Jan. 7, 1936. D. J. BAKER 2,026,725

TELEVISION SYSTEM AND METHOD

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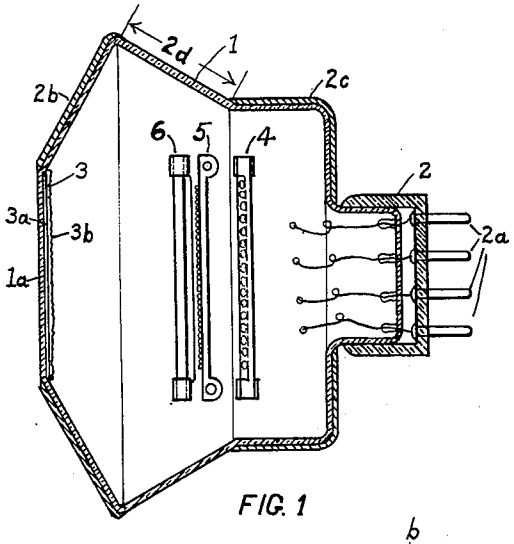


FIG. 1

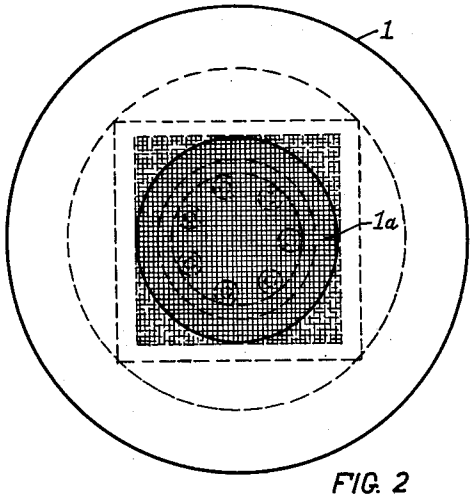


FIG. 2

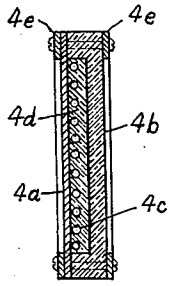


FIG. 3b

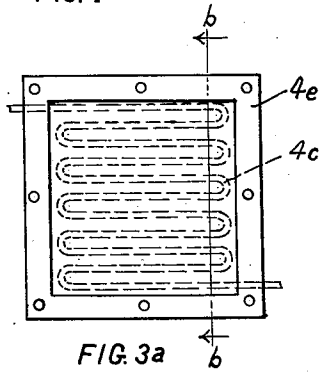


FIG. 3a

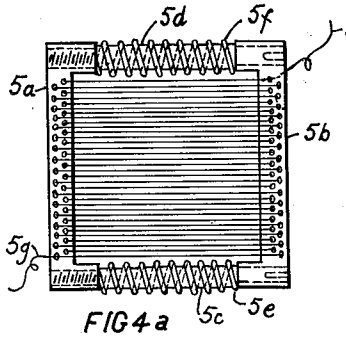


FIG 4a

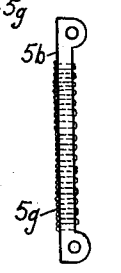


FIG. 4b

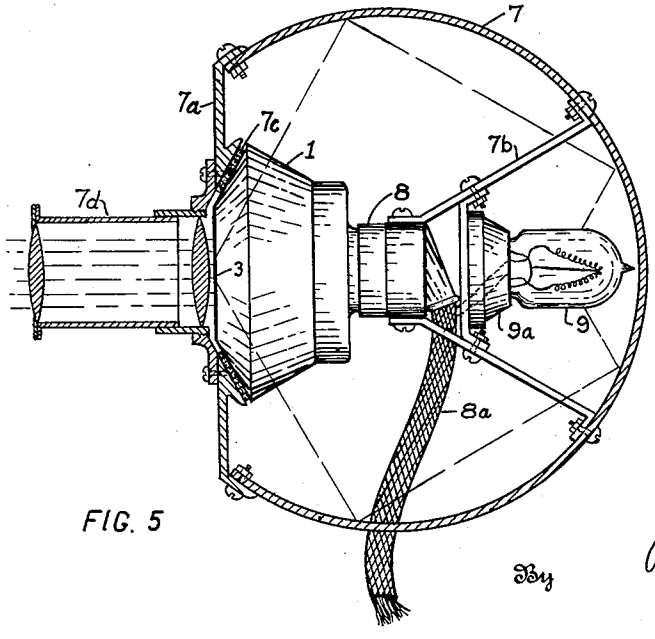


FIG. 5

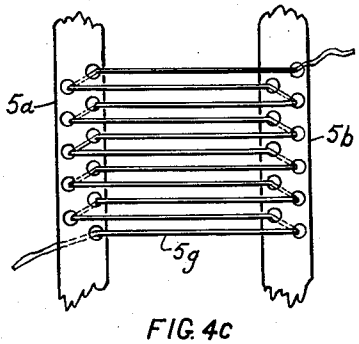


FIG. 4c

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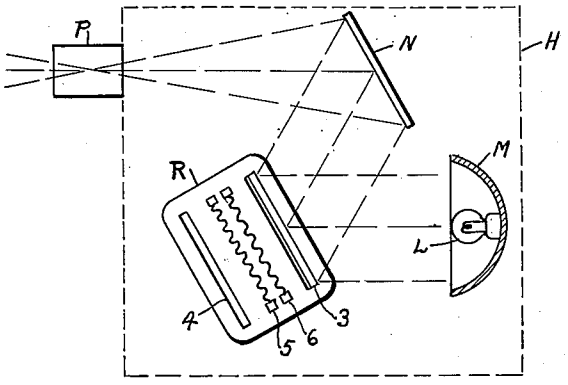


FIG. 5a

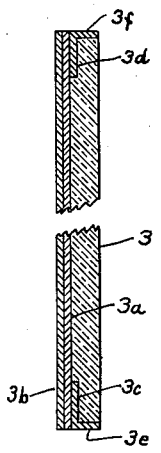


FIG. 5b

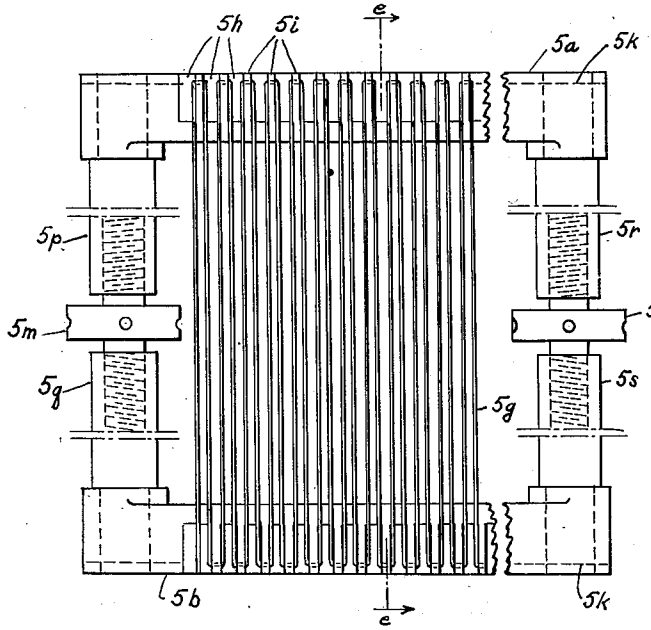


FIG. 4d

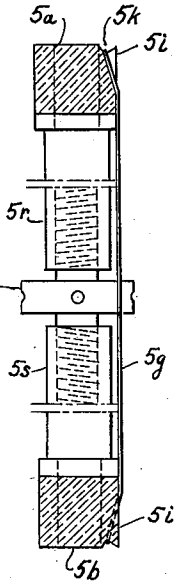


FIG. 4e

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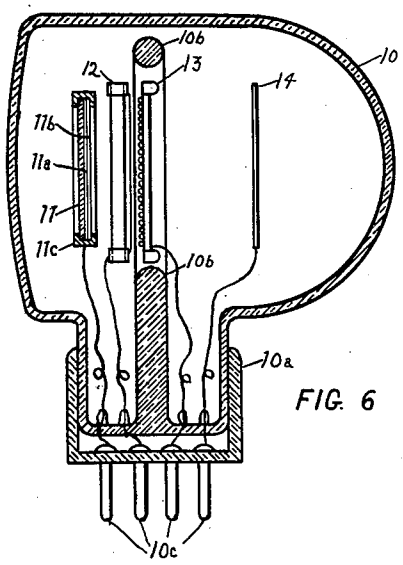


