

April 13, 1937.

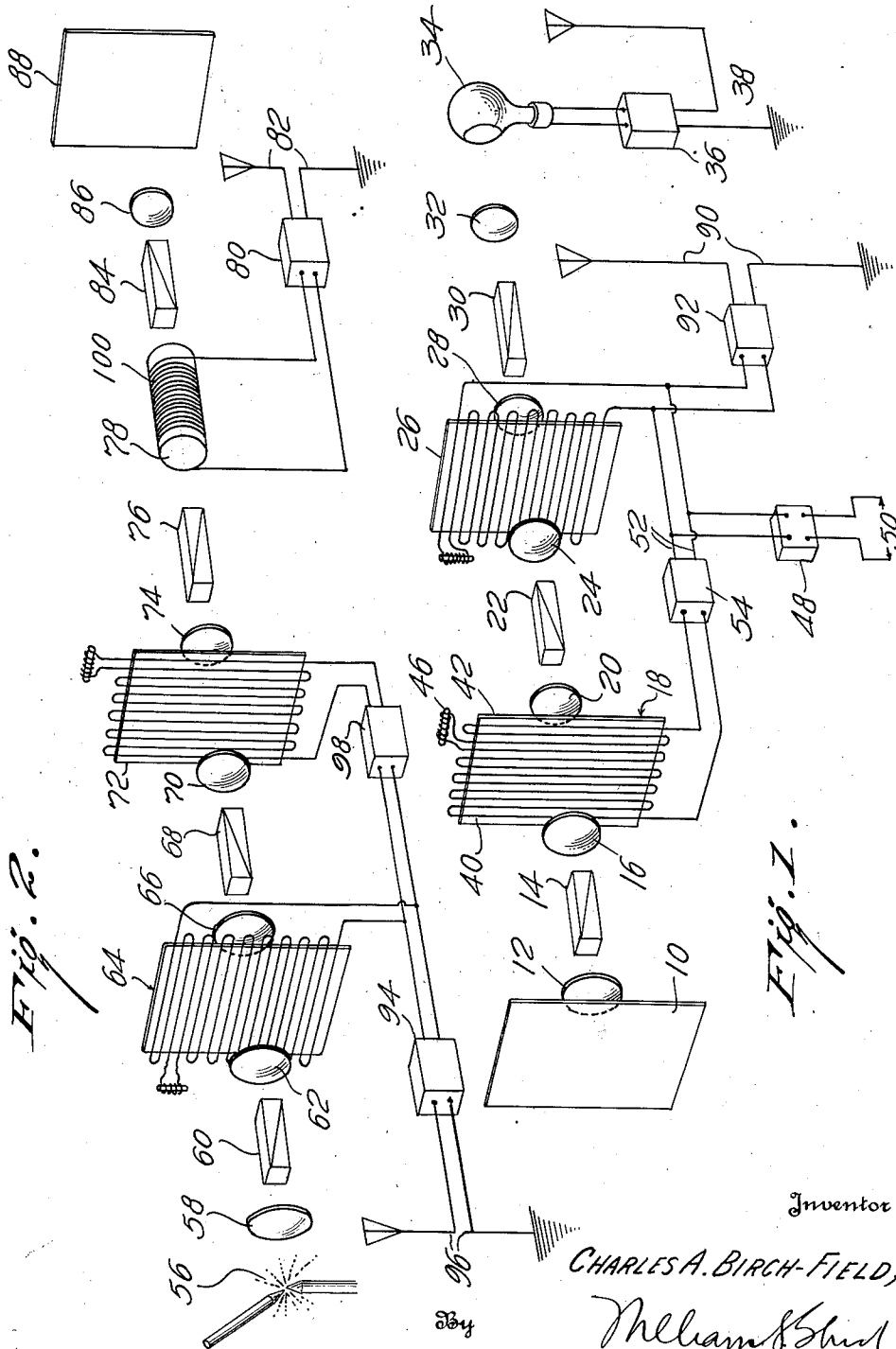
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2,077,031

