Feb. 18, 1941. L. H. SMITH 2,231,960

CATHODE RAY IMAGE PROJECTING DEVICE

Filed Oct. 16, 1939 2 Sheets-Sheet 1

FIG. 2

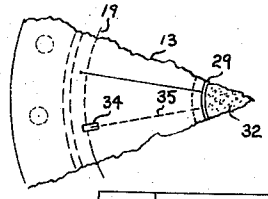


FIG. 1

FIG. 3

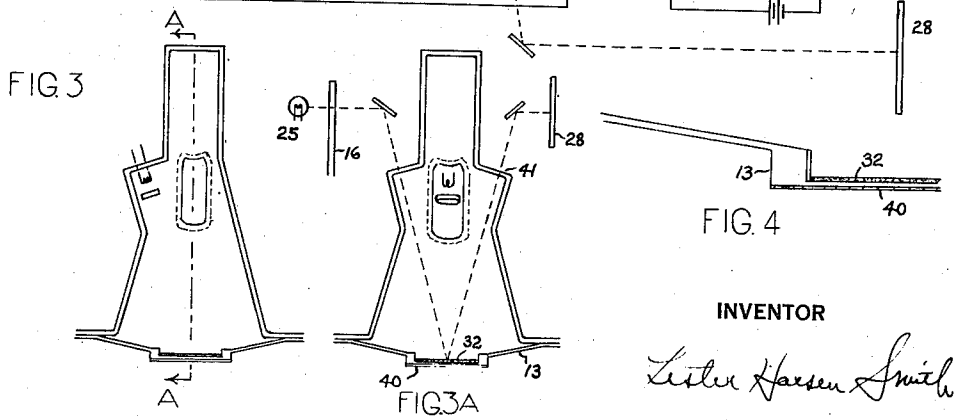


FIG. 3A

FIG. 4

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CATHODE RAY IMAGE PROJECTING DEVICE

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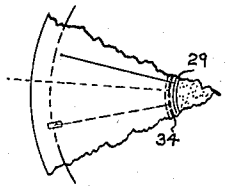


FIG. 6

FIG. 5

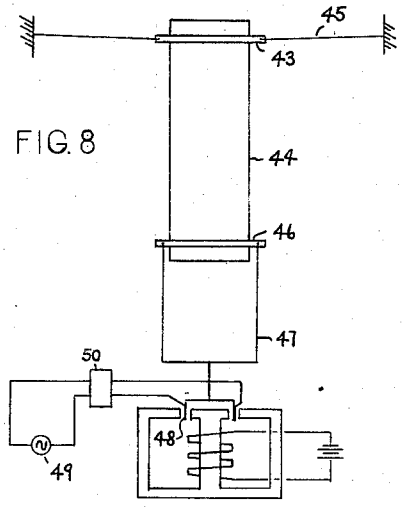


FIG. 8

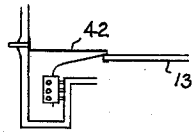


FIG. 7

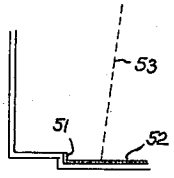


FIG. 9

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UNITED STATES PATENT OFFICE

2,231,960

CATHODE RAY IMAGE PROJECTING DEVICE

Lester Harsen Smith, Maplewood, N. J.

Application October 16, 1939, Serial No. 299,611

15 Claims. (Cl. 178—7.5)

This invention relates to electrically controlled light valves. More specifically, the invention relates to electrically controlled devices whereby the uniform cross-section of a beam of light may be converted into a light and shadow image in which all elemental areas occur simultaneously, much the same as a composite light and shadow image is generated by a photographic negative inserted in a light beam.

The primary application of this invention is to the reception of television scanning signals and the production therefrom of semi-opaque images which may be employed in a light projection system similar to that of a moving picture projector.

