Nov. 10, 1942. M. CAWEIN 2,301,521

COLOR TELEVISION SYSTEM

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FIG. 1

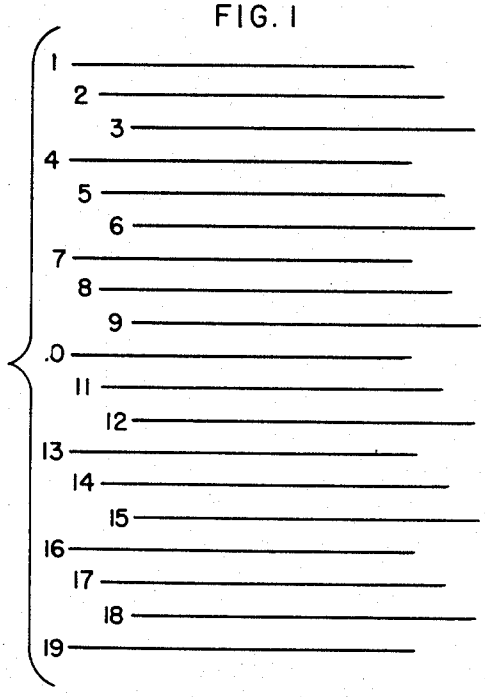


FIG. 2

FRAME	1	2	3	4	5	6
FIELD- 1	R	G	B	R	G	B
FIELD- 2	G	B	R	G	B	R
FIELD- 3	B	R	G	B	R	G

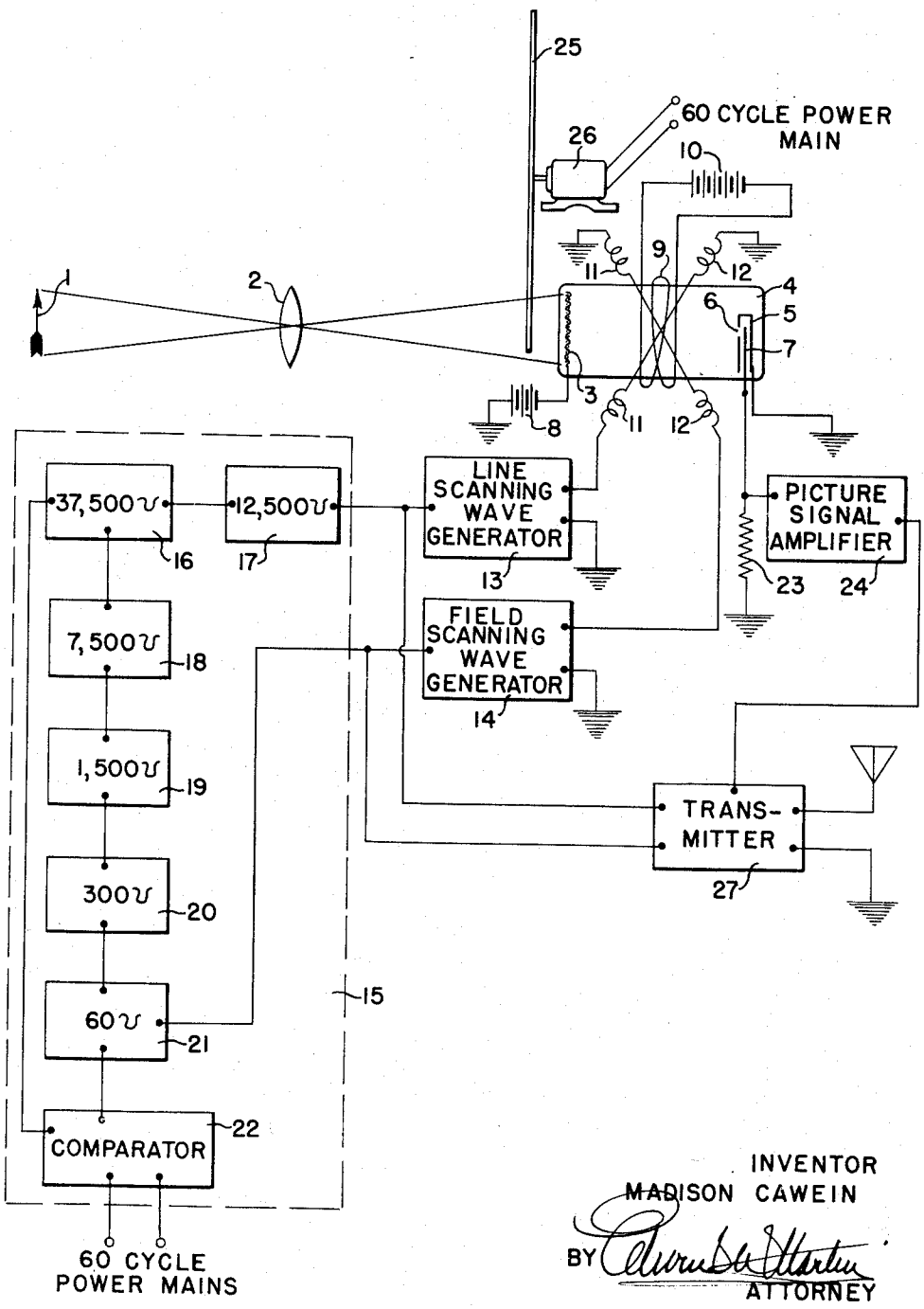
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FIG. 3



