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A. McL. NICOLSON

1,901,116

COLOR TELEVISION

Filed May 8, 1930

2 Sheets-Sheet 2

Fig. 2

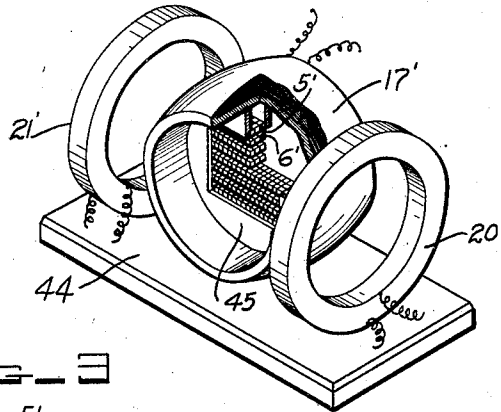


Fig. 3

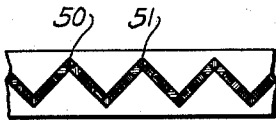


Fig. 5

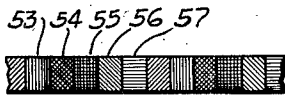


Fig. 4

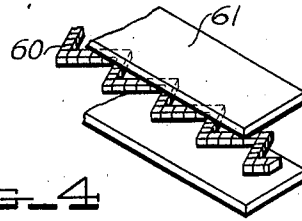
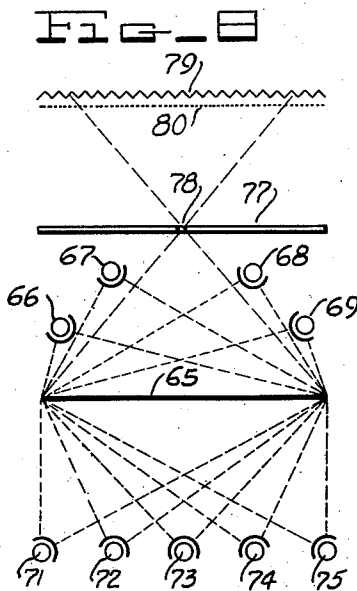


Fig. 6



Fig. 7



(Red) SrCa — R — CaSr (Red)
 (Yellow) Na — W — NiCo (Blue)
 (Blue) Co — P — K (Violet)
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COLOR TELEVISION

Application filed May 8, 1930. Serial No. 450,630.

This invention relates to the transmission and reception of images over wires or through space, and particularly to the transmission of colored images or objects in their natural colors.

In the transmission of images or pictures it is necessary to illuminate the object in some manner. This may be accomplished by scanning the object with a point of light, the reflection or projection of which will register the relative densities of light and shade of the object on a photoelectric cell. These relative densities of light will be transformed into corresponding electrical variations by means of the photoelectric cell which variations may be transmitted to receiving apparatus. It is well known that if these light variations are reproduced before the eye at the rate of 15 cycles per second or faster, they will appear as a picture of the object scanned by the transmitter.

In my copending application Ser. No. 397,826, filed October 7, 1929, now Patent No. 1,863,278, granted June 14, 1932, a system for the simultaneous transmission and reception of successive unit portions of a scene has been disclosed. In this patent an arc traveling at a high rate of speed between two polarized electrode rails in a magnetic field is employed as the scanning and reception medium. As this arc illuminates unit areas of the scene to be transmitted, reflected light from the scene or object is impressed on a photoelectric cell and transformed into electrical vibrations. In the system disclosed in this patent, direct current energy is used to energize the fields and direct current potential differences to maintain the traveling arc.

In my copending application Serial No. 450,025, filed May 5, 1930, now Patent No. 1,839,696, granted Jan. 5, 1932, a television system operating in a similar manner, but which is supplied entirely from an alternating current source is disclosed. Either of the above systems may be employed for the actual transmission and reception of the colored images, the apparatus for which is the subject of the present disclosure.

An object of this invention is to accomplish color television with transmitting and

receiving apparatus containing no moving parts whatsoever.