Methods heretofore proposed in the television art have been mainly concerned with producing by means of electronic scanning beams, images which are in a continual state of change. In this type of equipment the image forming surface may be either normally opaque or normally transparent before scanning. Certain fundamental limitations are inherent in each type. A scanning device with a normally transparent image surface must maintain all opaque parts of the image generated at least as long as the time between successive scanning operations. This comparatively long time lag is difficult to control. Image forming screens which are normally opaque are usually limited in the point by point variation in opacity which can be generated by a scanning beam without sacrificing fineness of detail. This point by point variation in opacity is usually of short duration which further limits the amount of light that can be passed through such an image forming surface.

Methods involving actual transfer of fine opaque particles from point to point on the surface to form a composite image should approach the results obtained with photographic negatives if a practical method can be found of transferring the particles from point to point on the image forming surface and controlling the disintegration of the image.

My invention resides in an improved method of forming composite stable images at intervals on an image forming surface that is normally transparent, but is cut off from view between image formations by a light shutter, and involving an improved method of transferring opaque particles from point to point on the image forming surface.

Other objects of this invention will be apparent from the drawings and the following description of the features of the invention and in the provision of apparatus and methods of operation for accomplishing the foregoing object.

In accordance with my invention, an electronic beam of varying intensity controlled by the image signals received from the picture transmitter is caused to scan a surface of transparent nonconducting material. This image forming surface is an integral part of the cathode ray tube and is in a state of rapid vibration in a vertical direction while it is being scanned. Distributed on the surface are small particles of an opaque material which may be of relatively high electrical resistance, such as soapstone, ceramic porcelain or Bakelite if the electronic features of the tube could be designed so that the vapor pressure of substances such as Bakelite would not be objectionable. With certain arrangements which will be described in detail later, conducting materials such as carbon might be used. When the image forming surface is vibrating, these particles are continually rebounding from the surface. The presence of this thin cloud of rebounding particles above the image forming surface does not prevent the scanning beam from depositing an image of electric charges on the image forming surface. As the particles leave the image forming surface they are in an electrically charged state due partly to collision with electronic rays impinging on the particular area and partly to a natural tendency of electric charges already on the image forming surface to spread onto the particles in contact with the surface and to remain on these particles as they rebound from the surface. Electrostatic repelling action between the charged particles themselves and between the charged particles and the electric image charges on the image forming surface produces a horizontal migration of these opaque particles, such that when the vibration of the image forming surface is stopped, the particles settle on the surface in a pattern which conforms to the pattern of electric image charges deposited on the image forming surface by the scanning beam. At the same time that the vibration of the image forming surface is stopped, light is allowed to pass through the tube and the semi-opaque image on the image forming surface, producing the desired light and shadow image.

Since the electric image charges deposited by the scanning beam must remain largely undissipated through each interval of vibration and agitating of the image forming particles, in order to maintain the variations of electrostatic potential from point to point on the image forming

surface to bring about horizontal migration and redistribution of the opaque particles, an auxiliary means of charging the opaque particles is desirable. For this purpose my invention may make use of an auxiliary cathode and anode in the tube producing a dispersed electronic beam impinging on the entire image forming surface, in addition to the scanning beam. With such an arrangement, the same variations of electrostatic potential would be produced on the surface by the scanning beam charges although they would be above a uniform datum potential due to the dispersed beam.

Referring to the drawings, Fig. 1 shows a preferred arrangement of a television receiving system with an image forming cathode ray tube.

Fig. 2 is a plan view of a section of the image forming diaphragm used in the tube of Fig. 1.

Fig. 3 shows a modification of the receiving tube of Fig. 1.

Fig. 3A is a sectional view along line A—A of the modified receiving tube of Fig. 3.

Fig. 4 is an enlarged sectional view of the diaphragm used in the tube of Fig. 3.

Fig. 5 is a television receiving system employing another modification of the receiving tube shown in Fig. 1.

Fig. 6 is a plan view of a section of the image forming diaphragm used in Fig. 5.

Fig. 7 is a sectional view of a modified type of image forming diaphragm of metal and glass construction.

Fig. 8 is a modification of the arrangement used in Fig. 1 and in Fig. 5 for vibrating the image forming surface, by means of vibrating the entire receiving tube.