FIG. 6

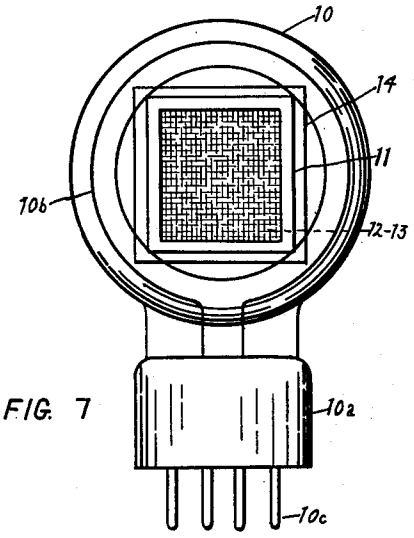


FIG. 7

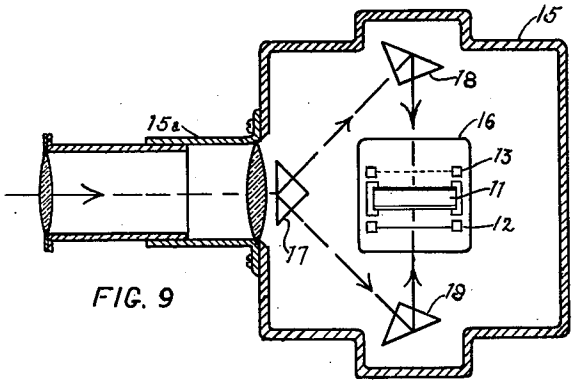


FIG. 9

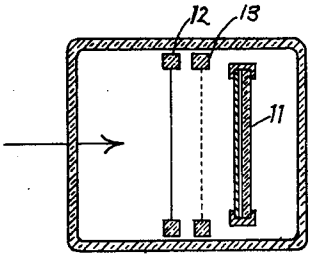


FIG. 8

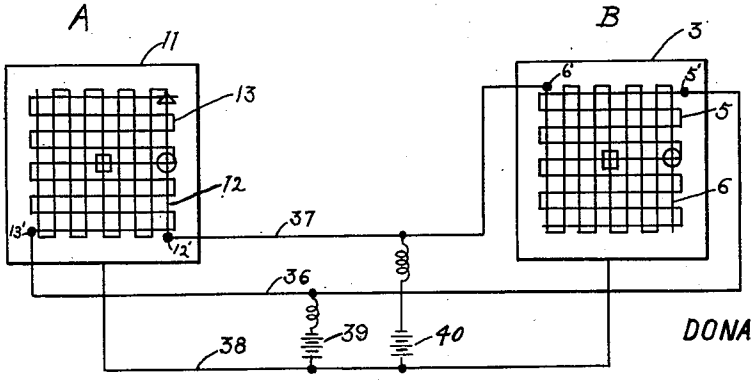


FIG. 12

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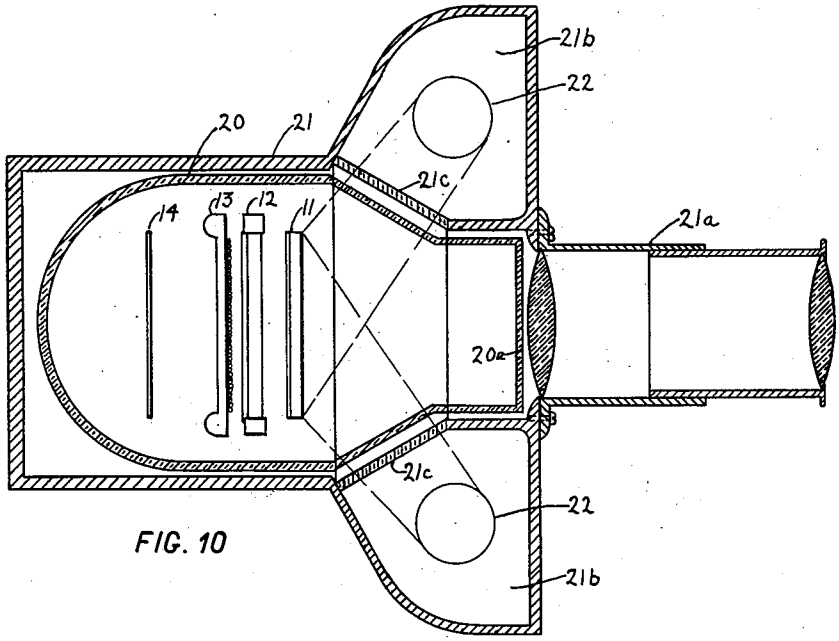


FIG. 10

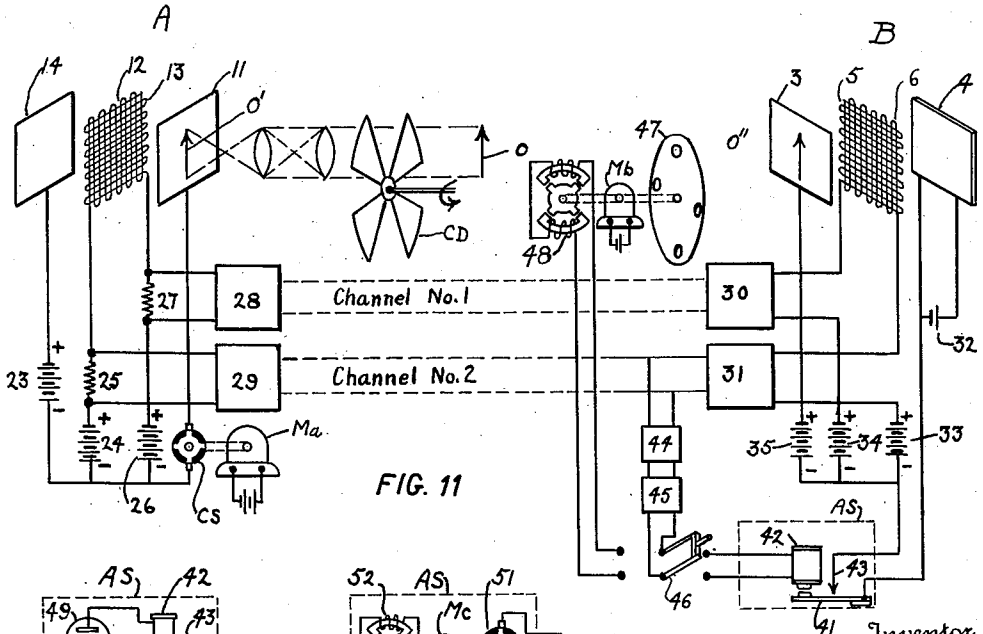


FIG. 11

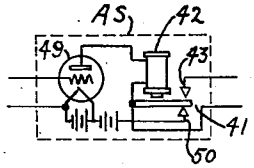


FIG. 11a

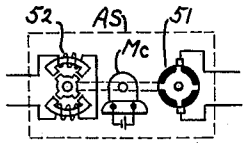


FIG. 11b

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Patented Jan. 7, 1936 2,026,725

UNITED STATES PATENT OFFICE

2,026,725

TELEVISION SYSTEM AND METHOD

Donald Jerome Baker, Hartford, Conn.