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FIG. 4

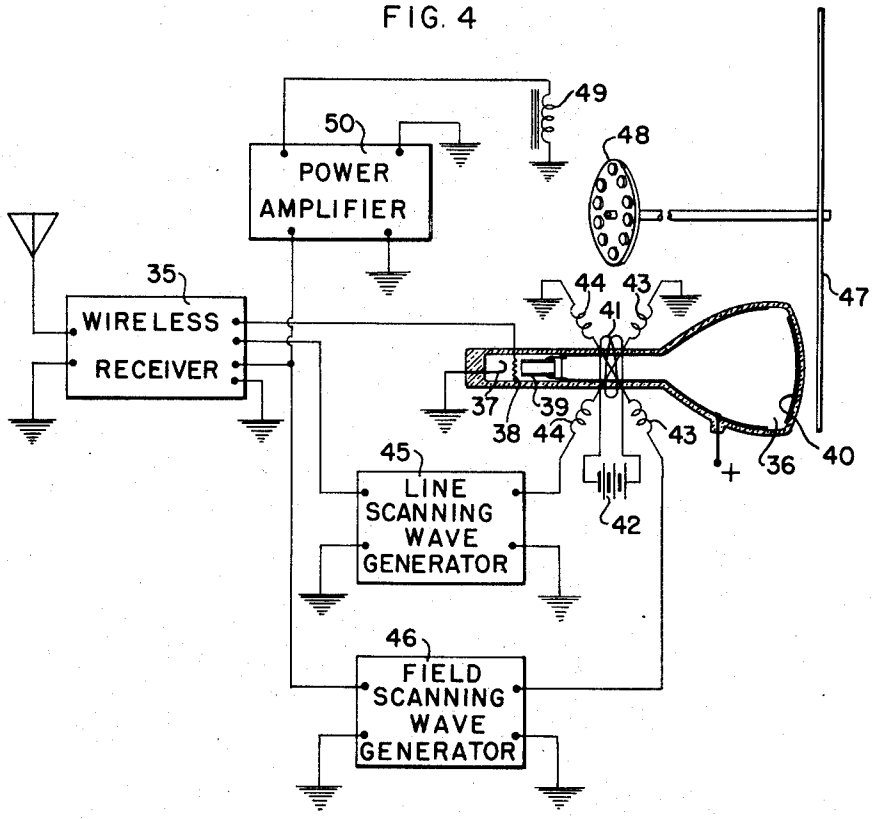
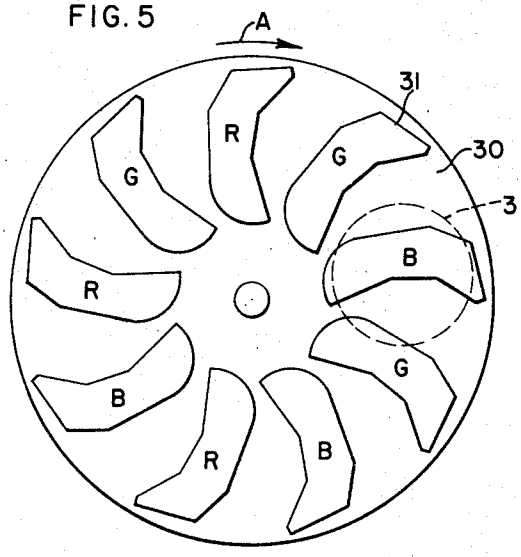


