

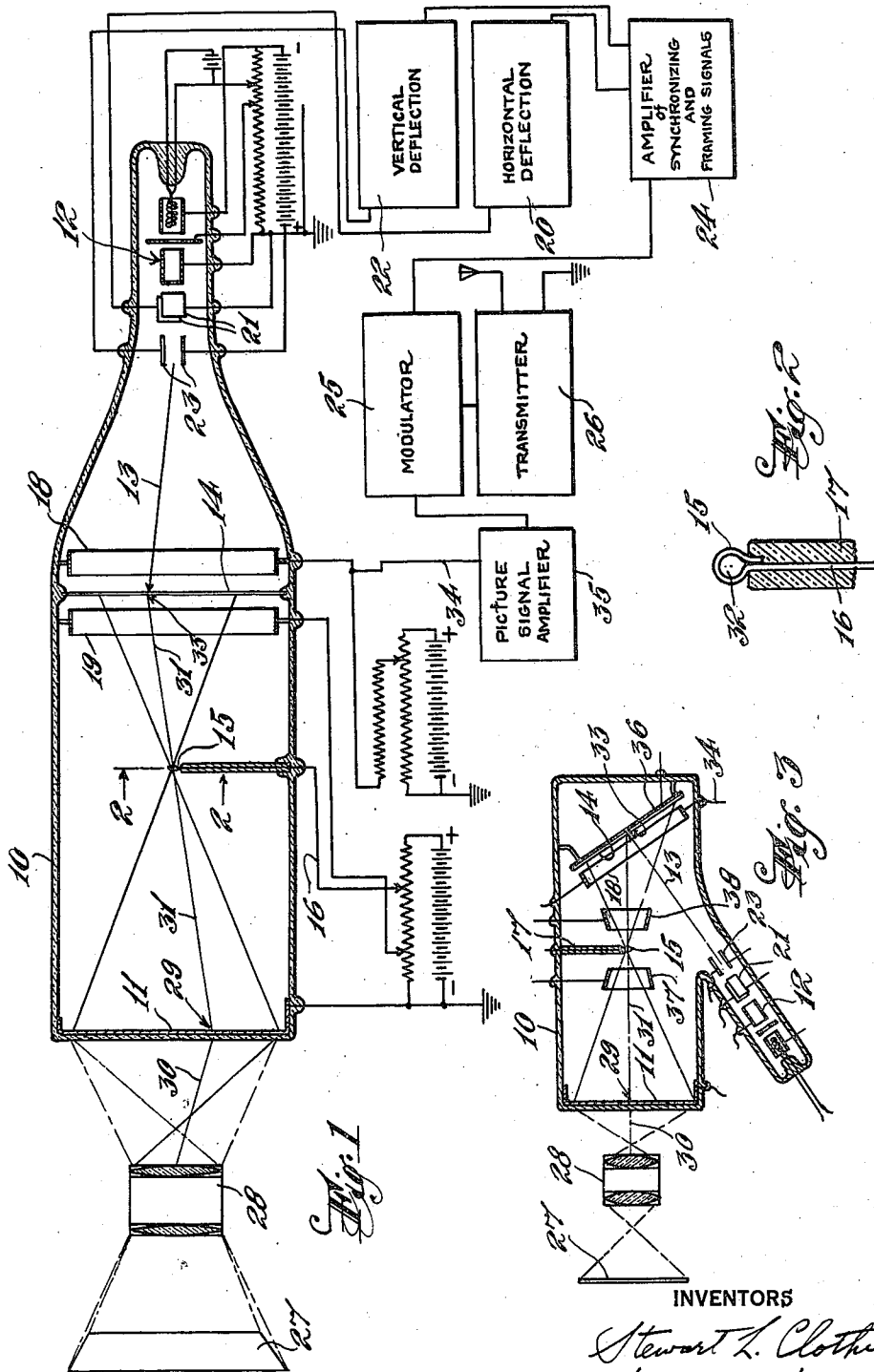
June 20, 1939.

S. L. CLOTHIER ET AL

2,163,545

APPARATUS AND METHOD FOR TELEVISION TRANSMISSION

Filed Aug. 31, 1937



INVENTORS

Stewart L. Clothier  
Harold C. Hogencamp

## UNITED STATES PATENT OFFICE

2,163,545

## APPARATUS AND METHOD FOR TELEVISION TRANSMISSION

Stewart L. Clothier, Irvington, and Harold C. Hogencamp, Maplewood, N. J., assignors to Kolorama Laboratories, Inc., Newark, N. J., a corporation of New Jersey

Application August 31, 1937, Serial No. 161,730

7 Claims. (Cl. 178—7.2)

Our invention relates to improvements in apparatus and methods for television transmission.