Another object of the invention is to obtain in a television transmission and receiving system, substantially all the colors required to reproduce an object in its natural colors.

A further object of the invention is to transmit and receive the image of an object in its natural colors without the use of mechanical moving elements.

The above objects are carried out by apparatus which gives to the arc as it traverses the scanning or receiving screen, various colors which may range from red to indigo. The electrode rails, therefore, may be made up of or coated with materials containing calcium, potassium, nickel, cobalt and others in successive units so as to impart to the arc and tinge it with a series of colors which primarily occur in all colored objects. Furthermore as sodium, when used as a photo cell element, is sensitive to white light, and to all the colors of the spectrum that are visible, and is responsive to red, and potassium as a cell element is sensitive to blue and green, the photo cells may be chosen to select various colors.

The invention will be more fully understood by reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic view of a transmission system embodying the invention;

Fig. 2 is a perspective view of the scanning screen and its associate coils;

Figs. 3, 4, 5 and 6 are plan and perspective views of electrode rail arrangements for permitting the scanning of an object with many colored light rays and the reception thereof;

Fig. 7 is a diagrammatic chart of a rail system; and

Fig. 8 is a diagram of a photoelectric cell arrangement for producing the color effects in accordance with another embodiment of the invention.

Referring specifically to Fig. 1, endless electrode rails 5 and 6 which have opposite polarities at any instant are shown with a fore-shortened gap 7 at which an arc initiates. A supply voltage for the arc is obtained from a

master oscillator 10 over conductors 8, the frequency of the master oscillator being maintained constant by the use of a crystal control 11. The piloting and synchronizing impulses are transmitted over conductors 12 to a synchronizer 13, and from the electrode rail screen to the synchronizer over conductors 14. This system may operate as a direct current field system such as disclosed in Patent No. 1,863,278, or as an alternating current field system in accordance with the disclosure in my Patent No. 1,839,696, mentioned above. A driving field coil 17, preferably, of the spherical type is shown surrounding the electrode rails 5 and 6 forming the scanning screen, the field being supplied from a source 18 shown as an alternating current source through a rectifier 19 over conductors 9. The source 18 further supplies energy to an anterior field coil 20 and a posterior field coil 21, through phase shifters 22 and 23, respectively, and rectifiers 24 and 26 respectively. A control field 30 is shown connected to the synchronizer 13 through a transformer 31. As the arc is propagated over the rails 5 and 6, it projects light through a pinhole 33 in a camera anterior to the scanning screen, scanning objects in front thereof. The reflected light rays according to the colors of the objects are impressed upon a photoelectric cell 35 or plurality of cells which may be placed around the periphery of the screen. The current variations generated by the cell which correspond to the relative color variations of the object are amplified by an amplifier 36 and transferred over conductors 37 to a modulator oscillator system 38. After modulation with a transmitting wave, these color transmitting frequencies are fed into an antenna system 39 through the transformer 40 for transmission to a distant point. The antenna system may be replaced by a wire system employing carrier currents or by an ordinary low frequency wire system without the modulator-oscillator system. Simultaneously with the transmission of the color frequencies there is also impressed on the modulator-oscillator 38 over conductors 41 for transmission to the corresponding receiving apparatus, the piloting and synchronizing impulses and the base illuminating frequency if the system is operated with an alternating current field.

The screen of Fig. 1 with its anterior, posterior and driving coils, is shown more clearly in Fig. 2, mounted upon a base 44. Corresponding elements have been designated by the same numerals as in Fig. 1 but having prime indicators. In Fig. 2 the screen is shown composed of rails 5' and 6', the turning portions of which are behind a frame 45 which defines the scanning portion of the transmitter or the image screen at the receiver. It will be observed that the rails 5' and 6' are compound to the extent of comprising three different elements in series in the anterior, poste-

rior direction and two different elements in the lateral direction. The arc propagation of this electrode system forms a Greek pattern, that is, it is driven from left to right by the field winding 17' for a sufficient period to traverse from one material to another as shown by the cubes forming the rails, and then backward by posterior coil 21', then to the right by driving coil 17' and then forward by anterior coil 20'. In this manner the arc is made to pass over all of the elements comprising the rails, each of which imparts to the arc a distinct color. The rail 6' may be composed of a different series of materials from that of rail 5' or of the same series of materials, depending upon the particular color spectrum desired.