FIG. 5



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2,301,521

UNITED STATES PATENT OFFICE

2,301,521

COLOR TELEVISION SYSTEM

Madison Cawein, Marion, Ind., assignor to Farnsworth Television and Radio Corporation, a corporation of Delaware

Application July 17, 1941, Serial No. 402,731

14 Claims. (Cl. 178—5.2)

This invention relates to a method of and apparatus for transmitting television pictures in natural colors and particularly relates to a method and apparatus for television transmission in which interlaced scanning is employed.

It is customary in television to employ interlaced scanning in which each complete scanning pattern or frame comprises a plurality of fields of scanning lines which are geometrically displaced with respect to each other whereby the lines of the respective fields are interlaced with each other. In this manner, it is possible to transmit a relatively high number of scanning lines per unit of time without necessitating the transmission of a prohibitively wide band of picture signal frequencies. It has become customary to transmit television pictures in accordance with a scanning pattern having an interlace ratio of 2 to 1; that is, a single frame comprises two fields of mutually interlaced scanning lines. Since it is desirable to transmit a still higher number of scanning lines per unit of time without increasing the required signal frequency band, it has been proposed to employ a scanning pattern having an interlaced ratio of 3 to 1, that is, three fields per frame. In such a pattern, the three fields beginning with the first, second and third lines of the frame, respectively, are scanned in consecutive order. According to an alternative method, the fields beginning with the third, second and first lines of the frame, respectively, are scanned in consecutive order. Since adjacent lines of such a pattern are scanned in consecutive order, there is produced upon the eye of an observer an effect as if the scanning lines were crawling in one direction or another, that is, in the case of a pattern of horizontal lines, upward or downward, according to the abovementioned scanning sequence of the fields. This effect is so annoying and distracting that interlaced scanning at an interlace ratio of 3 to 1 has not been employed, in spite of the desirability of transmitting more picture information per unit of time, without increasing the band of signal frequencies to be transmitted.

In the transmission of television pictures in natural colors, it has become customary successively to transmit picture signals representative of different color components of the image to be transmitted. Usually, the same color component is transmitted during an entire scanning field, the change from one color component to another being effected at the end of each complete field. In this manner, it has been possible by rapid transmission of a few color components only to effect transmission of television pictures in natural colors.

The object of the present invention is to provide a method of and means for transmitting television pictures in natural colors employing an interlaced scanning pattern having an odd number of scanning fields per frame, whereby the relation between the sequence of scanning fields and the sequence of transmitted color components is so chosen that the apparent crawling of the scanning lines is compensated by an apparent crawling of the color.

In accordance with the present invention, there is provided a method of and apparatus for transmitting television pictures in natural colors, in which an optical image of the object to be transmitted is produced and a train of picture signals derived therefrom, which is representative of the brightness of successive elemental areas of the image, by effectively scanning the image in accordance with an interlaced scanning pattern having an odd number of scanning fields per frame. The color of the image is changed several times during certain scanning frames in accordance with a predetermined sequence, while it is changed several times during other scanning frames in accordance with a different color sequence. Picture signals also representative of the color components of the image are thereby produced and the apparent crawling of the scanning lines is compensated by introduction of an apparent crawling of the color components in an opposite sense.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description, taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

In the accompanying drawings:

Figs. 1 and 2 are schematic diagrams to aid in the understanding of the invention;

Figs. 3 and 4 show a transmitter and receiver, respectively, embodying the invention; and

Fig. 5 shows a color filter disc for use in the apparatus of Figs. 3 and 4.

Referring now more particularly to Fig. 1, there is here shown a number of parallel lines representing a portion of the interlaced scanning lines of a frame. The total frame may comprise 625 lines, each field comprising 208⅓ lines in accordance with an interlace ratio of 1:3. The first field comprises lines 1, 4, 7, 10, and so forth, that is, the lines 3N+1, whereby N is an integer

number. The second field comprises lines 2, 5, 8, 11 and so forth, or the lines 3N+2, while the third field comprises lines 3, 6, 9, 12, 15 and so forth, that is, the lines 3N+3. The lines of the respective fields are shown displaced with respect to each other in the drawing for sake of clarity. Since the fields are scanned in the order of their geometrical position, it is obvious that an apparent downward crawling of the scanning lines will be observed by a viewer, if the lines are scanned in the order 3N+1, 3N+2 and 3N+3.