While the various apparatus and methods proposed heretofore for television transmission have been effective to transmit a recognizable picture at least over a relatively short distance, each of the same has been found to involve necessarily intrinsic structural characteristics and principles giving rise to problems of manufacture and, generally, definite limitations in the way of detail of the image reproduced at the receiving station, and output level of the picture signals produced by the transmitting apparatus for a given intensity of illumination of the view or subject being televised.

For example, television transmission apparatus of the general type disclosed in Patent Nos. 2,022,450 and 2,006,063 issued to Valdimir K. Zworykin and Arthur W. Vance, respectively embody essentially a photosensitive, mosaic screen composed of relatively small, photosensitive particles spaced and insulated from each other. In such apparatus, the detail or picture definition obtained is a direct function of the number of the photosensitive particles per square inch of the mosaic surface, and the fidelity and output level of the picture signals produced by the apparatus depends upon the uniformity of particle size, the uniformity of photosensitivity of the particles over the entire mosaic surface or area, and the prevention of leakage between adjacent particles. These requirements in the television transmitting apparatus of this general type give the same the definite limitations referred to.

In television transmission apparatus of the general type disclosed in Patent No. 1,773,980 issued to Philo T. Farnsworth, there is no requirement for a mosaic, photosensitive screen, but there is, however, the requirement for simultaneous deflection, in horizontal and vertical directions, of electrons issuing simultaneously from the individual elemental areas of a photosensitive screen, with respect to a single, remote and relatively minute anode disposed on the far side of a small aperture in a metallic plate. Such apparatus has been found to involve problems due to occurring distortion of the electron stream, and the fact that each of the individual rays of electrons making up the entire stream is not focused perfectly on the anode as the stream is deflected for scanning.

With the foregoing in mind, an object of our invention is the provision of an improved apparatus and method for television transmission which avoids the difficulties referred to, and by which a

substantially greater output level of picture signal can be obtained, for a given intensity of illumination of the view or subject being televised and for a given amount of signal amplification at the transmitter, than has been possible with the various apparatus and methods proposed heretofore for the same purpose.

Other objects and advantages will hereinafter appear.

Our invention resides in the improved construction and method of operation hereinafter described and claimed.

For the purpose of illustrating our invention, an embodiment thereof is shown in the drawing, wherein:

Figure 1 is a simplified, diagrammatic view of television transmission apparatus constructed and operating in accordance with our invention;

Figure 2 is an enlarged, fragmentary, sectional view, the section being taken on the line 2—2 in Fig. 1; and

Figure 3 is a view similar to Fig. 1, showing a modification.

In the drawing, the reference numeral 10 designates an evacuated tube provided at an end thereof with a photosensitive screen 11. The screen 11 may be formed on the inside surface of the transparent end wall of the tube, and be in the form of a continuous, semi-transparent coating of silver over which is silver oxide and cesium, as will be well understood by those skilled in the art. As an alternative, the screen 11 may be in the form of a wire screen of fine mesh, photosensitized and supported within the tube in spaced relation with respect to the adjacent end wall thereof.

At its opposite end, the tube 10 is provided with means, in the form of a gun 12 of a suitable conventional construction, for developing a ray 13 of electrons, directed at and focused on a screen 14. The screen 14 is supported between the photosensitive screen 11 and the gun 12, and the edge thereof is at least slightly spaced from the wall of the tube. The screen 14 is impermeable, that is, there are no apertures or openings in the effective or operating area of the same, and at least this area is made entirely of insulating material such as mica or glass.

Supported intermediate the screens 11 and 14, and disposed on a line through the respective centers of these screens, which in this case would also be the axis of the tube, is a single anode 15 of elemental size compared to the areas of the screens. As shown in Fig. 2, the anode 15 may be in the form of a small wire loop formed from

the end of a supporting and connecting wire 16 which may be encased in a glass stem 17 extending radially inwardly from the wall of the tube.

An electrode 18, which may be in the form of a metal ring, is supported adjacent to and on the gun side of the screen 14. A similar electrode 19 is supported on the opposite side of the screen 14, adjacent thereto. If desired, the electrodes 18 and 19 may be in the form of rings of silver coating or other electrically-conductive coating on the inside surface of the tube.

A saw-tooth voltage wave at line frequency is supplied by a generator 20 and impressed across deflecting plates 21. A saw-tooth voltage wave at the frame frequency is supplied by a generator 22 and impressed across deflecting plates 23. In this way, the ray 13 of electrons is deflected simultaneously in horizontal and vertical directions to cause it to scan the adjacent surface of the screen 14 in a conventional manner.

Synchronizing and framing signals are also supplied by the generators 20 and 22, respectively; and after amplification by a common amplifier 24 are fed to a modulator 25 and thence to the transmitter 26.