Fig. 9 is a sectional view of a rigid image forming surface which may be used in the vibrating tube of Fig. 8.

In Fig. 1 the scanning signals are received on some form of receiving element 1 which may be a wire circuit or a radio antenna. After passing through the receiving amplifier 2 the image signals which will determine the light and shadow effects in the light image to be produced are then connected to the cathode ray image reproducing tube 3 through the conductors 4 which are connected to the primary cathode 5 and the primary control grid 6. The output of the receiving amplifier 2 is also connected to the input of the scanning deflection signal amplifier 7. Amplifier 7 separates the high and low frequency scanning deflection signals which are transmitted separately to the amplifiers 8 and 9 having suitable characteristics for the respective deflection signals.

With the high frequency deflection signals from the output of amplifier 8 connected to the electrodes 10 and the low frequency deflection signals from amplifier 9 connected to the coils 11 the required deflecting fields are set up which cause the cathode beam 12 to scan the surface of diaphragm 13 in synchronism with the scanning operation at the transmitting end of the circuit.

The low frequency scanning deflection signals from selective amplifier 7 are also connected to amplifier 14 whose output is connected to the synchronous motor device 15 used to drive the light interrupting disk 16 and commutator and slip ring arrangements 17 and 18. In this manner the interrupting disk 16 and commutators 17 and 18 are rotated in synchronism with the low frequency scanning deflection signal. The shaded and unshaded segments of the commutators 17 and 18 are permanently connected to the respective shaded and unshaded slip rings.

Diaphragm 13 which may be formed of resilient glass material is fused at the edge to the flange of the glass tube 3. The flange of diaphragm 13 is provided with holes which receive the bolts 39 holding together cemented joints between the diaphragm 13 and iron core 21 and between the iron core 21 and the glass cover 33. The spaces above and below the diaphragm 13 are evacuated and the diaphragm 13 is entirely free to vibrate due to its flexible design. The top surface of diaphragm 13 has a ring shaped electrode 29 with a connection brought out through the flange of the tube 3. The ring 29 and its connection is of silver plated onto the diaphragm surface. The diaphragm 13 has a thin layer 32 of small particles of opaque ceramic insulating material on its top surface inside of the ring 29. The vibration of diaphragm 13 is controlled by the coil 19 which is mounted on porcelain insulating sleeves 34 on the stiff wire supports 35. The upper ends of the wires 35 are sealed into the diaphragm 13. Coil 19 carries an alternating current from source 20 during the scanning operation.

The iron core 21, shown in section, extends completely around the periphery of the tube 3 and is magnetized by the direct current winding 22 also shown in section. The iron magnetic shields 36 and 37 also extend completely around the periphery of the tube and serve to shield the center portion of the diaphragm 13 from stray magnetic flux. The shield 36 is provided with slots through which pass the coil supports 35.

The cathode ray tube 3 is also provided with the usual accelerating electrode 23 and auxiliary electrode 24 for focusing the primary cathode beam. The accelerating potential for the primary beam is supplied to anode 23 through the filter 30 and commutator and slip ring arrangement 17 mounted on the same shaft with the disk 16. The brushes and contact surfaces at 17 are so arranged that the accelerating potential to anode 23 is interrupted at the same instant that light is allowed to pass through the interrupting disk 16. The commutator and slip ring arrangement 17 also controls the potential of the collecting ring 29 on the diaphragm 13. The brushes and contact surfaces at 17 are arranged so that conductor 30 is connected directly to the primary cathode 5 during the scanning operation, ring 29 then being at a slightly negative potential relative to cathode 5. Between scanning operations and at the same instant that light from source 25 passes through the disk 16, the conductor 30 is connected to conductor 31 and the potential of collector ring 29 relative to both cathode 5 and cathode 26 is then positive. Collector ring 29 controls the leakage currents from the surface of diaphragm 13. The potential of anode 24 is constant and is about 4 times the potential applied to anode 23.