Fig. 2 illustrates the sequence of the transmitted color components, red, green and blue, indicated by the letters R, G and B. From left to right there are plotted a number of successive frames 1 to 6, and from top to bottom are plotted their respective fields 1 to 3. From this chart, it follows that, during field 3 of frame 1, the blue color component is transmitted. The same color is transmitted during field 2 of frame 2 and field 1 of frame 3. Hence, since the lines of fields 1, 2 and 3 are geometrically displaced with respect to each other in a downward direction and are scanned in the order of their geometrical position, an apparent crawling of the blue color component, as well as the other color components, occurs in the upward direction, thereby tending to balance or compensate the apparent downward crawl of the scanning lines.

It will be noted that the color sequence is cyclically shifted for each frame, which bring about the apparent upward crawling of the color components.

Referring now to Fig. 3 of the drawings, there is shown transmitting apparatus in accordance with the invention. An image of an object 1 is projected by means of an optical system 2 upon a transparent photosensitive member 3 of a picture signal generating tube 4 of the type of a Farnsworth image dissector, including a shield 5 with a scanning aperture 6 and a target 7 within the shield.

For the purpose of developing an electron image in the plane of the scanning aperture 6, corresponding to the optical image of the object to be transmitted, there is provided a source of operating voltage 8 connected to the photosensitive member 3 and a magnetic focusing coil 9 energized by means of a battery 10. For deflecting the electron image in two directions across the scanning aperture 6, there is provided a pair of deflecting coils schematically indicated at 11 and 12, connected to a line scanning wave generator 13 and a field scanning wave generator 14, respectively.

For synchronizing the line and field scanning wave generators, there is provided a synchronizing signal generator generally indicated at 15, comprising a master oscillator 16 adapted to develop signals at a frequency of 37,500 C. P. S. This generator is adapted to have its frequency controlled in accordance with a control signal, the generation of which is to be explained below. For deriving from the master oscillator synchronizing signals of line scanning frequency, there is provided a frequency divider 17 adapted to operate at a dividing ratio of 1 to 3, for developing synchronizing pulses at a frequency of 12,500 C. P. S., which are applied to the line scanning wave generator 13. For the purpose of deriving from the master oscillator field synchronizing pulses at a frequency of 60 C. P. S., there are provided a series of frequency dividers 18, 19, 20 and 21, each adapted to operate at a dividing ratio of 5 to 1. The field synchronizing pulses produced by the divider 21 are applied to the field scanning wave generator 14 for synchronization thereof.

For stabilizing the synchronizing signal frequencies, there is preferably provided a phase comparator 22, to which the 60-cycle field synchronizing pulses from the divider 21 are applied, as well as a 60-cycle sine wave derived from the power mains as indicated. Phase comparators of this type are well known in the art and serve to produce a control voltage indicative of the phase difference between the 60-cycle synchronizing signals and the power mains voltage, which control voltage is applied to the master oscillator 16 to control the frequency thereof.

An output resistor 23 is connected to the target 7 of the image dissector tube 4 for deriving a picture signal therefrom which is applied to a picture signal amplifier 24.

In order that the picture signals not only be representative of the brightness of successive elemental areas of the image to be transmitted but also representative of alternate color components thereof, there is provided in front of and closely adjacent to the photosensitive member 3 a color filter disc 25, driven by a synchronous motor 26, energized by the 60-cycle power mains. For phase adjustment of the color disc, the motor is provided with a rotatable stator, as in common practice in the art.

The color disc 25 is shown more in detail in Fig. 5 and comprises a circular disc 30, preferably of opaque material, provided with a plurality of openings having color filter sections 31 of red, green and blue colors, positioned and disposed thereon as indicated by the letters R. G. and B. The position of the photosensitive member with respect to the color disc is indicated by the dotted circular line indicating the photosensitive member 3. Since the image dissector tube is a non-storage device, it is necessary only successively to illuminate relatively limited areas of the photosensitive member 3 from which photoelectrons are entering the scanning aperture 6. For this reason, the filter sections 31 can be made relatively narrow, as shown. The direction of rotation of the disc 25 is indicated by the arrow A, and the disc is made to rotate at 400 R. P. M.

