3 are mounted together on support 5 so that they may be focused on the same object 7. The special mounting 5 is mechanically coupled with the lens focusing equipment to keep all the cameras focused at the same distance and at the same point regardless of the focusing distance adjustment. The parallax correction method shown and described in Burns Patent 1,931,890 may be adapted to this form of the invention by substituting two television cameras for the photographic camera and viewing screen shown by Burns.

A synchronizing pulse generator 9 supplies a vertical saw-tooth wave voltage generator 11 which in turn supplies the vertical deflection coils of the cameras 1 and 3 with a saw-tooth wave potential for the vertical deflection of their corresponding electron beams.

The synchronizing pulse generator 9 also supplies a horizontal saw-tooth wave generator 13 with synchronizing pulses. The generator 13 generates a saw-tooth wave voltage which is fed to the commutator 15 driven by a synchronous motor 17 which causes the horizontal deflection voltage to be fed first to one transmitter tube and then to the other at a frequency which corresponds to the field frequency or to the vertical deflection frequency. That is, first one tube image screen is scanned and then the other.

In the system which has been used in the United States by the National Broadcasting Company, the field frequency is 60 passages per second. According to this invention and using two cameras, the photosensitive electrode in each camera will be scanned 30 times per second.

When interlaced scanning is used, each alternate set of lines in each camera is scanned on alternate passages over its image screen in order that there may be a maximum of time, and an equal time, before each passage over the image screen.

During waiting periods, while the other camera is active in producing the output signal, the scanning potentials in each camera are held to keep the electron stream off the image screen or, preferably, the electron stream is cut off by dropping potential on one or more electrodes, similar to the method of blanking employed in receiving tubes of the Kinescope type.

It is desirable to supply the synchronous motor 17 with A.-C. driving voltage from the same source which drives the synchronous pulse generator 9 so that the switching from one transmitter tube to another will be synchronized with the synchronizing pulse generator 9. Video signal resulting from the alternate scanning of the plurality of cameras 1 and 3 is combined and fed to the television signal amplifier and transmitter 19 at which point synchronizing pulses from the synchronizing pulse generator 9 are combined with the video signal.

In another form of this invention, the pulse from the vertical saw-tooth wave generator 11 may be fed through the commutator and the horizontal deflection voltage be fed directly to the cameras 1 and 3. Then absence of vertical pulse potential will leave the electron stream off the image plate during idle or waiting periods.

Referring now to Fig. 2 wherein like figures represent similar parts, television transmitter tubes 21 and 23 and associated lenses 25 and 27, respectively, are each adapted to focus image 7 on photosensitive elements 29 and 31, respectively.

Another modification of the Burns Patent 1,931,890 is shown in which two of the parallax correcting means are combined to provide a viewing screen 24 which is preferably of the ground glass type whose associated lens 26 is adapted to cause an image of the object 7 to fall upon the screen 24. Lenses 25, 26 and 27 are of equal focal length and are mechanically coupled together so that they are in one plane parallel to the viewing screen 24. The transmitter tubes 21 and 23 are provided with a mounting which allows them to move in a direction indicated by the arrows, causing the same image which appears on the viewing screen 24 to fall upon the photosensitive mosaic 29 and 31 in a similar position. Cams 28 and 30 are mechanically coupled to the lens support. The curved surface of the cams 28 and 30 come in contact with the supports of the tubes 21 and 23, respectively, so that they are moved in the directions shown by the arrows automatically as the lenses are focused on the object 7. This provides a correction for parallax and provides a viewing screen for the operator.

Transmitter tube 21 is provided with an electron gun comprising a heater 33, cathode 35, a control electrode 37, a first anode 39. Transmitter tube 23 is provided with an electron gun comprising a heater element 43, a cathode 45, a control electrode 47, a first anode 49.

Pulses from the synchronizing pulse generator 9 are transmitted to the vertical saw-tooth wave potential generator 11 which supply the vertical deflecting coils 53 and 55 of the transmitter tubes 23 and 21, respectively. Pulses from the synchronizing pulse generator 9 are also supplied to the horizontal saw-tooth wave generator 13 which, in turn, generates a saw-tooth wave potential for horizontal deflecting coils 57 and 59 of the transmitter tubes 23 and 21, respectively.

A synchronous motor 17 which is maintained in synchronism with the vertical deflection frequency generated by the synchronizing pulse generator 9 drives a commutator 15 which is supplied with a negative potential by a suitable source 61. Contacts are so arranged on the commutator 15 that first one control electrode 47 and then another control electrode 37 of the transmitter tubes 23 and 21, which at other times are maintained at a constant positive potential, respectively, are provided with a negative potential from the potential source 61 such that the electron gun of each of the tubes is blocked for one complete scanning cycle, thus allowing the optical image on the photosensitive electrodes 31 and 29 of the transmitter tubes 23 and 21 to build up electrical charge over a greater period of time.

The video signal from each of the transmitter tubes 21 and 23 alternately supplies the television signal amplifier in transmitter 19 where the synchronizing pulses from the generator 9 are combined with the picture signal to be transmitted as a composite signal.

In the operation of the system just described, if interlaced scanning is used and, for example, a ratio of line frequency to frame frequency is 441, then each camera will transmit only alternate lines of the image. This in itself may be preferable but, if it is desired to scan every line in each camera, it is only necessary to change the ratio of line frequency to frame frequency slightly. For example, instead of a ratio of 441, we may employ a ratio of 440.5.