The commutator and slip ring arrangement 18 controls the vibration of the diaphragm 13 and its brushes and contact surfaces are so arranged that an alternating current from source 20 is supplied to the winding 19 during the scanning of diaphragm 13 by the primary beam 12, but between scanning operations and at the same instant that light is allowed to pass through the disk 16 the alternating current through the coil 19 is interrupted and the coil 19 short circuited to dampen its motion.

The secondary cathode 26 and secondary anode 27 produce a uniform dispersed cathode beam impinging on the entire upper surface of the diaphragm 13.

The light interrupting disk 16 is provided with holes distributed at proper intervals around the periphery. By means of the optical system shown briefly, light from the source 25 passing through a hole in disk 16 is transmitted through the tube 3 and diaphragm 13 and is projected upon screen 28 in the form of a light and shadow image produced by the small particles on the top surface of diaphragm 13.

Fig. 2 is a plan view of a section of the diaphragm 13 and shows how the electrical connections to the collector ring 29 are brought out through the flange of tube 3.

The operation of the system shown in Fig. 1 is as follows: The primary cathode beam 12 scans the top surface of diaphragm 13 and at the same time the beam varies in intensity all in accordance with the scanning and image signals received through the receiving element 1. During the scanning operation the diaphragm 13 is vibrated by coil 19. The secondary cathode 26 and secondary anode 27 provide a continuous and dispersed cathode beam having a uniform ionizing effect on all the vibrating ceramic particles 32 on the top surface of diaphragm 13. After each scanning operation or cycle of the low frequency deflection signal the commutator slip ring arrangement 17 removes the positive potential from electrode 23 interrupting the beam 12 and also changes the potential of the collector ring 29 which tends to withdraw the stray electrical charges from the surface of diaphragm 13. At the same time the commutator slip ring arrangement 18 interrupts the alternating current in coil 19 also short circuiting the coil and stopping the vibration of diaphragm 13. Disk 16 at the same time allows light from source 25 to pass through the wall of tube 3 and through the diaphragm 13. Due to the action of the primary scanning beam and secondary cathode beam upon the ceramic particles 32 on the top surface of 13, the distribution of these particles now corresponds to the light and dark portions of the light image which was scanned at the transmitting end of the circuit. This image is projected upon the screen 28 by the light originating at source 25.

The image forming tube shown in Fig. 3 and Fig. 3A is similar to the tube of Fig. 1 except that the diaphragm 13 has a silver reflecting surface 40 plated on the lower surface of the diaphragm. Light from the source 25 at the proper instant passes through the interrupting disk 16 and into the tube and through the open spaces in the layer of ceramic image forming particles 32 and after passing through the glass diaphragm 13 is reflected by the silver surface 40 and passes back through the diaphragm 13 and out through the wall of the tube at 41 to be projected on the screen 28.

Fig. 4 is a sectional view of the image forming diaphragm of Fig. 3 and shows the plated silver reflecting surface 40 on the bottom of the diaphragm 13.

The receiving system shown in Fig. 5 is very similar to the one just described in connection with Fig. 1. In Fig. 5 the scanning signals from the receiving element 1 pass through the receiving amplifier 2 and the image signals are impressed across the cathode 5 and control grid 6 while the deflection signals after passing through amplifiers 7, 8, and 9 are impressed on the electrodes 10 and windings 11 in the same manner as in Fig. 1. The low frequency scanning deflection signals through amplifier 14 also control a synchronous motor device 15 driving the light interrupting disk 16 and commutator devices 17 and 18 as in Fig. 1. In Fig. 5 the image forming tube is arranged with the scanning beam acting on the under side of the diaphragm while the secondary cathode 26 and secondary anode 27 produce a dispersed beam acting on the top surface of diaphragm 13. In this instance the tube 3 and glass cover 33 are designed so that the iron core 21 is entirely outside of the tube since the space on both sides of diaphragm 13 is highly evacuated and the triple joint between the flange of tube 3 and the edge of diaphragm 13 and the glass cover 33 is a fused joint.