For transmitting a composite television signal, the amplified picture signals from the amplifier 24, as well as the line and field synchronizing signals from the dividers 17 and 21, are applied to a transmitter 27 capable of producing carrier wave modulated by the composite synchronizing and picture signals transmitting the same into space.

Fig. 4 shows the receiving apparatus comprising a wireless receiver 35 adapted to receive the signals from the transmitter 27, to demodulate the received carrier wave and to produce separate picture signals and line and field synchronizing signals.

For the purpose of reproducing the received television image, there is provided a cathode ray picture signal reproducing tube 36 having an electron gun comprising a cathode 37, a control element 38 and an anode 39. The tube 36 also contains a fluorescent screen 40 adapted to be scanned by the electron beam produced by the electron gun. For the purpose of modulating the electron beam in accordance with the received picture signals, the control element 38 of the electron gun is operatively connected to the output of the receiver 35, to receive the demodulated

picture signals therefrom. A focusing coil 41, energized by a battery 42, is provided for focusing the electron beam on the fluorescent screen 40. For scanning the modulated electron beam across the fluorescent screen 40, there are provided a pair of deflecting coils 43 and 44, connected to the line scanning wave generators 45 and 46, respectively, which are synchronized by synchronizing signals applied thereto from the output of the receiver 35.

For reproducing the television image in natural colors, there is provided in front of the fluorescent screen 40 and immediately adjacent thereto a color filter disc 47, driven by a phonic motor comprising a phonic wheel 48 and an electromagnetic driving means 49. The driving means 49 is energized by means of field synchronizing pulses, amplified by a power amplifier 50, so that the color filter disc 46 rotates in synchronism and in proper phase with the field scanning motion. The scanning disc 47 is of the same general construction as the disc 25 at the receiver, the distribution of the color filter sections thereon being identical. The width of the color filter sections 31 of the disc of Fig. 5 is preferably adjusted in proportion with the time of persistence of the fluorescent material of the screen 40, as will be obvious to those skilled in the art.

In operation, an electron image corresponding in density distribution to the emission from the photo-sensitive member 3 of the dissector tube 4 at successive incremental areas thereof is scanned in two directions across the scanning aperture 6 in accordance with the line scanning frequency of 12,500 C. P. S, and the field scanning frequency of 60 C. P. S., resulting in a scanning pattern having a frame including 625 scanning lines and comprising three fields of 208⅓ lines consecutively scanned in the order of their geometrical position. The color disc 25 rotates in front of the photosensitive member 3 in synchronism and phase, with respect to the scanning motion, thereby changing the color of the image focused thereon after the completed scansion of each field, whereby the color sequence during each frame is cyclically rotated in accordance with a chart shown in Fig. 2, due to the position of the color filter sections 31 on the disc.

Hence, there are developed across the output resistor 23 of the dissector tube 4 signals representative of the brightness of successive elemental areas of the image to be transmitted and also representative of different color components thereof, whereby the color sequence is changed after the scanning of each frame. These picture signals are amplified by means of the amplifier 24 and applied to the transmitter 27, to which line and field synchronizing pulses are also applied for the purpose of transmitting a composite television signal.

At the receiving end the wireless receiver 35 produces at its output terminals the demodulated picture signal, as well as separated line and field synchronizing pulses. In the picture reproducing tube 36, an electron beam, whose intensity is modulated in accordance with the received picture signals, is deflected across the fluorescent screen 40, thereby to produce a luminous image preferably of white light. The field synchronizing signals are amplified by the power amplifier 50 and applied to the driving means 49 of the phonic wheel 48, which drives the color disc 47 in synchronism and in phase with the color disc 25 at the transmitter.

As mentioned above, there is visible to an observer, through the color disc 47, a television picture in natural colors, scanned in accordance with an interlace ratio 3 to 1, in which the apparent crawling of the scanning line structure in one direction is offset by an apparent crawling of the color components in the opposite direction.

While the invention has been described in connection with a television system employing a scanning pattern having an interlace ratio of 3 to 1, it will be understood that the invention is equally useful in any other systems in which interlaced scanning patterns are employed which exhibit apparent crawling of scanning lines, it being necessary only to so adjust the color sequence that a compensating crawl with respect to the color is provided.