Another method of obtaining a spectrum color effect is by using a single element electrode system of configurations as shown in Figs. 3, 4, 5 and 6. Fig. 3 shows the zigzag method of directing the arc such that when it travels from point 50 to point 51, it will pass over eleven elements. The arc in traveling over this path may scan only a small unit area of the object which is determined by the shortest distance between the points 50 and 51 and the focus of the camera. The elements forming the rails may be composed of any number of various materials in accordance with the invention as shown by the various types of cross hatching which may represent the materials or the colors obtained. Fig. 3 may represent a plan view or a front view of a rail. Assuming that it is a front view, each rail will have this configuration when viewed from the front, but such a system will appear as a straight line when viewed from the top and as shown in Fig. 5. However, if the system appears from the top as shown in Fig. 3, then the electrode rails will appear from the front as straight lines as shown in Fig. 5. Either system will produce the same results, since the propagation of the arc is so rapid that the particular path of travel of the arc is not observed.

Fig. 4 shows a scanning screen in which only alternate rails are of the zigzag or triangular type or in fact one rail is of this pattern since like horizontal portions are joined together. The arc will follow the zigzag rail 60 which is composed of arc tingeing materials while the plate rail 61 may be the usual electrode.

In Fig. 5 a better representation of the materials is shown in order to clearly illustrate that each adjoining element will be of a different surface material producing a distinct color as the arc forms from it to a like or different material. For instance 53 may be calcium, providing a red light; 54 may be of sodium, producing a yellow light; 55 may be cobalt, producing a blue light; 56 of potassium, producing a violet light; etc., when their opposite electrodes are of the same mate-

rials or of plain conducting metal. Of course, these elements will be used in the form of alloys or oxides and preferably as a coating.

5 In Fig. 6 the sine wave configuration for the electrodes is shown. This may be a top or elevational view of the rail in the same manner as explained above in connection with Fig. 3. The purpose of this configuration is
10 the same as that of Fig. 3, and that is to scan a unit area with many colors, in order to more accurately obtain a fine color definition for the image and reproduce the colors of the object more accurately. Perfect scanning
15 would provide a means for producing all the colors on one area at one instant, and although this result has been substantially obtained in the system shown in Figs. 1 and 2, it is approached in a simpler manner in the rail
20 systems using the single element electrode but with the diagonal or sine wave configuration as shown in Figs. 3, 4, 5 and 6. No posterior or anterior fields are required, the arc being driven only by its main driving
25 field 17.

Referring now to the chart in Fig. 7, the elements producing the various coloring effects are shown together with the colors obtainable from a compound arc which is
30 formed from various combinations of certain elements. For instance an arc forming between calcium and strontium, or between calcium and calcium, will provide a red arc, while the combination between calcium and
35 sodium will produce orange light when an arc is formed. Again an arc forming between nickel or cobalt and sodium will produce white light. Now, when the arc is driven from the calcium electrodes to the sodium and
40 nickel electrodes, there will be a variation from red to orange to white, as the arc retains the color given it from the electrode from which it has just been disconnected. So on to the other electrodes. The arc between
45 nickel and cobalt when containing the effect of sodium, will provide a purplish light, and the arc between cobalt and potassium will provide indigo light. The arc, therefore, as driven by the posterior and anterior fields
50 will scan a unit area of the object with colored light ranging from red to indigo with the intermediate shades occurring as the combination effects are obtained from three or more electrode materials.

55 The compound arc screen, therefore, of Fig. 2, may be made up of alternate materials as shown in Fig. 7, producing the spectrum of light just described. In this manner very small areas of the picture may be scanned with
60 substantially all the colors, those which are present in the object being transmitted by the photoelectric cell into the color frequency variations corresponding to the color of the object scanned.