Application April 11, 1932, Serial No. 604,622

19 Claims. (Cl. 178—6)

My invention relates to a television system and also to certain component parts employed in this system.

An object of my invention is to devise a television system involving a new method of scanning which does not involve the point-to-point scanning method of the prior art and does not employ moving mechanical parts.

A further object of my invention is to devise a television system which is self-synchronizing, that is, when the system is properly adjusted, synchronism is inherently maintained between the transmitter and the receiver without attention from the operator, and without employing special synchronizing apparatus.

Still another object of my invention is to devise a television system which operates upon a relatively narrow band of transmission frequencies as compared with the band required by systems now in use.

Another object is to devise a television system which is positive in operation, simple of construction, and, therefore relatively inexpensive.

In prior television systems, the method of transmission involves scanning the image to be transmitted one elementary area at a time, transmitting successive current impulses corresponding in light intensity to the different elementary areas forming the image, and at the receiving station these current impulses are translated into corresponding light variations which are distributed upon a receiving screen in the same order in which the original image was scanned. In such systems where only a single point of the image is scanned at any instant, it is necessary to cover in succession all the elementary areas forming the image and at such a rate that the image must be completely scanned 16 or more times per second. In the television system which I have devised the entire image is scanned instantaneously by a horizontal scanning element and at the same time the entire image is scanned instantaneously by a vertical scanning element. Two transmission channels are provided, one for transmitting the current variations derived from horizontal scanning, and another for transmitting current variations derived from vertical scanning. These transmission channels may be either wired circuits or radio channels as will be readily understood by one skilled in the art. At the receiving station the two currents cooperate to project upon a screen every point of the transmitted image at the same instant.

This application is in part a continuation of my copending application Serial No. 573,961, filed November 9, 1931.

My invention is illustrated in the accompanying drawings in which:

Figure 1 is a vertical sectional view illustrating the construction of one form of receiving tube employed at the receiving station;

Figure 2 is a front elevational view of the tube shown in Figure 1;

Figure 3*a* is a front view of the cathode element employed in Figure 1;

Figure 3*b* is a sectional view along line *b*—*b* in Figure 3*a*;

Figure 4*a* is a side elevational view of one of the grid elements employed in Figure 1;

Figure 4*b* is an end view of Figure 4*a*;

Figure 4*c* is an enlarged fragmentary view illustrating the details of construction of Figure 4*a*;

Figure 4*d* is an enlarged broken view of a second form of grid construction;

Figure 4*e* is a sectional view of Figure 4*d* taken along line *e*—*e*.

Figure 5 is an elevational view partly in section illustrating a projector receiving tube assembly on a reduced scale;

Figure 5*a* illustrates another form of projector for intensifying the reproduced image;

Figure 5*b* is a sectional view illustrating the details of construction of the fluorescent plate employed in Figure 5*a*;

Figure 6 is a vertical sectional view illustrating the construction of one form of light sensitive cell employed in the transmitting station;

Figure 7 is a front elevational view of Figure 6;

Figure 8 is a vertical sectional view of a second form of transmitting cell;

Figure 9 is a plan view in section showing a third arrangement of transmitting cell;

Figure 10 is a vertical sectional view illustrating the construction of a fourth form of transmitting cell;

Figure 11 is a schematic circuit diagram of my complete television system;

Figures 11*a* and 11*b* illustrate modified forms of circuit closers employed in Figure 11;

Figure 12 is a simplified circuit diagram for explaining the operation of the system.

Referring to Figure 1, the tube employed at the receiving station for translating the receiving current variations into corresponding light variations comprises a glass envelope 1 provided with a base 2 which in turn is provided with a number of connecting prongs 2*a*. The envelope 1 is provided with a clear circular window 1*a* onto which

the received picture is to be impressed. On the inside of this window section is formed a fluorescent target 3 comprising a thin transparent film of gold or other highly conductive metal deposited on the glass window and on top of this conductor film is deposited a layer of material 3b which fluoresces under bombardment of electrons, such for example, as Willemite or other similar material. An electron emitting cathode element 4 having an active surface substantially as large as the fluorescent screen 3 is mounted parallel to the screen within the tube as shown. Interposed between the screens 3 and the cathode 4 are two control grid elements 5 and 6 arranged parallel to the screen and to the cathode, with their grid wires running at right angles to each other. In the arrangement shown in Figures 1 and 2 the wires in grid 6 are vertical, while the wires in grid 5 run horizontally. The details of the construction by which elements 4, 5 and 6 are mounted within the tube have been omitted for the sake of clearness of showing, and the manner in which these elements may be supported will be obvious to one skilled in the art.

The annular portion of bulb 1 surrounding the window 1a is covered with an opaque coating 2b, such as a metallic foil coating. A second opaque coating 2c is applied over the back portion of the tube, leaving a clear transparent annular portion 2d extending entirely around the tube between the two opaque coatings. It will be understood that elements, 3, 4, 5 and 6 are shown in side elevation in Figure 1, while the tube and its base 2 are shown in sectional view. Each of elements 3, 5 and 6 are provided with a connection to corresponding prongs 2a, and the heating coil in the cathode 4 is connected to two of the prongs 2a. These connections have been omitted from Figures 1 and 2 for the sake of clearness of showing.

The details of construction of the cathode element 4 are illustrated in Figures 3a and 3b. This element is formed of an electron emitting metallic plate 4a which faces the grid elements 5 and 6. This plate is treated in a well known manner or coated with a suitable substance to increase its capacity for electron emission. Plate 4a is mounted upon an insulating, heat resisting backing plate 4b, which is provided with a channel to receive a heating coil 4c, which is retained in position in the channel by an insulating, heat resisting filler material 4d. The electron emitting plate 4a is secured to the base plate 4b by suitable rivets or screws passing through the entire assembly and engaging clamping plates 4e arranged around the outer edge of each side of the cathode element. The backing plate 4b may be formed of any suitable insulating, heat resisting material such as Isolantite or the like, and the filler material 4d may be any suitable ceramic material which is highly heat resistant and insulating. It is obvious that instead of employing a channeled backing plate 4b, the heating coil 4c may be incased in a solid plate at the time of molding the plate. The heating coil would then be baked into the plate as a complete unit. It will be understood that the heating coil 4c is so arranged that the entire surface of plate 4a enclosed within the clamping strips 4e emits electrons from each elementary surface at the same rate.