It will also, of course, be obvious that while in the present preferred embodiment of the invention, while has been described above, mechanical means are provided at the transmitter and receiver for effecting transmission and reproduction in colors, the invention is not limited to such systems but is equally well adapted for use in color television systems where either the transmitter or receiver or both are entirely electronic.

Finally, it will be understood that the invention is not limited to the use of an image dissector tube as a picture signal generating tube, since tubes employing the storage principle can be equally well employed, as will be obvious to those skilled in the art.

While there has been described what is at present considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. Television apparatus for transmitting pictures in natural colors comprising a picture signal generating device having a photosensitive member, means for projecting an optical image of the object to be transmitted on said member, means for effectively scanning successive elemental areas of said image in accordance with an interlaced scanning pattern having at least three fields of consecutively scanned lines per frame to produce a train of picture signals representative of the brightness of said elemental areas, said fields being displaced in one direction in regular sequence whereby the lines of successive fields of a picture reproduced from said signals will tend to exhibit an apparent crawling motion in said direction, means for changing the color of said image several times during certain predetermined scanning periods in accordance with a predetermined color sequence and during other predetermined scanning periods in accordance with a different predetermined color sequence so that successive fields of the same color component are displaced in the opposite direction in regular sequence, thereby to produce picture signals also representative of the color components of said image whereby a picture reproduced from said signals will tend to exhibit an apparent crawling of color components in said opposite direction for compensating for said first-named crawling motion, and means for transmitting said signals.

2. Television apparatus for transmitting pictures in natural colors comprising a picture signal generating device having a photosensitive

member, means for projecting an optical image of the object to be transmitted on said member, means for effectively scanning successive elemental areas of said image in accordance with an interlaced scanning pattern to produce a train of picture signals representative of the brightness of said elemental areas, said pattern comprising successive frames each having an odd number of fields of consecutively scanned parallel lines, said fields being displaced in one direction in regular sequence, whereby the lines of successive fields of a picture reproduced from said signals will tend to exhibit a crawling motion in said direction, means for changing the color of said image in such manner that the same image color successively prevails during the scanning intervals of certain fields of successive frames, said last-named fields being displaced in the opposite direction in regular sequence, whereby a picture reproduced from said signal will tend to exhibit an apparent crawling of colors in said opposite direction tending to compensate said crawling motion of said lines, and means for transmitting said signals.

3. Television apparatus for transmitting pictures in natural colors comprising a picture signal generating device having a photosensitive member, means for projecting an optical image of the object to be transmitted on said member, means for effectively scanning successive elemental areas of said image in accordance with an interlaced scanning pattern to produce a train of picture signals representative of the brightness of said elemental areas, said pattern comprising successive frames, each having an odd number of fields of consecutively scanned parallel lines, said fields being displaced in one direction in regular sequence, whereby the lines of a picture reproduced from said signals will tend to exhibit a crawling motion in said direction, light filtering means for successively selecting the same color components of said image during each frame, the sequence of said color components being cyclically shifted for succesive frames so that successive fields of the same color component are displaced in the opposite direction in regular sequence, whereby a picture reproduced from said signals will tend to exhibit an apparent crawling of colors in said opposite direction tending to compensate said crawling motion of said lines, and means for transmitting said sginals.

4. Television apparatus for transmitting pictures in natural colors comprising a picture signal generating device having a photosensitive member, means for projecting an optical image of the object to be transmitted on said member, means for effectively scanning successive elemental areas of said image in accordance with an interlaced scanning pattern to produce a train of picture signals representative of the brightness of said elemental areas, said pattern comprising successive frames, each having three fields of consecutively scanned parallel lines, said fields being displaced in one direction in regular sequence, whereby the lines of a picture reproduced from said signals will tend to exhibit a crawling motion in said direction, means for changing the color of said image in such manner that the same image color successively prevails during the scanning intervals of the third, second and first fields, respectively, of periodically reoccurring groups of three consecutive frames, so as to produce picture signals also representative of the color components of said image, and means for transmitting said signals.