65 In Fig. 8 another embodiment of the inven-

tion is shown, in which an object 65 may be either a translucent colored motion picture film or an opaque object. Photoelectric cells 66, 67, 68, and 69 are to be used when the object 65 is opaque to receive reflected light
70 while photoelectric cells 71, 72, 73, 74, and 75 are to be used when the object is translucent to receive projected light. A camera 77 is shown with its pinhole 78 together with a scanning rail system 79. This color system
75 functions either by providing screens in front of the various photoelectric cells which are colored with the important colors so as to permit each cell to be sensitive to only one particular color, or by having the element of
80 each cell responsive to an important color. In this manner the various colors of the objects are obtained from the selectivity of the photoelectric cells as the arc traverses the electrode system 79, and projects white light
85 thereon. The electrode 79 is shown in the form of a zigzag rail as in Figs. 3 and 4, and may either project white light or be made up of varied elements which produce colored lights which will augment the color selectivity
90 of the cells. Furthermore, Fig. 8 shows a shutter screen 8 which may be composed of a lattice work of rods or posts such that shadows may be obtained at the receiver. By the use of this screen, the scanning rays are
95 periodically obscured as the arc passes behind the rods. This screen may be used also in front of the system of Figs. 1 and 2, or on any similar system to produce this periodic
100 shuttering effect, which will produce spatial shadows anterior to the scanning arc. Since the basic scanning action of the arc and the operation of the piloting and synchronizing impulses are the same as in the systems of
105 my patent mentioned above, they will not be explained herein but the method of propagation of the arc over the compound electrode rails is as follows:

Assuming that an arc has been initiated at the front and to the right by the force caused
110 by the arc current flowing in a magnetic field produced by the field winding 17. This field impulse is of a frequency and amplitude to progress the arc one element distance during its positive half cycle for instance, from
115 a calcium to a sodium element. The negative portion of field current is then eliminated by the rectifier 19, and the driving field impulse becomes zero. Immediately a magnetic field from the posterior coil 21 is applied, so
120 phased by the phase shifter 23 that the arc will be driven toward the rear of the screen and be tinged by the elements of cobalt and potassium for instance. This posterior coil
125 impulse may have an amplitude of twice that of the main field impulse to drive the arc twice the distance. The force of this impulse will be eliminated at the antinode by the rectifier 26 and the field winding 17 will be energized by the next positive cycle to drive
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the arc from one element to another on the back portion of the screen in the same manner as on the front of the screen. When this field impulse is of zero value, the anterior coil 20 is energized through the phase shifter 22 and rectifier 24 to drive the arc forward in the screen over other colored elements. These interposed impulses, therefore, force the arc to travel over all electrodes consecutively, and although the arc has actually progressed along the screen only one scanning unit, it has contacted with twelve elements. In this manner, many colors may be projected on a single unit area for scanning purposes, one or more of the colors of which may appear in this unit area of the object.

The above arc driving system may be varied by connecting the anterior and posterior coils 20 and 21, respectively, in series or parallel, so as to provide a quadrature field with respect to driving coil 17. The coils 20 and 21, for highest efficiency, should take the form of a single spherical coil such as coil 17 but this form is impractical because it will interfere with the field of view. However, with either the series or parallel arrangement of the coils in the form shown, a satisfactory approximation of the spherical coil may be had. Also, this arrangement permits the elimination of the rectifiers and phase shifters, since the resultant components from the quadrature fields will provide the necessary posterior and anterior driving forces.

The arc may produce a color spectrum varying from red to indigo, as shown in Fig. 7. As this spectrum is projected on a unit area of the object through the pinhole 33 of the camera, the colored light corresponding to the color of the object will be reflected onto the photoelectric cell 35, the other light projections being absorbed by the object. The cell will transform these impulses into electrical vibrations for transmission to the receiver. These impulses may be synchronized by the synchronizer 13 in the same manner as in my patents.