The details of construction of one form of grid elements 5 and 6 are illustrated in Figures 4a and 4b. The two grids are the same in construction, but they are so mounted that the wires in the two grids are arranged at right angles to each other. The grid element is formed of two side members 5a and 5b made of suitable insulating, heat resisting material. Two rods 5c and 5d are screw-threaded into the ends of side-piece 5a, and side-piece 5b is provided with holes in each end to slidably receive the free ends of the rods 5c and 5d. Expansion springs 5e and 5f are arranged on rods 5c and 5d respectively and tend to push side-pieces 5a and 5b apart. Each of side members 5a and 5b is provided with a number of holes arranged in staggered relation in two rows as shown. The object of staggering the holes is to permit the use of a relatively large hole for a small spacing between adjacent bars of the grid. The vertical distance of separation of adjacent holes is equal to the desired separation between the grid wires. A single wire 5g is threaded through the holes to form a continuous grid beginning at one side of the frame and ending at the other and passing back and forth between the side members 5a and 5b. By threading the grid wire 5g through the holes in the manner shown in greater detail in Figure 4c, the wires forming the grid lie in the same plane on one side of the grid frame. In order that the two grids may lie as close together as possible, the two grid elements 5 and 6 are arranged with their grids facing each other as shown in Figure 1, but not in contact with each other. In winding the grid elements, the side-pieces are pressed towards each other to compress springs 5e and 5f; the grid wire is then threaded onto the frame in the manner shown in Figure 4c, and then the side-pieces are released. The springs 5e and 5f, by pressing the side bars apart, keep the grid wire under constant tension and prevent the grid bars from sagging due to unequal expansion between the wire and the frame with changes in temperature. The wire 5g forming the grid should preferably be of a very small size, and the spacing of the adjacent bars of the grid may be arranged to suit the detail required in the picture; a close spacing giving greater detail than a wide spacing. The spacing between adjacent grid bars will, of course, correspond to the dimension of an elementary area of the picture being transmitted or received, and this will depend upon the degree of detail desired in the transmission.

A second form of construction for the grid element is illustrated in Figures 4d and 4e. In this construction, the insulating side members 5a and 5b, which may be made from Isolantite, are not provided with holes or apertures for receiving the grid wire, but a series of narrow slots 5h are cut in one side of the side members, thus forming a series of equally spaced ribs 5i along one face of each side member. The slots 5h are cut at an angle to the face of the side member so that the slots cut through one corner of the side member and emerge on the adjacent face. A groove or slot 5k is formed in the adjacent side throughout the length of each side member for the purpose of forming a notch or heel on each rib 5i for receiving and retaining the loops of wire 5g forming the grid. As will be seen from the drawings, the ribs of side member 5b are staggered with relation to the ribs of the side member 5a, and the width of the slots 5h and the thickness of the ribs 5i are suitably chosen to produce uniform spacing between adjacent bars of the grid wire 5g. It will be understood that the grid is formed by looping the wire 5g over the slotted ends of the ribs 5i and passing alternately from a rib on one side member to the next rib on the

other side member. It will be seen that this construction presents a more easily assembled grid than that illustrated in Figures 4*a* and 4*b*. The side members **5***a* and **5***b* are held apart by double-ended screws **5***m* and **5***n*, the opposite ends of which are provided with right and left screw threaded engagements with spacing bars **5***p*—**5***q* and **5***r*—**5***s* respectively. By adjustment of the double ended screws **5***m* and **5***n*, the side members **5***a* and **5***b* may be forced apart to apply the proper tension to the grid wire **5***g* after the same is wound upon the grid frame.

It is apparent that Figures 3*a*, 3*b*, and 4*a* to 4*e* are not drawn to scale, but the dimensions have been exaggerated in some cases for the sake of clearness of showing.

Figure 5 illustrates the construction of a projector for the receiving tube shown in Figure 1. This projector comprises a parabolic or elliptic reflector **7** having a highly polished interior surface and provided with a cover **7***a* over its front end. The cover **7***a* is provided with a central opening over which the tube **1** is placed with an annular layer of felt or other resilient material **7***c* interposed. The tube **1** is supported in a socket **8** which in turn is supported by a bracket **7***b* secured to the reflector **7**. The lamp socket **8** is provided with usual connector contacts cooperating with the tube prongs, and a wire cable **8***a* is provided to lead the connections out of the reflector **7**. An incandescent lamp **9** provided with a base **9***a* is also mounted upon bracket **7***b*, and the supply circuit for this lamp is provided through the conductors of cable **8***a*. The lamp **9** is located approximately at the focal point of the reflector **7**. A lens tube **7***d* is mounted on the front of the reflector cover **7***a* immediately in front of the opening in which the tube **1** is mounted. As shown by the two dotted lines proceeding from the lamp **9**, the rays of light from the lamp are reflected by the polished inner surface of the reflector and pass through the transparent portion **2***d* of the tube **1** and illuminate the fluorescent screen **3** within the tube. Any picture which is impressed upon this screen will, therefore, be projected through the lens tube **7***d* onto an enlarged screen outside of the projector. In Figure 5 the projector **7**, its cover **7***a*, felt strip **7***c* and the lens tube **7***d* are shown in vertical sectional view, while the remaining elements are shown in side elevation. It will be understood that the receiving tube **1** may be used without the projector shown in Figure 5, by viewing directly the image formed on the screen **3**.

A second form of projector for intensifying the reproduced image is illustrated in Figure 5*a*. In this arrangement the receiving tube is diagrammatically illustrated at R and comprises an electron emitting cathode **4**, two grid elements **5**, **6** and a fluorescent plate anode **3**. A source of intense light, symbolized by the lamp L provided with a reflector M, is arranged to illuminate the backside of the fluorescent plate **3** with light of uniform and constant intensity. A reflecting mirror N is arranged in the path of light reflected from the fluorescent plate and is so positioned that the light reflected from its reflecting surface is directed along the axis of a lens tube P. This projecting arrangement may conveniently be enclosed in any suitable housing diagrammatically illustrated by the dotted square H.

The construction of the cathode element **4** and the grid elements **5** and **6** of Figure 5*a* may be in accordance with any of the constructions described hereinbefore. Fluorescent plate **3** may, if desired, be formed upon the front wall of the enclosing envelope after the manner described in connection with Figure 1. Another form of construction of this fluorescent plate is illustrated in Figure 5*b*. The plate comprises a transparent plate **3** of insulating material such as glass or Pyrex, on one face of which is deposited a thin transparent film of gold **3***a*, and deposited upon this film of gold is a layer of fluorescent material **3***b* such as Willemite. In order to provide a good electrical connection to the gold film and the fluorescent surface, the plate **3**, before the film is deposited, is first provided with two shallow slots **3***c* and **3***d* on opposite sides in the face of the plate to receive the film. Silver or platinum is then deposited in the slots, as well as upon the two adjacent edges of the plate, to a thickness sufficient to fill the slots, thereby forming metallic corners **3***e* and **3***f* for the plate. Both faces of the plate are then ground to a smooth flat surface, and then the transparent film of gold **3***a* is deposited upon the face of the plate **3** and extends over and into the contact with the metallic corner members **3***e* and **3***f*. Instead of providing the plate **3** with a metallic border on two edges only, it is obvious that this metallic border may be provided around the entire periphery of the plate. This metallic edge affords a means for obtaining good electrical connection with the transparent gold film. It is understood that the dimensions in Figure 5*b* are greatly exaggerated and are not to scale.

In the operation of the projector shown in Figure 5*a*, the transparent film of gold on the fluorescent anode **3** is a very good reflector of the light from the source L, but the fluorescence of the Willemite layer superimposed upon the gold film decreases the reflecting quality of the gold film in proportion to the amount of fluorescence. Accordingly, when different areas of the plate **3** fluoresce to different degrees in accordance with a picture being transmitted from a distant transmitting station and impressed upon the receiving tube R, the amount of light reflected from the different areas on the plate **3** from source L and onto the reflecting surface N will vary according to the changing light values of the picture being transmitted. The light rays forming an image of the received picture are reflected from the reflecting surface N through the lens tube P and onto any suitable viewing screen.