5. A television receiving system for reproducing television pictures in natural colors comprising a cathode ray picture reproducing tube, including means for developing a beam of electrons and a target adapted to be scanned by said beam, means for controlling said beam in accordance with received picture signals representative of picture brightness and color components thereof, means for deflecting said beam across said target in accordance with an interlaced scanning pattern of successive frames each having at least three fields of consecutively scanned parallel lines, thereby to produce a luminous image of substantially white light, said fields being displaced in one direction in regular sequence whereby said scanning lines of successive fields exhibit an apparent crawling motion in said direction, the picture signals occurring during corresponding scanning fields of alternate scanning frames being representative of different color components, and light filtering means operating in synchronism with the scanning motion of said beam and adapted to transmit different color components of said luminous image during corresponding field scanning intervals of alternate scanning frames in such manner that successive fields of the same color component are displaced in the opposite direction in regular sequence thereby to produce an apparent crawling of color components in said opposite direction tending to compensate said first-named crawling motion.

6. A television receiving system for reproducing television pictures in natural colors comprising a cathode ray picture reproducing tube, including means for developing a beam of electrons and a target adapted to be scanned by said beam, means for controlling said beam in accordance with received picture signals representative of picture brightness and color components thereof, means for deflecting said beam across said target in accordance with an interlaced scanning pattern of successive frames each having at least three fields of consecutively scanned lines, said fields being displaced in one direction in regular sequence whereby said scanning lines of successive fields exhibit an apparent crawling motion in said direction, the picture signals occurring during corresponding scanning fields of alternate scanning frames being representative of different color components, and means adapted selectively to reproduce different color components of the image to be produced operating in synchronism with a scanning motion of said beam thereby to reproduce different color components during corresponding field scanning intervals of alternating scanning frames in such a manner that successive fields of the same color component are displaced in the opposite direction in regular sequence thereby to produce an apparent crawling of color components in said opposite direction, tending to compensate said first-named crawling motion.

7. A television receiving system for reproducing television pictures in natural colors comprising a cathode ray picture reproducing tube, including means for developing a beam of electrons and a target adapted to be scanned by said beam, means for controlling said beam in accordance with received picture signals representative of picture brightness and color components thereof, means for deflecting said beam across said target in accordance with an interlaced scanning pattern, thereby to produce a luminous image of substantially white light, said pattern comprising successive frames each having an odd num-

ber of fields of consecutively scanned parallel lines, said fields being displaced in one direction in regular sequence, thereby causing said lines to exhibit a crawling motion in said direction, light filtering means operating in synchronism with the scanning motion of said beam and adapted to transmit different color components of said luminous image, said filtering means being so constructed that the same color component successively prevails during the scanning intervals of fields of successive frames, said last-named fields being displaced in the opposite direction in regular sequence so as to produce an apparent crawling of colors in said opposite direction, tending to compensate said crawling motion of said lines.

8. A television receiving system for reproducing television pictures in natural colors comprising a cathode ray picture reproducing tube, including means for developing a beam of electrons and a target adapted to be scanned by said beam, means for controlling said beam in accordance with received picture signals representative of picture brightness and color components thereof, means for deflecting said beam across said target in accordance with an interlaced scanning pattern, thereby to produce a luminous image of substantially white light, said pattern comprising successive frames, each having an odd number of fields of consecutively scanned parallel lines, said fields being displaced in one direction in regular sequence, thereby causing said lines to exhibit a crawling motion in said direction, light filtering means operating in synchronism with the scanning motion of said beam and adapted successively to select the same color components of said luminous image during each frame, the sequence of said color components being cyclically shifted for successive frames so that successive fields of the same color component are displaced in the opposite direction in regular sequence, thereby to produce an apparent crawling of colors in said opposite direction, tending to compensate said crawling motion of said lines.

9. A television receiving system for reproducing television pictures in natural colors comprising a cathode ray picture reproducing tube, including means for developing a beam of electrons and a target adapted to be scanned by said beam, means for controlling said beam in accordance with the received picture signals representative of picture brightness and color components thereof, means for deflecting said beam across said target in accordance with an interlaced scanning pattern, thereby to produce a luminous image of substantially white light, said pattern comprising successive frames, each having three fields of consecutively scanned parallel lines, said fields being displaced in one direction in regular sequence, thereby causing said lines to exhibit a crawling motion in said direction, light filtering means operating in synchronism with the scanning motion of said beam for alternately transmitting different color components of said luminous image in such manner that the same color component successively prevails during the scanning intervals of the third, second and first fields, respectively, of periodically reoccurring groups of three consecutive frames so as to reproduce a television image in natural colors without apparent crawling.