The collecting ring 29 in Fig. 5 is connected directly to anode 27 and has a positive potential. The commutator slip ring arrangement 18 and diaphragm actuating coil 19 control the vibration of diaphragm 13 as in the tube of Fig. 1. The commutator slip ring arrangement 17 controls the potential of anode 23 through filter 38 and reverses the potential of collector ring 34 in synchronism with the low scanning frequency. The collector ring 34 on the lower surface of diaphragm 13 controls the dissipation of electrical charges deposited by the scanning beam 12 and has a potential which is negative relative to cathode 5 during the scanning operation and positive between the scanning operations. The diaphragm 13 has on its top surface a thin layer of powdered ceramic insulation material 32 as in the tube of Fig. 1. The magnetic shields 36 and 37 are similar to those in Fig. 1.

Fig. 6 is a plan view of a section of the resilient glass diaphragm used in Fig. 5 showing the connections to electrodes 29 and 34.

In Fig. 5, during the scanning of the under side of diaphragm 13 the beam 12 leaves certain areas highly charged and other areas charged very little, if any. The distribution of ionized particles agitated on the top side of diaphragm 13 will be influenced by the charges on the lower surface of the diaphragm. Since the intensity of the scanning beam 12 varies in accordance with the image signals, the distribution of the particles on the top surface will correspond to the light and shadow image scanned at the transmitting end of the circuit. Between scanning operations light from the source 25 passes through a hole in the disk 16 and then through the tube 3 and diaphragm 13 and the resulting light and shadow image is projected through a suitable optical system upon the screen 28.

Fig. 7 shows a sectional view of a modified construction of a flexible image forming diaphragm consisting of a flexible metal ring 42 with a glass plate 13 mounted in the center.

A cathode ray image forming device such as I propose may be considerably smaller in size than the conventional type of receiving tube which forms a luminous image on the end wall of the tube. Fig. 8 shows a modified method of vibrating an image forming surface by suspending and vibrating the entire receiving tube. In Fig. 8 a metal band 43 is clamped around the top portion of the tube 44. Short lengths of wire 45 extend from the metal band 43 to suitable points of attachment. At the bottom of the tube a second metal band 46 is clamped around the tube and connected by a linkage 47 to the alternating current winding 48. Alternating current from the source 49 passes through a switching device 50 which controls the vibration of the tube 44 and synchronizes the intervales of vibration with the scanning operation in the tube.

If the entire tube is vibrated with an arrange-

ment similar to that of Fig. 8, a more rigid type of image forming surface than those of Figs. 1, 3 and 5 may be used. The image forming surface shown in Fig. 9 is a part of the tube wall and includes a collecting ring or electrode **51** similar to that of Fig. 1 and a layer of ceramic insulating particles **52** which are exposed to the action of a scanning beam **53**.

In the several preferred forms of this invention illustrated in the drawings, I have shown image forming particles of opaque ceramic insulating material. Particles of opaque conducting material such as carbon might be used when the use of such a material would not bring about too rapid dissipation of the electric image deposited by the scanning beam. With the arrangement of Fig. 5, for example, opaque image forming particles of conducting material might be used since the electric image surface and the semi-opaque image forming surface are separated by the thickness of diaphragm **13**.

In Figs. 1 and 5 I have shown a constant potential used between the secondary cathode and secondary anode. I may arrange the connections so that the potential across the secondary cathode and anode is adjustable thereby controlling the intensity of the secondary dispersed beam which would vary the general density of the agitated layer of opaque particles on the top surface of the diaphragm due to mutual repulsion of the ionized particles. This would change the general opaqueness of the image formed on the diaphragm.

In the receiving systems of Figs. 1 and 5 instead of the commutator and slip ring contact surfaces used to control vibration of the diaphragm **13** and the potentials on various electrodes in the tubes, I may employ alternating potentials properly synchronized to perform one or more of these control functions.

In Figs. 1 and 5 instead of the light interrupting disk **16** I may use any other synchronized light interrupting device capable of transmitting the required amount of light for projecting the image upon the screen **28**.