One form of light sensitive tube or cell employed at the transmitting station for translating light variations into electric current variations is illustrated in Figures 6 and 7. The cell comprises a glass envelope **10** provided with a base **10***a* and a reentrant stem having a ring **10***b* formed on its end for supporting the elements of the cell. The base **10***a* is provided with a number of connecting prongs **10***c* for bringing out connections to the elements enclosed within the tube. The front of the envelope **10** shown to the left is substantially flat and is formed of clear optical glass. Behind this clear portion is located a light sensitive element formed of a clear glass plate **11**, one side of which is coated with a transparent conductive film **11***a* such as a film of gold, and on top of this film is a layer of light sensitive material **11***b*, such as a caesium or potassium surface. A metallic frame **11***c* is provided around the outer edge of plate **11** and serves to afford a means for making an electric connection to the light sensitive element, the frame being connected to one of the prongs **10***c*. The

active area of the light sensitive element is sufficiently large to receive a complete image of the object or scene to be transmitted. Behind the light sensitive element is located a vertical screen grid 12 and a horizontal grid 13. These two grids are constructed in the same manner as the grids shown in connection with Figure 1 and illustrated in greater detail in Figures 4a, 4b and 4c. A plate or anode element 14 is located behind the grid 13 as shown. All the elements 11, 12, 13 and 14 may be supported from the stem 10b of the tube in a manner which is obvious to one skilled in the art. The actual supporting extensions have not been shown for the sake of clearness of illustration. Each of these elements is connected to one of the connecting prongs 10c on the base 10a as shown.

Instead of employing the construction shown in Figure 6, the light sensitive element may be formed by replacing the glass plate 11 and the conductive film 11a with a fine wire grid or mesh stretched across the frame 11c and on which the light sensitive material 11b will be deposited and supported. The wires forming the mesh may be so small that they will not materially obstruct the light rays forming the image to be transmitted, and at the same time this wire screen serves to provide an effective electrical connection to the light sensitive surface. The fluorescent screen 3 employed in the tube shown in Figure 1 may be formed in a similar manner.

Another form of light sensitive cell for use at the transmitting station is illustrated in Figure 8. This form of cell employs a light sensitive cathode 11 having the same construction as that shown in Figure 6, and also a vertical grid element 12 and a horizontal grid element 13 of the same construction as described above. These grid elements are only schematically indicated in Figure 8. This form of cell is not provided with a plate element 14 as shown in Figure 6. Also, the image of the picture or object to be transmitted is projected upon the light sensitive element through the screens 12 and 13, and the electrons emitted from the surface of the cathode 11 travel back to the anode screens in a direction opposite to the impressed light rays.

A third form of light sensitive cell is illustrated in Figure 9, where 15 indicates a light tight housing for the cell provided with a lens tube 15a. The light sensitive cell proper, located within the housing 15, comprises a glass envelope 16 enclosing a light sensitive cathode plate 11, both sides of which are coated with light sensitive material. On one side of cathode plate 11 is located a grid anode element 12, and on the other side a grid anode element 13, with the grid bars of the two grid elements arranged at right angles to each other. Mounted within the housing 15, and immediately in front of the lens tube 15a, is a prism 17 for dividing the incoming rays into two paths, one leading to prism 18 and the other to prism 19. As shown by the arrows, prisms 17, 18 and 19 serve to impress identical images on opposite sides of the light sensitive cathode 11. It is obvious that prisms 18 and 19 may be replaced by suitable mirrors.

The cathode elements 11 of Figures 6, 8 and 9 may be constructed in accordance with Figure 5b by substituting a layer of light sensitive material for the layer of fluorescent material.

Since it is not necessary for the light rays forming the image being transmitted to pass through the cathode plate 11 in the tubes illustrated in Figures 8 and 9, these plates, as well as the metallic coating deposited thereon, may be replaced by suitable metallic plates for supporting the light sensitive substance.

In Figure 10 I have illustrated a light sensitive cell arrangement wherein the sensitivity of the cell is increased by the use of infrared rays or any other penetrating ray, such as X-ray or ultraviolet. In this arrangement a light sensitive cell indicated at 20 is enclosed within a light tight housing 21 which is provided with a lens tube 21a covering the optical aperture in front of the face 20a of the cell. The internal construction of the light sensitive cell is like that shown in Figure 6, and corresponding elements are indicated by corresponding reference numerals. Casing 21 is provided with an annular light tight compartment 21b surrounding the front end of the light sensitive cell and in which is located one or more light sources 22 which emit infrared rays. The infrared ray source may be a single lamp of annular form arranged in the annular compartment or a series of small bulb shaped lamps may be arranged at different points around the compartment. The compartment 21b is cut off from the rest of the housing by an opaque annular window 21c, which cuts off visible light but allows infrared rays to pass through and impinge upon the light sensitive cathode 11. The light filter window 21c may be formed of an ordinary glass window coated with copper oxide, or it may be formed of a thin sheet of ebonite. The action of the infrared rays upon the light sensitive cathode 11 causes the image formed on the cathode by lens tube 21a to be more clearly defined and to produce greater electron emission from the cathode surface.

Figure 11 is a schematic circuit diagram illustrating my complete television system. A transmitting station is shown at A and the receiving station at B. The light sensitive cell employed at station A may be any of the cells described hereinbefore, but the arrangement of the tube elements shown corresponds to the tube constructions illustrated in Figures 6 and 10, and like elements are indicated by corresponding reference numerals. The plate element 14 is connected to the light sensitive cathode 11 through battery 23, and this plate element supplies a biasing potential tending to draw the electrons emitted from the cathode 11 to the plate along straight paths passing through the grid elements 12 and 13. Vertical grid 12 is connected to the cathode 11 through a biasing battery 24 and a resistance 25. Likewise horizontal grid 13 is connected to cathode 11 through a battery 26 and a resistance 27. The input terminals of amplifier 28 are connected across the terminals of resistance 27, and the output terminals of this amplifier are connected to transmission channel 1. Likewise the input terminals of amplifier 29 are connected across resistance 25, and the output terminals are connected in a suitable manner to transmission channel 2. These two channels may be wired circuits, in which case the amplifiers 28 and 29 would have direct connection to the line wires, or the channels may be radio channels employing carrier waves of different frequencies. In case radio channels are employed, it is obvious that suitable wave generators and modulators will be provided for converting the currents supplied by amplifiers 28 and 29 into modulated waves for transmission over the channels. One channel may be a radio channel and the other a wire channel.

The object to be transmitted is represented as

an arrow at O, an image of which is formed on cathode 11 by the lens tube in front of the light cell. Arranged immediately in front of the lens tube is a rotating chopper disc CD, which is driven at a speed to interrupt the light rays entering the lens tube at a rate of 16 times per second or higher. Instead of using chopper disk CD, a chopper switch CS may be inserted in the cathode lead and operated by a suitable motor Ma to interrupt and close the cathode circuit 16 or more times per second. When using the chopper disk, the switch CS will be left in a position to complete the cathode circuit or will be short-circuited by a suitable switch. The object of both forms of chopper devices is to render the transmitting tube effective for short intervals in rapid succession or at a rate of 16 or more times per second.

At the receiving station B, channel 1 is connected to the input terminals of an amplifier 30 and channel 2 is connected to the input terminals of an amplifier 31. It will be understood that where the channels involve the use of radio waves, suitable detecting devices are provided in front of the amplifiers 30 and 31. Cathode 4 of the receiving tube is maintained in an electron emitting condition by means of heating battery 32. Vertical grid 6 is connected to the cathode circuit in series with the output circuit of amplifier 31 and in series with biasing battery 33. Likewise horizontal grid 5 is connected to the cathode circuit in series with the output circuit of amplifier 30 and a biasing battery 34. Batteries 33 and 34 may not be required for all tubes, depending upon the tube characteristics. The fluorescent anode screen 3 is connected to the cathode circuit through a battery 35 which maintains the screen at a high positive potential with respect to the cathode. In the lead to cathode 4 is arranged an automatic switch or interrupter indicated at AS and comprising a vibrating contact 41 operated by a magnet 42, and a cooperating fixed contact 43. The magnet 42 is energized from one of the transmission channels through suitable detecting and amplifying devices 44, a suitable phase adjusting device 45, and a switch 46. The arrangement is such that the contact 41 operates in response to the group frequency of the waves transmitted from station A; in other words, in response to the frequency of operation of chopper disk CD or chopper switch CS. If desired, vibrating contact 41 may be a reed contact having means for adjusting its natural period of vibration to correspond to the group or interruption frequency. Also, the circuit of magnet 42 may be electrically tuned to this frequency.