At the receiver, which has a screen of preferably the same form as that of the transmitters but of exactly the same color arrangement, the arc will have superimposed upon it the corresponding color impulse received from the photoelectric cell 35, causing a heightening of the color which the receiver arc has at that instant. Since the colors of the arc corresponding to the colors of the object scanned at the transmitter will be emphasized, they will dominate their respective unit areas and as they are presented to the eye in rapid succession, they provide to the eye the mixed detail of natural colors of the object scanned. The scanning speed is sufficiently rapid to produce the solid image effect, and consequently the solid color effect. The transmitter and receiver may alternate in function as disclosed in my above men-

tioned patents, thereby obtaining two-way television.

The screen of Fig. 2 with the coloring materials arranged as shown in Fig. 7 is adaptable to another method of scanning and receiving colored images. The arc without a field current in coils 20' and 21' will travel in a straight line between elements of sodium and nickel or cobalt producing a white light. To obtain colored scanning rays, the anterior-posterior coils, which are connected in series or parallel, are energized so as to have a field flux in quadrature with the field flux obtained from the coil 17' to bow the arc forward and backward. By this bowing the arc will be tinged with the various colors indicated in Fig. 7 by the merging of the ionized discharges. The colored spectrum of red to indigo will thus be projected on the object for scanning purposes as above explained.

At the receiver screen the output of the photoelectric cells will be impressed on the anterior and posterior coils 20' and 21', respectively, which may be connected in series or parallel. In other words, the arc will be driven transversely by the field coil 17' and toward the front and toward the rear of the screen by the photoelectric currents in the coils 20' and 21'. The receiving arc will be bowed at the exact position of the scanning arc at the transmitter, and in the same direction, thus coloring the image with the color of the object scanned. This is brought about by the two arcs being synchronized as described in the patents mentioned above, the photoelectric cell being energized by the particular colored light corresponding to the position of the arc at that time. A more positive action is obtained by superposing the photo cell currents onto a quadrature field current in the anterior and posterior coils. This method of receiving is similar to one embodiment of my receiving system disclosed in Patent #1,863,278, in which increased brightness of the arc is obtained by bowing the arc toward the front of the screen and nearer the observer's eye and darkening of the arc is obtained by bowing the arc toward the back of the screen and away from the observer's eye for contrast effect. The amount of bowing determines the various degrees of light and shade of the object scanned.

An important aspect of this invention is that detail and resolution of an object may be enhanced by the alternate scanning of elements by intenser white light intermingled in succession by the other color components reflected from or transmitted through the object. The scanning arc may introduce, therefore, black and white definition by white radiation between or in association with the other scanned coloration. The eye will subconsciously mix detail and color to form a bright colored image.

This invention has been disclosed in one particular embodiment for producing a television system for transmitting and receiving colors, but it is adaptable to equivalent systems and is to be limited only by the scope of the appended claims.

What I claim as my invention is:

1. In a television system, means for producing an arc for scanning an object, electrode rails for predetermining the path of said arc, means for moving said arc, and means for imparting various colors to said arc.
2. In a television system, means for producing an arc, electrode rails for predetermining the path of said arc, and means for moving said arc over color tingeing materials.
3. In a television system, means for producing an arc for scanning an object, electrode rails for predetermining the path of said arc, means for moving said arc, means for transmitting reflected light from said object, said means including a photo cell and means for actuating said cell with light corresponding to the color of said object.
4. In a television system, a transmitter scanning screen, means for producing an arc in said screen, said screen having electrode rails for determining the path of said arc, means for moving said arc, a receiver comprising a receiving screen, means for producing an arc in said receiver screen, and means for transmitting an image of said object in its natural colors for reproduction on said receiving screen.
5. In a television system comprising means for producing an arc for scanning an object, means for moving said arc, electrode rails for determining the path of said arc, means for scanning an object with said arc, a receiver comprising a receiver screen with a similar arc, and means for reproducing with said second arc an image of said object in its natural colors.
6. In a television system, a transmitter having a scanning screen and means for initiating an arc in said screen, said screen having electrode rails for determining the path of said arc, means for moving said arc, a receiver having a receiving screen and means controlled by said first means for initiating an arc in said receiver screen, and means for coloring said transmitter and receiver arcs.
7. An illuminating screen comprising a colored arc path in a magnetic field, said arc being formed from and determined by polarized electrode rails between which said arc is created.
8. An illuminating screen comprising an endless colored arc path in a magnetic field, said arc path being formed from and determined by polarized electrode rails between which said arc is created.
9. An illuminating screen comprising end-