A light image of the view or subject 27 for transmission is focused by a suitable lens system 28 on the adjacent surface of the semi-transparent, photosensitive screen 11.

In operation, the anode 15 and the electrodes 18 and 19 are maintained at potentials positive with respect to the potential of the screen 11, and the potentials of the anode 15 and the electrode 18 are positive with respect to the potential of the electrode 19, as represented in the drawing. It will be understood that for any particular condition of operation, adjustments will be made to place the respective potentials of the anode 15 and the electrodes 18 and 19 at the values for most efficient operation. As an example, the potential of the anode 15 with respect to that of the screen 11 might be of the order of 1,000 volts positive.

In explaining the manner in which our improved apparatus is believed to operate, the electrical action at only one of the minute, elemental areas or points 29 of the entire effective portion of the photosensitive screen 11, will first be considered. Electrons are emitted from the point 29 in amount corresponding to the intensity, at the instant, of the light ray 30 coming from the corresponding point of the subject 27, and the amount of electronic emission varies instantaneously with and directly proportionally to occurring variations in intensity of the light ray 30. At any instant, the electronic emission directly at the photosensitive point 29 takes place in many different directions and in a more or less haphazard fashion. However, the strong attraction of the anode 15 for the electrons causes them to fall in line and travel a common, straight path 31, at high velocity, to the anode 15. Some of the electrons will be absorbed by or passed to ground by way of the anode 15, but the remainder, still at a relatively high velocity, will pass on through the pinhole aperture 32 in the anode and continue along the straight path 31 to the complementary or corresponding elemental area or point 33 of the adjacent surface of the screen 14, whereupon an electrostatic charge is developed or induced on the opposite side of the screen 14, directly opposite the point 33. Such electrostatic charge, like the original electronic emission from the point 29 of the photosensitive screen 11, corresponds in value to the intensity, at the instant,

of the light ray 30, and varies instantaneously with and directly proportionally to occurring variations in intensity of the light ray 30.

When the electron ray 13, the intensity of which is constant, strikes the screen 14 at the point 33 during the scanning action, the electrostatic charge referred to is instantaneously neutralized by the electrons of the ray, but only such number of electrons are taken or absorbed from the ray as is required to neutralize the charge. The remainder of the electrons of the ray 13 are collected by the electrode 18 and constitute the picture current or picture signal for that particular point of the subject 27 being analyzed at the instant.

The picture signals are taken from the collector electrode 18 by a connection 34 and supplied to a picture-signal amplifier 35, from whence they pass to the modulator 25 and the transmitter 26.

The electrical action at each of the other minute, elemental areas or points of the entire effective portion of the photosensitive screen 11 is the same as that at the point 29.

Excessive electrons are collected by the electrode 19.

From the foregoing it will be seen that a light image of the view or subject 27 being televised is converted into electrical picture signals which, when transmitted to complementary scanning apparatus at a receiving station, can be reconverted to produce a visible image or reproduction of the subject 27.

In the modification shown in Fig. 3, the various parts corresponding respectively to and serving the same purpose as the respective parts in Fig. 1, are designated by the same respective reference numerals as the latter. In this case, however, the electron gun 12 and the collector electrode 18 are on the same side of the screen 14 as the photosensitive screen 11, and neutralization of the electrostatic charges by the electrons of the scanning ray 13 takes place on this side of the screen 14. Also, the screen 14 is backed by a supporting metallic plate 36 from which the picture signals may be taken instead of from the electrode 18. The arrangement and operating action, otherwise, is similar to that in Fig. 1.

In Fig. 3, oppositely directed, conical electrodes 37 and 38 are shown, on opposite sides of the anode 15, and both are maintained at potentials positive with respect to that of the screen 14. The potential of either or both of the electrodes 37 and 38 may be negative with respect to that of the anode 15. While use of the electrodes 37 and 38 is not essential, it is seen that the electrical influence of the same might improve the operating action. By variation of the respective potentials on the electrodes 37 and 38, the size of the electrostatic image on the adjacent surface of the screen 14 may be controlled, and, also, the number of effective electrons reaching this surface by way of the aperture 32 may be brought to a maximum. Similar electrodes may be embodied in the construction shown in Fig. 1.

Considering our invention from the broader aspect thereof, it will be seen that this resides in a new method of operation in which electrons, emitted from the individual, elemental areas or points of the entire effective portion of a photosensitive screen, are caused to converge simultaneously toward a common focal region remote from such screen, this region in the embodiment disclosed being that immediately at or about the anode 15. Also, in our new method of operation, 75

electrons are caused to travel toward the respective, individual elemental areas or points of the entire effective portion of a screen, such as the screen 14, and simultaneously in paths diverging from a common focal region remote from this screen.