Instead of using the automatic switch AS, the same result may be obtained by viewing the fluorescent plate 3 through a chopper disk 47 driven by a motor Mb. The speed of the disk 47 is automatically maintained at the proper value by a small synchronous motor 48 mounted on the same shaft and energized by the group frequency currents supplied over one channel and through devices 44 and 45. In using the disk 47, the switch 46 is thrown to the left and the switch AS is set to close the cathode circuit, or a short-circuiting switch may be provided around the switch AS.

A second form of switch AS is shown in Figure 11a. In this arrangement the magnet 42 is connected in the plate circuit of a gaseous relay 49 of the thyratron type, the input circuit of which is to be connected to the switch 46. The plate circuit of the relay is completed through a fixed contact 50 cooperating with the armature 41 in such manner as to open the circuit when the magnet is energized. Thus each pulse of the group frequency current supplied to the tube causes the magnet to operate and close the cathode circuit for a short interval through contacts 41 and 43, and at the same time interrupts the plate circuit so that the tube will be in condition for operation by the next pulse.

A third form of switch AS is shown in Figure 11b. Here a rotary switch 51 is driven by a suitable motor Mc, and the speed of rotation is automatically regulated in accordance with the group frequency current by a small synchronous type motor 52 mounted on the same shaft.

In using any of the forms of the switch AS or in using chopper disk 47, the exact instant of operation of the switch or disk is adjustable by the phase controlling device 45 which may comprise any well known adjustable phase shifting arrangement.

It will be understood that the two screen grids located at the transmitting and receiving stations are of the same effective length or size and that the two transmission channels extending between the two stations are of the same effective length. In case these two channels are not of the same length, suitable loading devices may be interposed to balance the channels.

The operation of my invention is as follows, referring to Figure 11: Assume that the chopper disk CD is being used and that the chopper switch CS is either short-circuited or placed in a position to complete the cathode circuit. When an opening in the disk CD passes in front of the transmitting cell, rays of light forming image O' on cathode 11 cause electrons to be liberated from the cathode 11 in the areas covered by the image. These electrons are caused to travel in straight lines from cathode 11 towards the anode 14; some of the electrons passing through grids 12 and 13. Since grids 12 and 13 are charged positively with respect to the cathode 11, each linear section of the two grids lying within the path of the electrons will absorb or receive a certain number of the electrons and produce current pulses in the grid circuits proportional to the light intensity affecting each individual section. Each current pulse from each elementary linear section of each grid will be transmitted as a distinct current pulse independently of the other current pulses produced in other linear portions of each grid. Therefore, where the image of the object being transmitted covers an extended area and contains areas of high and low light value, the current produced in each grid circuit will be a complex current formed of many individual current pulses produced in the different linear sections of the grid. Since one grid is arranged in the form of a screen with its bars horizontal and the other arranged with its bars vertical, each grid will have produced in it current pulses caused by the electron stream proceeding from each individual area of the image O', but the current pulse produced in one grid by a given elementary area may have a longer or a shorter path to the terminal of its grid than the same pulse produced by the same area in the other grid, depending upon the position of the elementary area in the image. This action will be better understood by reference to Figure 12.

Figure 12 is a simplified diagram wherein the elements 11, 12 and 13 represent the cathode and the two grids of the light sensitive cell employed at the transmitting station A, and the elements 3, 5 and 6 represent the fluorescent screen and the

two grids in the receiving tube employed in receiving station B. Line wires 36 and 37, together with the common return wire 38, form, respectively, transmission channels corresponding to channels 1 and 2 in Figure 11. Batteries 39 and 40 represent the sources of current necessary to produce and transmit the current pulses over the two channels. For the purpose of illustration, I have shown the grids formed of 9 bars each, although it will be understood that the actual grids contain a greater number of bars spaced very close together. The grids at the transmitting and receiving stations must be so connected that current pulses produced in the two grids by any given elementary area of the image being transmitted must travel over transmission paths of equal distance before they coincide in position in front of the fluorescent screen 3. This may be illustrated by tracing the paths of travel for current pulses set up in the vertical and the horizontal grids 12 and 13 by the elementary area represented by the small square at the center of the grid at station A, it being remembered that the two transmission channels are of the same length. Referring to Figure 12 it will be seen that the current pulse set up in the vertical grid must travel 4½ bars of the grid before reaching terminals 12', and the current pulse set up in horizontal grid by the square area must travel a distance of 4½ bars before reaching the grid terminals 13'. The two current pulses will travel over the two channels and arrive at grid terminals 5' and 6' at the receiving station simultaneously. Assuming that the pulses travel through the grids at the same speed, it will be seen that each pulse must travel through 4½ bars of grid before the two pulses coincide in position, and this position of coincidence is located in the center of the grid, corresponding in position to the elementary square at the transmitting station.

Taking next two current pulses produced by light from an elementary area located in the position of the small circle at the transmitting station; the current pulse produced in the vertical grid must travel through only ½ bar before reaching terminal 12', while the current pulse produced in the horizontal grid must travel through 5 bar lengths before reaching the terminal 13'. The current pulse transmitted over line 37 will arrive at terminal 6' before the current pulse set up in the horizontal grid 13 arrives at the terminal 5', and the first current pulse will be 4½ bars ahead of the second. Accordingly, the two current pulses set up by the round elementary area will coincide at a point where grid wires 5 and 6 intersect each other, and this point must be such that the distance from terminal 6' is greater than the distance from the terminal 5' by 4½ bar lengths. It will be seen that this point of intersection is located at the point of the small circle at station B, which corresponds in position to the small circle at the transmitting station. In the same manner, if current pulses are produced by an elementary area at the point represented by the triangle on the grids at the transmitting station, by following through paths of equal length from this point, it will be found that these pulses will coincide at the point indicated by the small triangle on the grids at the receiving station. It will thus be seen that the two current pulses produced by each of the three elementary areas will coincide at the receiving station in positions corresponding to the positions of the elementary areas at the transmitting station. Since the current pulses transmitted vary in magnitude in accordance with the light value of the elementary area producing the current pulse, the charges produced on the grids at the receiving station at the point of intersection will correspond in magnitude to the light intensity of the elementary area being transmitted. These coinciding charges act cumulatively to cause an electron stream to flow through the grids at this point and impinge upon the fluorescent screen 3 to produce a luminous spot whose intensity corresponds to the light value of the elementary area under consideration, it being understood that the cathode circuit is effective at the time the charges are in proper position. Since each elementary section of each grid produces an independent current pulse, the intensity of which varies in accordance with the light value of the elementary area opposite each section, the resultant current transmitted over the two channels will comprise a series of pulses following each other in the same linear arrangement as they are produced on the grid. These series of individual current pulses are transmitted to the receiving station and impressed upon corresponding grids, and when the series in the two grids coincide, the original image will be reproduced on the fluorescent screen 3. A series of current pulses as described above will be sent out over each channel each time the chopper disk CD uncovers the lens tube. Each series of pulses produces a complete image at the receiving station, and since the chopper disk rotates at a speed to produce 16 or more interruptions per second, the rapid succession of slightly different images at the receiving station appear as one moving image. In order to render the reproduced image more discernible to the eye it is desirable to expose the screen 3 to vision only at the instants at which the charges on the two grids are in proper position, assuming that the switch AS is not being used and the cathode circuit is active at all times. This is accomplished by the operation of the chopper disk 47, the rotational speed of which is regulated by the incoming picture currents. The exact instant of exposure through the disk is adjusted by suitable adjustment of the phase shifter 45. The speed of the disk is such that the screen is exposed to view through an aperture in the disk each time a series of pulses are in proper position on the two grids.