less rail electrodes supported in a magnetic field, said electrodes being composed of various color imparting materials and means for creating a moving arc along said electrodes.

10. An illuminating screen comprising a plurality of rows of interconnected electrodes supported in a magnetic field, said rows being composed of different color imparting materials and means for creating a moving arc along said electrodes.

11. An illuminous screen comprising a gas filled envelope containing rail electrodes of various color imparting materials supported in a magnetic field and means for creating a moving arc along said electrodes.

12. An illuminous screen comprising a colored arc path in a gas filled envelope in a magnetic field said arc path being formed from and determined by polarized electrode rails between which said arc is created.

13. An illuminous screen comprising an arc path, polarized electrode rails, means for initiating a moving arc on said rails, means for coloring said arc, and means controlled by said arc for regulating its speed of propagation.

14. In a television system comprising a master station and a subscriber's station, a colored arc screen having electrode rails between which said arc is formed at each of said stations for transmitting objects therebetween in their natural color, and means for initiating in synchronism arc discharges from said screen.

15. In a television system comprising a master station and a subscriber's station, an arc screen having electrode rails to determine the path of said arc at each of said stations, means for initiating and synchronizing an arc discharge in each of said screens, said arc discharge varying in color as it progresses on said screen, and means for maintaining said arcs in synchrony throughout their entire travel.

16. In a television system comprising a moving arc in a magnetic field, electrode rails determining the path of said arc, and means for coloring said arc to project a spectrum of color on a unit area of an object.

17. In a television system, a pair of composite electrode rails forming adjacent paths, means for initiating an arc between said electrode rails, a plurality of flux producing coils for propagating said arc in different directions over said electrode rails, means for directing light from said arc in a definite pattern over an object, means for transforming the various colors of said object into electrical currents, and means for reproducing an image of said object in its natural colors on a similar arc electrode screen.

18. In a television receiving system, an incoming line having signals thereon corresponding to the colors of an object and the

intensity of said colors, an electrode rail system composed of different materials having an irregular path, means for creating an arc between said electrodes, a plurality of driving field coils for driving said arc over said irregular path of said electrodes, and means for impressing said incoming signals upon said electrode rails for intensifying the color of said arc in accordance with the colors of said object and their intensity.

19. In a color television transmission system, a set of composite electrode rails forming adjacent paths, means for creating an arc between said electrodes, a plurality of field driving coils for propagating said arc in an irregular manner over said electrode rails, said arc being colored in accordance with the material of said rails at any particular instant, means for projecting all of said colors on said object in a definite pattern, means for detecting the various colors of the object and transforming said color pattern into corresponding electrical current variations, means for transmitting said detected currents to a similar arc screen operating as a receiver, and means for impressing the received currents on said receiving screen to increase the color intensity of the receiver screen arc and create a colored image of said object.

20. In a television transmission system, a composite electrode rail arrangement having adjacent paths, means for creating an arc between said electrode rails, and a plurality of field coils for driving said arc in an irregular manner over said rails, said rails imparting a plurality of colors to said arc, means associated with said apparatus for projecting all of said colors on each unit area of an object, means for detecting the color of each unit area and transforming said color in accordance with its intensity into corresponding current variations, means for transmitting said variations to a similar receiving arc screen, said receiving screen reproducing said object in its natural colors by an increase in its color at the respective positions on said screen in accordance with the color of said object.

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