In Figs. 1 and 5 I have used deflecting plates and electro magnetic windings for controlling the high and low frequency deflections respectively. Instead of this arrangement I may employ deflecting plates for both high and low frequency deflections of the scanning beam or electromagnetic windings may be used throughout instead of deflecting plates.

In Figs. 1 and 5 I have used a synchronous motor device **15** which may consist of a sonic motor and synchronous motor combination controlled by the low scanning deflection frequency to operate a light interrupting disk. Where the alternating current supply is synchronized with alternating current available at the television transmitter, I may employ an ordinary synchronous motor running on the alternating current supply to drive any mechanical light interrupting or electrical contact devices required.

In the systems described in Figs. 1 and 5 an equal number of scanning operations and light image projections take place per intervale of time. Twenty scanning operations per second would produce 20 image projections or frames per second. This invention is not limited to operation with an equal number of scanning and projection cycles per intervale of time. The number of one of these cycles may be a multiple of the other cycle per time intervale. Where the frequency of the scanning cycle and the frequency of the image projecting cycle differed widely they would not need to be synchronized.

This invention has been illustrated only in a general preferred form throughout and it should be understood that it is capable of many and varied modifications without departing from its purpose and scope and I therefore believe myself to be entitled to make and use any and all of these modifications such as suggest themselves to those skilled in the art to which the invention is directed provided that such modifications fall fairly within the purpose and scope of the hereinafter appended claims.

What is claimed is:

1. Receiving tube comprising an electron gun emitting an electronic beam, a screen of transparent material of low electrical conductivity arranged so as to be exposed to the electrons emitted by the electron gun, said screen having a layer of fine opaque particles on its upper surface, means associated with the said electron gun for concentrating the beam emitted by said electron gun and for causing it to scan the said screen to deposit electric image charges thereon, means associated with said receiving tube for causing said screen to vibrate in a vertical direction at definite time intervals thereby agitating the opaque particles and causing the said particles to rebound from the surface of the screen, means for ionizing said particles, whereby said ionized particles being electro-statically influenced by the said electric image charges are redistributed on the upper surface of the said screen so as to form on said screen when it ceases to vibrate a semi-opaque image conforming to the pattern of the said electric image charges.

2. Receiving tube comprising an electron gun emitting an electronic beam, a screen of transparent material of low electrical conductivity arranged so as to be exposed to the electrons emitted by the electron gun, said screen having a layer of fine opaque particles on its upper surface, means associated with the said electron gun for concentrating the beam emitted by said electron gun and for causing it to scan the said screen to deposit electric image charges thereon, means associated with said receiving tube for causing said screen to vibrate in a vertical direction at definite time intervals thereby agitating the opaque particles and causing the said particles to rebound from the surface of the screen, means for ionizing said particles, whereby said ionized particles being electro-statically influenced by the said electric image charges are redistributed on the upper surface of the said screen so as to form on said screen when it ceases to vibrate a semi-opaque image conforming to the pattern of the said electric image charges, means for directing a light beam at the said image formed by the opaque particles and out through a window of the tube in the form of a light and shadow image.

3. Receiving tube comprising a first electron gun emitting a first electronic beam, a second electron gun emitting a second electronic beam, a screen of transparent material of low electrical conductivity arranged so that its upper surface is exposed to the electrons emanating from said first and second electron guns, said screen having a layer of fine opaque particles on its upper surface, means associated with one of said electron guns for concentrating the beam emitted by said electron gun and for causing it to scan the said screen to deposit electric image charges thereon, means associated with the other elec-

tron gun for spreading the electronic rays emitted by said electron gun over the upper surface of the said screen, means associated with said receiving tube for causing said screen to vibrate in a vertical direction at definite time intervals thereby agitating the opaque particles and causing the said particles to rebound from the surface of said screen, said particles being acted upon by the electric charges derived from the said first and second electron guns so as to form on the said screen when it ceases to vibrate a semi-opaque image which is in accordance with the pattern of electric image charges deposited on the said screen by the said electronic scanning beam.