Instead of providing a constantly active cathode circuit and an intermittent viewing of screen 3, the chopper disk 47 may be omitted and the automatic switch AS may be brought into operation by placing the switch 46 in the right-hand position. The switch AS now functions to periodically close the cathode circuit only at the instants at which the charges are in proper position. The instant of closing of the circuit may be adjusted by adjustment of phase shifter 45. Any of the three different forms of switch AS illustrated may be used. It will be understood that the stationary contact 43 may, if necessary, be mounted on the front side of movable contact 41 shown in Figures 11 and 11a.

While I have described a form of my invention in which two grids are employed in the light sensitive cell at the transmitting station, and two transmission channels are provided to transmit the impulses from the two grids to separate grids in a receiving tube at a distant station, it is obvious that the system will operate with only one grid at each station and one transmission channel. However, by employing two grids at

each station, one arranged with its bars at right angles to the bars of the other grid, a better reproduction is obtained and less distortion will result from the effects of static or like transmission disturbances.

From the foregoing description of my invention it will be seen that due to the new method of scanning, the current produced does not cover a wide range of frequencies such as in the systems now in use and involving point-to-point scanning. Also, when the transmission circuits and channels are once adjusted for proper circuit constants, the system does not require synchronizing devices or adjustments. In order to prevent distortion due to reflection caused by the free ends of the grids, suitable loading elements or artificial lines may be connected between the free ends of the grids and the other side of the circuit to produce balanced transmission circuits.

It will be understood that two separate carrier waves are not necessary in the operation of my invention, but a single carrier wave may be employed for the transmission of the currents derived from the two grids of the transmitting tube by employing any well known multiplex transmission system using a single carrier wave, and effecting modulation of two channels of the carrier wave system by the two currents derived from the two transmitting grids. Multiplex transmission systems suitable for this purpose, wherein a single carrier wave serves to transmit simultaneously a plurality of separate transmissions over separate channels, are well known to those skilled in the art.

It will be obvious to one skilled in the art that the structural details of the elements employed in my television system may be modified in various ways without departing from the spirit of the invention.

What I claim is:

1. In a television system the combination of a transmitting station and a receiving station, a pair of transmission channels connecting said stations, each of said channels including a linear conductor arranged at each of said stations, means at said transmitting station for forming an image of an object to be transmitted, means for simultaneously impressing upon different linear portions of one of said transmission conductors current impulses corresponding in intensity to the light values of successive elementary areas of the image arranged in parallel lines crossing the image in one direction, means for simultaneously impressing upon different linear sections of the second transmitting conductor current impulses corresponding in intensity to the light values of successive elementary areas of the image arranged in parallel lines crossing the image at right angles to said first parallel lines, means for periodically interrupting the light rays forming said image, means at the receiving station including one of said receiving conductors for distributing the current impulses from one of said channels over an area in the same order in which said impulses were derived from said image, means including said second receiving conductor for distributing the current impulses from the second channel over a like superimposed area in the same order in which said impulses were derived from said image, and means controlled by the joint action of said two receiving conductors for translating said superimposed current impulses into corresponding light variations.

2. In a television system the combination of a light sensitive cathode having an extended area, means for forming an image of an object to be transmitted on said area, an anode adjacent said cathode and comprising a transmission conductor arranged in the form of a grid having an area substantially as large as said cathode area, a second anode comprising a second grid element having its bars arranged at right angles to the bars of said first grid element, a source of current maintaining each grid element positive with respect to said cathode, a transmission channel connected to each grid element and extending to a distant receiving station, an electron emitting cathode at said receiving station having an extended area, a grid element arranged in front of said cathode comprising a transmission conductor formed as a grid, a second grid element adjacent said first grid element and comprising a second transmission conductor grid with its bars arranged at right angles to the bars of the first grid, a fluorescent plate anode located in line with said grids and said cathode, a source of current for maintaining said anode positive with respect to said cathode, said grids being connected to said transmission channels, and means for periodically interrupting the light rays forming said image at said transmission station.

3. The method of transmatting optical images to a distance which consists in simultaneously impressing upon successive linear sections of a transmission conductor, current impulses corresponding in intensity to the light values of the successive elementary areas of the image arranged in parallel lines crossing the image in one direction, simultaneously impressing upon a second transmission conductor current impulses corresponding in intensity to the light values of successive elementary areas of the image arranged in parallel lines crossing the image at right angles to said first parallel lines, transmitting said two sets of current impulses to a distant receiving station over transmission paths of equal length, impressing one set of said received impulses upon a transmission conductor arranged in parallel lines to form an area, impressing the other set of received impulses upon a second transmission conductor arranged in parallel lines at right angles to the lines of said first receiving conductor forming an area superimposed on said first conductor area, and translating the conjoint action of said impulses in said areas into corresponding light variations.

4. The method of transmitting optical images to a distance which consists in simultaneously impressing upon successive linear sections of a transmission conductor, current impulses corresponding in intensity to the light values of the successive elementary areas of the image arranged in parallel lines crossing the image in one direction, simultaneously impressing upon a second transmission conductor current impulse corresponding in intensity to the light values of successive elementary areas of the image arranged in parallel lines crossing the image at right angles to said first parallel lines, transmitting said two sets of current impulses to a distant receiving station over transmission paths of equal length, distributing one set of impulses over an area in the same order as they were derived at the transmitting station, distributing the other set of impulses over a second area superimposed over the first area in a like manner, and translating the conjoint action of said impulses in said areas into corresponding light variations.

5. A transmitting cell for a television system comprising an evacuated envelope containing a light sensitive cathode element having an extended area for receiving an image of the object to be transmitted, an anode arranged adjacent said cathode and comprising a continuous conductor formed into a grid of substantially the same area as said cathode, a second anode associated with said cathode and comprising a second continuous conductor formed as a grid with its bars arranged at right angles to the bars of the first grid, the bars in each of said grids being connected in serial circuit relation but otherwise insulated from each other, said two grids being insulated from each other, and terminal connections for each of said elements sealed into said envelope.

6. A transmitting cell for a television system comprising an evacuated envelope containing a light sensitive cathode element having an extended area for receiving an image of the object to be transmitted, an anode arranged adjacent said cathode and comprising a continuous conductor formed into a grid of substantially the same area as said cathode, a second anode arranged in front of said first anode and comprising a second continuous conductor formed as a grid with its bars arranged at right angles to the bars of the first grid, the bars in each of said grids being connected in serial circuit relation but otherwise insulated from each other, said two grids being insulated from each other, and terminal connections for each of said elements sealed into said envelope.

7. A transmitting cell for a television system comprising an evacuated envelope containing a light sensitive cathode element having an extended area for receiving an image of the object to be transmitted, an anode arranged adjacent said cathode and comprising a continuous conductor formed into a grid of substantially the same area as said cathode, a second anode arranged in front of said first anode and comprising a second continuous conductor formed as a grid with its bars arranged at right angles to the bars of the first grid, the bars in each of said grids being connected in serial circuit relation but otherwise insulated from each other, said two grids being insulated from each other, a plate anode element arranged parallel to said grids and in line with said grid and cathode elements, and terminal connections for each of said elements sealed into said envelope.