Furthermore, in our new method of operation, it will be seen that electrons are caused to travel from any one, individual, elemental area or point of a first screen, such as the point 29, toward a corresponding elemental area or point of a second screen, such as the point 33, and along paths which substantially intersect the respective paths of simultaneous and similar travel of electrons from the other individual, elemental areas or points of the first screen.

Another important aspect of our invention resides in the operating step wherein electrical conditions occurring at the individual, elemental areas or points of the entire portion of a screen, such as the photosensitive screen 11, are simultaneously utilized to produce, at the respective and corresponding individual, elemental areas or points of the entire portion of a second screen, such as the screen 14, electrical conditions corresponding respectively in value to said first-mentioned electrical conditions.

As to the construction of our improved apparatus, it will be seen that this does not embody the undesirable mosaic screen to be found in some of the various constructions of television transmitting tubes proposed heretofore, and, furthermore, avoids the various difficulties of manufacture and operation referred to before.

It will be understood that various modifications, such as in the size, shape and arrangement of the parts, are possible without departing from the spirit of our invention or the scope of the claims.

We claim as our invention:

1. In apparatus for television transmission, a photosensitive screen, a second screen, means for causing the travel of electrons from each individual elemental area of said first screen toward a corresponding elemental area of said second screen and along a path which substantially intersects the respective paths of simultaneous and similar travel of electrons from all other individual elemental areas of said first screen at a common focal point intermediate said screens, and means including a cathode ray gun structure for scanning said second screen with an electron beam to develop picture signals.

2. In apparatus for television transmission, a photosensitive screen, a second screen, a single ring anode of minimum surface area with an aperture of elemental size compared to the respective areas of said screen, said anode being disposed intermediate said screen and substantially on a line through the respective centers of said screens, and means including a cathode ray gun structure for scanning said second screen to develop picture signals.

3. In apparatus for television transmission, a photosensitive screen, a second screen of insulating material, a single apertured ring anode of elemental size compared to the respective areas of said screens, said anode being disposed intermediate said screens and operating to effect travel of electrons from the individual elemental areas of said photosensitive screen to the respective and corresponding elemental areas of said second screen and simultaneously along paths which intersect in the region of said anode, means including a cathode-ray gun structure for devel-

oping a ray of electrons and directing the same at said second screen, and means for deflecting said ray to cause the same to scan said second screen.

4. In apparatus for television transmission, a photosensitive screen, a second and imperforate screen at least the effective portion of which is entirely of insulating material, a single centrally apertured anode of elemental size compared to the respective areas of said screens, said anode being disposed intermediate said screens and substantially on a line through the respective centers of said screens, means including a cathode-ray gun structure for developing a ray of electrons and directing the same at said second screen, means for deflecting said ray to cause the same to scan said second screen, and an electrode disposed between said second screen and said ray-deflecting means.

5. In apparatus for television transmission, a tube provided at one end thereof with a photosensitive screen substantially perpendicular to the longitudinal axis of the tube, a lens system for projecting onto said screen a light image of the subject for transmission, an electron gun at the other end of said tube for developing a ray of electrons, a screen disposed in said tube between and spaced from the photosensitive screen and said gun and being substantially perpendicular to said axis, said second-named screen consisting entirely of imperforate insulating material at least in the operating area thereof, means for causing the travel of electrons simultaneously from each of the individual elemental areas of said photosensitive screen to the respective and corresponding elemental areas of said second-named screen and along paths which intersect said axis at a common focal point, and means for deflecting said ray of electrons to cause the same to scan said second-named screen.

6. In apparatus for television transmission, a tube provided at one end thereof with a photosensitive screen substantially perpendicular to the longitudinal axis of the tube, a lens system for projecting onto said screen a light image of the subject for transmission, an electron gun at the other end of said tube for developing a ray of electrons, a screen disposed in said tube between and spaced from the photosensitive screen and said gun and being substantially perpendicular to said axis, said second-named screen consisting entirely of imperforate insulating material at least in the operating area thereof, means disposed between said screens and operating to effect travel of electrons from the individual elemental areas of said photosensitive screen to the respective and corresponding elemental areas of said second-named screen and simultaneously along paths each of which intersects said axis at a common focal point, and means for deflecting said ray of electrons to cause the same to scan said second-named screen.

7. In a television transmitter a cathode-ray tube including a photosensitive screen at one end, a second screen of imperforate insulating material spaced from said first screen, means intermediate said screens for causing electrons emitted from said photosensitive screen to travel to said second screen, and means including a cathode-ray gun structure for scanning said second screen with an electron beam to develop picture signals.

STEWART L. CLOTHIER.  
HAROLD C. HOGENCAMP.