4. Receiving tube comprising a first electron gun emitting a first electronic beam, a second electron gun emitting a second electronic beam, a screen of transparent material of low electrical conductivity arranged so that the lower surface of said screen is exposed to the electrons emanating from said first electron gun and the upper surface of said screen is exposed to the electrons emanating from said second electron gun, said screen having a layer of fine opaque particles on its upper surface, means associated with the said first electron gun for concentrating the beam emitted by said electron gun and for causing it to scan the lower surface of said screen to deposit electric image charges thereon, means associated with the said second electron gun for spreading the electronic rays emitted by said second electron gun over the upper surface of the said screen, means associated with said receiving tube for causing said screen to vibrate in a vertical direction at definite time intervals thereby agitating the opaque particles and causing the said particles to rebound from the upper surface of said screen, said particles being acted upon by the electric image charges deposited on the lower surface of the screen by the said first electron gun and the electric charges derived from the said second electron gun so as to form on the said screen when it ceases to vibrate a semi-opaque image which is in accordance with the pattern of electric image charges deposited on the lower surface of said screen by the said first electron gun.

5. In a television receiving tube, a screen of transparent material of high electrical resistance, said screen having on its upper surface a layer of fine opaque particles, an electron gun emitting an electronic beam, means associated with said electron gun for concentrating the beam emitted by said electron gun and for causing it to scan one surface of said screen to deposit electric charges thereon, means associated with said receiving tube for causing said screen to vibrate in a vertical direction at definite time intervals thereby agitating said opaque particles, said opaque particles being acted upon by the electric charges contained in the electronic scanning beam so as to form on said screen when it ceases to vibrate, a semi-opaque image which is in accordance with the electric charges deposited on said screen by said electronic scanning beam.

6. Receiving tube comprising an electron gun emitting an electronic beam, a screen of low electrical conductivity arranged so as to be exposed to the electrons emitted by the electron gun, said screen having a layer of fine opaque particles on its upper surface, means associated with the said electron gun for concentrating the beam emitted by said electron gun and for causing it to scan the said screen to deposit electric image charges thereon, means associated with said receiving tube for causing said screen to vibrate in a vertical direction at definite time intervals thereby agitating the opaque particles and causing the said particles to rebound from the surface of the screen, means for ionizing said particles, whereby said ionized particles being electro-statically influenced by the said electric image charges are redistributed on the upper surface of the said screen so as to form on said screen when it ceases to vibrate a semi-opaque image conforming to the pattern of the said electric image charges, means for directing a light beam at the said image formed by the opaque particles on said screen, means associated with the said screen for reflecting the said light beam from said screen in the form of a light and shadow image.

7. In a television receiving tube, a controlled vibrating screen, said screen being electro-magnetically actuated, said screen having a layer of opaque particles on its upper surface, an electron gun emitting an electronic beam, means associated with said electron gun for concentrating the beam emitted by said electron gun and for causing it to scan one surface of said screen.

8. In a television receiving tube, a screen of transparent high electrical resistance material, means for vibrating said screen, said screen having a layer of opaque particles on its upper surface, an electron gun emitting an electronic beam, means associated with said electron gun for concentrating the beam emitted by said electron gun and for causing it to scan one surface of said screen, said screen comprising a collecting electrode at a varying electrical potential, means for varying said electrical potential so as to control leakage of electric charges deposited on the screen by said electronic scanning beam.

9. In a television receiving tube, a screen of transparent high electrical resistance material, means for vibrating said screen, a first electron gun emitting a first electronic beam, a second electron gun emitting a second electronic beam, said screen having a layer of fine opaque particles on its upper surface, means associated with said first electron gun for concentrating the beam emitted by said first electron gun and for causing it to scan one surface of said screen, means associated with said second electron gun for spreading the electronic rays emitted by said second electron gun over the upper surface of said screen, means associated with said second electron gun for controlling the intensity of the electronic rays emitted by said second electron gun so as to determine the overall density of the semi-opaque image formed on said vibrating screen.