8. A transmitting cell for a television system comprising an evacuated envelope containing a light sensitive cathode element having an extended area for receiving an image of the object to be transmitted, an anode arranged adjacent said cathode and comprising a continuous conductor formed into a grid of substantially the same area as said cathode, the bars in each of said grids being connected in serial circuit relation but otherwise insulated from each other, a second anode arranged in front of said first anode and comprising a second continuous conductor formed as a grid with its bars arranged at right angles to the bars of the first grid, the bars in each of said grids being connected in serial circuit relation but otherwise insulated from each other, said two grids being insulated from each other, a plate anode element arranged parallel to said grids and in line with said grid and cathode elements, and a source of infra-red rays arranged to act upon said cathode element.

9. A receiving tube for a television system comprising a glass envelope containing an electron emitting cathode having an extended active area, an anode associated with said cathode comprising a continuous conductor formed into a grid area, a second grid anode arranged parallel to the first grid anode and having its bars at right angles to the bars of the first grid, a fluorescent plate anode arranged parallel to said grid anodes and in line with said cathode, and terminal connections to each of said elements sealed into said envelope.

10. In a television system the combination of a transmitting station and a receiving station, a transmission channel connecting said stations, said channel including a linear conductor arranged at each of said stations, means at said transmitting station for forming an image of an object to be transmitted, means for simultaneously impressing upon different linear portions of said transmission conductor current impulses corresponding in intensity to the light values of successive elementary areas of the image arranged in parallel lines crossing the image in one direction, means for periodically interrupting the light rays forming said image, means at the receiving station including said receiving conductor for distributing the current impulses from said channel over an area in the same order in which said impulses were derived from said image, means for translating said current impulses into corresponding light variations, and means for rendering said light variations visible only at the instant when said current impulses are in proper position within said area.

11. In a television system the combination of a light sensitive cathode having an extended area, means for forming an image of an object to be transmitted on said area, an anode adjacent said cathode and comprising a transmission conductor arranged in the form of a grid having an area substantially as large as said cathode area, a source of current for maintaining said grid element positive with respect to said cathode, a transmission channel extending to a distant receiving station, an electron emitting cathode at said receiving station having an extended area, a grid element arranged in front of said cathode comprising a transmission conductor formed as a grid, a fluorescent plate anode located in line with said grid and said cathode, a source of current for maintaining said anode positive with respect to said cathode, said grid being connected to said transmission channel, means at the transmitting station for periodically rendering the light sensitive cathode effective, and means at the receiving station for periodically rendering the electron emitting cathode effective.

12. The method of transmitting optical images to a distance which consists in simultaneously impressing upon successive linear sections of a transmission conductor, current impulses corresponding in intensity to the light values of the successive elementary areas of the image arranged in parallel lines crossing the image in one direction, transmitting said current impulses to a distant receiving station, repeating said first and second operations at a rate of the order of sixteen or more times per second, at the receiving station, impressing said received impulses upon a transmission conductor arranged in parallel lines to form an area, translating said impulses in said area into corresponding light variations, and periodically rendering said light variations visible only at the instant when said current impulses are in proper position within said area.

13. The method of transmitting optical images

to a distance which consists in simultaneously impressing upon successive linear sections of a transmission conductor, current impulses corresponding in intensity to the light values of the successive elementary areas of the image arranged in parallel lines crossing the image in one direction, transmitting said current impulses to a distant receiving station, repeating said first and second operations at a rate of the order of sixteen or more times per second, at the receiving station distributing said impulses over an area in the same order as they were derived at the transmitting station, translating said impulses in said area into corresponding light variations, and periodically rendering said light variations visible only at the instant when said current impulses are in proper position within said area.

14. In a television system, the combination of a transmitting station including a light sensitive cell comprising a light sensitive cathode having an extended area, an anode adjacent said cathode and comprising a transmission conductor arranged in the form of a grid having an area substantially as large as said cathode area and having its grid bars spaced apart a distance of the order of the dimension of an elementary area of the image to be transmitted, and a plate anode element mounted on the opposite side of said grid from said cathode, means for forming an image of an object to be transmitted on said cathode, a source of current for maintaining said plate anode positive with respect to said cathode, means for periodically interrupting the cathode circuit, a transmission channel extending between said grid anode and a distant receiving station, a receiving cell at said receiving station comprising an electron emitting cathode having an extended area, a grid element arranged in front of said cathode comprising a transmission conductor formed as a grid and connected to said transmission channel, a fluorescent plate anode located in line with said grid and said cathode, a source of current for maintaining said fluorescent anode positive with respect to said electron emitting cathode, and means for periodically interrupting the circuit of said electron emitting cathode in timed relation with the current impulses transmitted over said transmission channel.

15. In a television system the combination of a light sensitive cathode having an extended area, means for forming an image of an object to be transmitted on said area, an anode adjacent said cathode and comprising a transmission conductor arranged in the form of a grid having an area substantially as large as said cathode area, a source of current for maintaining said grid element positive with respect to said cathode, a transmission channel extending to a distant receiving station, means for periodically opening and closing the circuit of the light sensitive cathode for transmitting periodic current impulses over said channel, an electron emitting cathode at said receiving station having an extended area, a grid element arranged in front of said cathode comprising a transmission conductor formed as a grid, a fluorescent plate anode located in line with said grid and said cathode, a source of current for maintaining said anode positive with respect to said cathode, said grid being connected to said transmission channel, and means at the receiving station responsive to the received periodic impulses for periodically opening and closing the circuit between the cathode and the fluorescent plate.

16. A transmitting cell for a television system comprising an evacuated envelope containing a light sensitive cathode element having an extended area for receiving an image of the object to be transmitted, an anode arranged adjacent said cathode and comprising a grid electrode of substantially the same area as said cathode and having its grid bars mutually insulated from each other and spaced apart a distance of the order of the dimension of an elementary area of the image to be transmitted, means effectively connecting said grid bars in serial circuit relation and terminal connections for each of said elements sealed into said envelope.

17. A transmitting cell for a television system comprising an evacuated envelope containing a light sensitive cathode element having an extended area for receiving an image of the object to be transmitted, an anode arranged adjacent said cathode and comprising a continuous conductor formed into a grid of substantially the same area as said cathode and having its grid bars connected in serial relation but otherwise electrically insulated from each other and spaced apart a distance of the order of the dimension of an elementary area of the image to be transmitted, and terminal connections for each of said elements sealed into said envelope.

18. A receiving tube for a television system comprising a glass envelope containing an electron emitting cathode having an extended active area, a fluorescent plate anode arranged parallel to said cathode within said envelope, and a control electrode arranged between said cathode and anode comprising a continuous conductor formed into a grid having its bars spaced apart a distance of the order of the dimension of an elementary area of the picture to be reproduced and connected in serial circuit relation but otherwise electrically insulated from each other.

19. A receiving tube for a television system comprising a glass envelope containing an electron emitting cathode having an extended active area, a fluorescent plate anode arranged parallel to said cathode within said envelope, a control electrode arranged between said cathode and anode and comprising a grid structure having its bars mutually insulated from each other and spaced apart a distance of the order of the dimension of an elementary area of the picture to be reproduced, and means effectively connecting said grid bars in series circuit relation.

DONALD JEROME BAKER.

CERTIFICATE OF CORRECTION.

Patent No. 2,026,725. January 7, 1936.

DONALD JEROME BAKER.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 8, first column, lines 60, 61 and 62, claim 8, strike out the words "the bars in each of said grids being connected in serial circuit relation but otherwise insulated from each other" and insert the same before "a" in second column, line 6, claim 9; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 18th day of February, A. D. 1936.

(Seal)

Leslie Frazer
Acting Commissioner of Patents.