An alternate method of operation is to run the synchronous commutator 15 at half speed, or to design it with half as many segments so that each camera scans all lines in its image and then remains inactive for an equal period while the other camera scans all of its lines.

To switch the scanning potentials from one iconoscope to another, a synchronous commutator as above may be employed to switch from one transmitter tube to the other every $\frac{1}{60}$ or $\frac{1}{30}$ of a second in accordance with American television standards or every $\frac{1}{50}$ or $\frac{1}{25}$ of a second in accordance with the British standards.

In still another form of this invention, a vacuum tube tripping circuit is used to switch from one transmitter tube to another. Such a circuit as the "Finch" tripping circuit which may be caused to unbalance in one direction to another by means of pulses derived from the television synchronizing pulses or from pulses derived from potential change when the scanning in the iconoscope or transmitter tube is moved suddenly from bottom to top of the image during scanning. The Finch tripping circuit is described in his U. S. Patent No. 1,948,103, issued February 20, 1934. In Fig. 1 of his patent will be found tubes 12, 14, the anode potentials of which change quickly in opposite directions in response to input pulses. Potentials of two tubes in a similar arrangement may be utilized to perform the same functions as potentials from the commutators in the circuit I have illustrated. It is only necessary that current of correct frequency and phase be applied to the circuit to make it provide the same sort of synchronous switching as the commutators.

At football games and at scenes of similar nature, four or more cameras or groups of cameras in one rack may be employed, each camera or group of cameras either continuously active, or successively active for providing picture currents, but each continuously active in building up change images. Such an arrangement permits a much better reproduction of the scene by making possible greater depth of focus and greater signal to noise ratio.

When successive scanning is employed, it probably would not be practical to use more than about four cameras or groups of cameras on scenes with rapid action in them because the image in each iconoscope would tend to blur due to motion and relatively long image storage time. However, for still pictures or for pictures with little action, a much greater number of camera elements might be used successfully in order to make transmission possible with poor light or in order to make possible a much greater depth of focus. This blurring of action is, of course, not a factor when all cameras operate simultaneously, with added outputs.

By groups of cameras in the previous paragraphs an arrangement is meant in which two or more of the cameras have iconoscopes which are scanned simultaneously to make a common combined picture signal. This use of multiple cameras alone makes possible an improvement in signal to noise ratio with increase in depth of focus or decrease in unnecessary illumination because it improves signal to noise ratio in proportion to not less than the square root of the number of cameras simultaneously active. When properly adjusted, the signal of the cameras can be made to add in phase and produce a maximum resultant useful current. However, the spontaneous noise currents from the several cameras have random instantaneous phase and frequencies and so cannot add up to a maximum signal. Consequently, improvement in signal to noise ratio while operating cameras in parallel to reproduce the same scene may approach a ratio equal to the number of cameras if a great enough number of cameras are used. The circuits are designed to provide optimum output impedance for signal currents and far from optimum output impedance for noise currents. The effect obtainable is identical with that obtainable by operating several parallel receivers and antennas to pick up the same signal, having no mutual couplings between antennas and receivers until the final output, but having the output signals combined in phase with correct impedance adjustments. Such an arrangement can be very effective in improving the signal to noise ratio when the noise is due to independent spontaneously generated potentials in the first circuits and tubes of the receiver. It can be applied in the case of paralleled television cameras without increasing the blurring of the moving images because it does not increase the storage time for each image.

While a number of systems for carrying this invention into effect have been indicated and described, it will be apparent to one skilled in the art that this invention is by no means limited to the particular organizations shown and described, but that many modifications may be made without departing from the scope of this invention as set forth in the appended claims.

I claim as my invention:

1. In a television camera system including a plurality of transmitter tubes each having a light sensitive electrode and means for producing an electron beam adapted to scan said electrode, an optical system for applying like images to each of said electrodes, and means for interrupting the beams of said transmitter tubes in a predetermined sequential relation during the scanning operation of the other of said beams to effect a composite picture signal therefrom.

2. In a television camera system including a plurality of transmitter tubes each having a light sensitive electrode and an electron gun for producing an electron beam adapted to scan said electrode, an optical system for applying like images to each of said electrodes, and means for interrupting the beams of said transmitter tubes in a predetermined sequential relation dur-

ing the scanning operation of the other of said beams to produce a train of picture signals representing said image from each of said transmitter tubes.

3. A television camera system comprising a plurality of transmitter tubes each having a light sensitive electrode, and an electron gun including a control electrode for directing a stream of electrons toward said light sensitive electrode, an optical system for applying like images to each of said light sensitive electrodes, and means for alternately impressing a bias potential on each of said control electrodes to interrupt the operation of each of said electron guns in sequence.

4. A television camera system comprising a plurality of transmitter tubes each having a light sensitive electrode, and an electron gun including a control electrode for directing a stream of electrons toward said light sensitive electrode, means for deflecting said stream to cause it to scan said light sensitive electrode, an optical system for applying like images to each of said light sensitive electrodes, a source of bias potential and means including a synchronously driven switch for impressing said bias potential on each of said control electrodes sequentially to interrupt each of said electron streams for a time interval equal to the time required to scan said light sensitive electrode.

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