10. The method of transmitting television pictures in natural colors comprising the steps of producing an optical image of the object to be transmitted, deriving from said image a train picture signals representative of the brightness of successive elemental areas of said image by effectively scanning said image in accordance with an interlaced scanning pattern, said scanning pattern comprising a frame consisting of at least three fields of consecutively scanned lines displaced in one direction in regular sequence, whereby said scanning lines of successive fields exhibit an apparent crawling motion in said direction, changing the color of said image several times during certain scanning frames in accordance with a predetermined color sequence, changing the color of said image several times during other scanning frames in accordance with a different color sequence so that successive fields of the same color component are displaced in the opposite direction in regular sequence, thereby to produce picture signals also representative of the color components of said image in such manner as to produce an apparent crawling of color components in said opposite direction tending to compensate said first-named crawling motion, and transmitting said signals.

11. The method of transmitting television pictures in natural colors comprising the steps of producing an optical image of the object to be transmitted, deriving from said image a train of picture signals representative of the brightness and color of successive elemental areas of said image by effectively scanning said image in accordance with an interlaced scanning pattern, said pattern comprising successive frames, each having an odd number of fields of consecutively scanned parallel lines, said fields being displaced in one direction in regular sequence, thereby causing said lines to exhibit a crawling motion in said direction, changing the color of said image in such manner that the same image color successively prevails during the scanning intervals of certain fields of successive frames, said last-named fields being displaced in the opposite direction in regular sequence so as to produce an apparent crawling of colors in said opposite direction, tending to compensate said crawling motion of said lines, and transmitting said signals.

12. The method of transmitting television pictures in natural colors comprising the steps of producing an optical image of the object to be transmitted, deriving from said image a train of picture signals representative of the brightness and color of successive elemental areas of said image by effectively scanning said image in accordance with an interlaced scanning pattern, said pattern comprising successive frames, each having three fields of consecutively scanned parallel lines, said fields being displaced in one direction in regular sequence, thereby causing said lines to exhibit a crawling motion in said direction, changing the color of said image in such manner that the same image color component successively prevails during the scanning intervals of the third, second and first fields, respectively, of periodically reoccurring groups of three consecutive frames, thereby to produce an apparent crawling of the color components in the opposite direction tending to compensate said crawling motion of said lines, and transmitting said signals.

13. A television system for transmitting pictures in natural colors comprising a picture signal generating device having a photosensitive member, means for projecting an optical image of the object to be transmitted on said member, means for effectively scanning successive ele-

mental areas of said image in accordance with an interlaced scanning pattern to produce a train of picture signals, means for transmitting said signals, means for receiving said signals, a cathode ray picture reproducing tube including means for developing a beam of electrons and a target adapted to be scanned by said beam, means for controlling said beam in accordance with the received picture signals, means for deflecting said beam across said target in accordance with said interlaced scanning pattern, thereby to produce a luminous image of substantially white light, said pattern comprising successive frames, each having an odd number of fields of consecutively scanned parallel lines, said fields being displaced in one direction in regular sequence, thereby causing said lines to exhibit a crawling motion in said direction, means for changing the color of said projected image and said luminous image in such manner that the same color component successively prevails during the scanning intervals of certain fields of successive fields, last-named fields being displaced in the opposite direction in regular sequence so as to produce an apparent crawling of colors in said opposite direction, tending to compensate said crawling motion of said lines, thereby to transmit and reproduce television pictures in natural colors.

14. A television system for transmitting pictures in natural colors comprising a picture signal generating device having a photosensitive member, means for projecting an optical image of the object to be transmitted on said member, means for effectively scanning successive elemental areas of said image in accordance with an interlaced scanning pattern to produce a train of picture signals, means for transmitting said signals, means for receiving said signals, a cathode ray picture reproducing tube including means for developing a beam of electrons and a target adapted to be scanned by said beam, means for controlling said beam in accordance with the received picture signals, means for deflecting said beam across said target in accordance with said interlaced scanning pattern, thereby to produce a luminous image of substantially white light, said pattern comprising successive frames, each having three fields of consecutively scanned parallel lines, said fields being displaced in one direction in regular sequence, thereby causing said lines to exhibit a crawling motion in said direction, means for changing the color of said projected image and said luminous image in such manner that the same color component successively prevails during the scanning intervals of the third, second and first fields, respectively, of periodically reoccurring groups of three consecutive frames, thereby to transmit and reproduce television pictures in natural colors.

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