10. A television receiving system comprising a signal receiving element, receiving amplifiers for impressing image signals upon a cathode ray image reproducing tube, a cathode ray image reproducing tube comprising a screen of transparent high electrical resistance material, said screen having a layer of fine opaque particles on its upper surface, an electron gun emitting an electronic beam, means associated with said electron gun for concentrating the beam emitted by said electron gun and for causing it to scan one surface of said screen, means for vibrating said screen in a vertical direction, said receiving system also comprising a source of light and means for interrupting the passage of light from said source through said cathode ray image re-

producing tube in synchronism with the vibration of said screen.

11. A television receiving system comprising a signal receiving element, receiving amplifiers for impressing image signals upon a cathode ray image reproducing tube, a cathode ray image reproducing tube comprising a screen of transparent high electrical resistance material, said screen having a layer of fine opaque particles on its upper surface, an electron gun emitting an electronic beam, means associating with said electron gun for concentrating the beam emitted by said electron gun and for causing it to scan one surface of said screen, means for causing intermittent vibration of said screen in a vertical direction, said intermittent vibration being synchronized with said image signals, said receiving system also comprising a source of light and means for interrupting the passage of light from said source through said cathode ray image reproducing tube in synchronism with the vibration of said screen.

12. A television receiving system comprising a signal receiving element, receiving amplifiers for impressing image signals upon a cathode ray image reproducing tube, a cathode ray image reproducing tube comprising a screen of transparent high electrical resistance material, said screen having a layer of fine opaque particles on its upper surface, an electron gun emitting an electronic beam, means associated with said electron gun for concentrating the beam emitted by said electron gun and for causing it to scan one surface of said screen, means for vibrating said screen in a vertical direction, said receiving system also comprising a source of light and means for interrupting the passage of light from said source through said cathode ray image reproducing tube in synchronism with the vibration of said screen, and an optical system for projecting the light and shadow image produced in the tube upon an exhibiting screen.

13. A television receiving system comprising a signal receiving element, receiving amplifiers for impressing image signals upon a cathode ray image reproducing tube, a cathode ray image reproducing tube comprising a screen of transparent high electrical resistance material, said screen having a layer of fine opaque particles on its upper surface, an electron gun emitting an electronic beam, means associated with said electron gun for concentrating the beam emitted by said electron gun and for causing it to scan one surface of said screen, means for causing intermittent vibration of said screen in a vertical direction, said intermittent vibration being synchronized with said image signals, said receiving system also comprising a source of light and means for interrupting the passage of light from said source through said cathode ray image reproducing tube in synchronism with the vibration of said screen, and an optical system for projecting the light and shadow image produced in the tube upon an exhibiting screen.

14. A vibrating receiving tube comprising an electron gun emitting an electronic beam, a screen of low electrical conductivity arranged so as to be exposed to the electrons emitted by the electron gun, said screen having a layer of fine opaque particles on its upper surface, means associated with the said electron gun for concentrating the beam emitted by said electron gun and for causing it to scan the said screen to deposit electric image charges thereon, means for causing said receiving tube to vibrate in a vertical direction at definite time intervals thereby agitating the opaque particles on said screen and causing the said particles to rebound from the surface of the screen, means for ionizing said particles, whereby said ionized particles being electro-statically influenced by the said electric image charges are redistributed on the upper surface of the said screen so as to form on said screen when said receiving tube ceases to vibrate a semi-opaque image conforming to the pattern of the said electric image charges.

15. A receiving system comprising a signal receiving element, receiving amplifiers for impressing image signals upon a cathode ray image reproducing tube, a cathode ray image reproducing tube comprising a screen of transparent high electrical resistance material, said screen having a layer of fine opaque particles on its upper surface, an electron gun emitting an electronic beam, means associated with said electron gun for concentrating the beam emitted by said electron gun and for causing it to scan one surface of said screen, means for vibrating said cathode ray image reproducing tube in a vertical direction so as to agitate said opaque particles on said screen, said receiving system also comprising a source of light and means for interrupting the passage of light from said source through said cathode ray image reproducing tube in synchronism with the vibration of said cathode ray image reproducing tube.

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