TELEVISION APPARATUS

Filed July 24, 1931

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

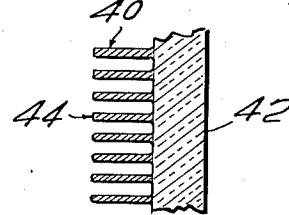
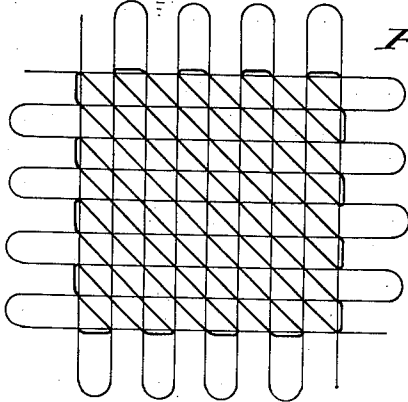
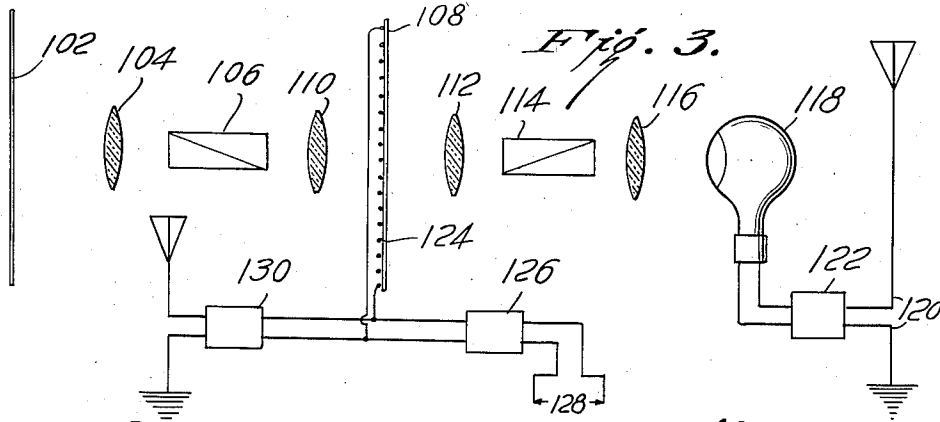


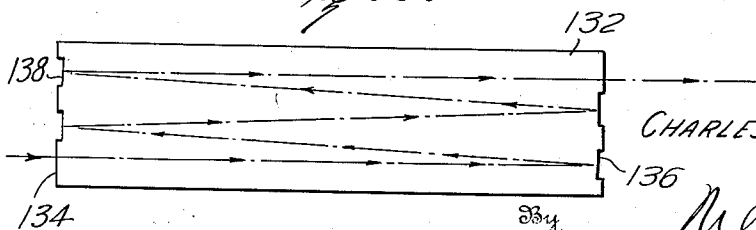
Fig. 6.



Fig. 7.



Fig. 8.



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2,077,031

TELEVISION APPARATUS

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Application July 24, 1931, Serial No. 552,858

16 Claims. (Cl. 178—6)

This invention relates to television apparatus. It is an object of the invention to provide a method of converting into electrical impulses the light rays emanating from a scene or an object, so that such electrical impulses, or other impulses the characteristics of which are determined by the original impulses, may then be reconverted, at some position removed from that of the scene or like light source to be reproduced, into a simulation having the appearance of the original object or scene. For this purpose, it is intended to project, across the path of the light rays, a plurality of electrical charges, travelling transversely of the rays in the same or different planes. The travel of the charges across the rays will be controlled at both transmitting and receiving stations so that they will be synchronous in movement and identical in position at any distinct moment, thus to produce at the two stations the necessary simultaneous action for the reproduction of the scene at the receiving station.

Light which has been polarized, when subjected to the effect of a magnetic field, has its plane of polarization rotated, in the case of plane polarized light; an analyzer, previously set to extinguish the polarized light in its original plane of polarization, will now be ineffective to bar such rotated light.

It is an object of the invention to apply this principle for television purposes. In order to do this, and recognizing the law of persistence of vision, it is intended to divide out of any ray or rays of light, emanating from a scene or like source, portions as small as possible, and then, in the reproduction of the scene, to make each portion individually visible at distinctly different times. These portions, however, will be made visible to the eye in rapid succession so that their consolidated effect would be to present to the eye the appearance of a single picture, either of moving or still images, in accordance with the scene from which the original light rays were derived.

For this purpose, the light emanating from the source or the body is first polarized, and then is subjected to a magnetic field of such characteristics that but a small portion of the light will be rotated at any particular time. An analyzer, set to extinguish light in the original plane of polarization, will pass only the small portion of rotated light, which then may be made effective to position an image upon a screen or to affect a light sensitive member, which, in the latter case, may then modulate a

transmitter either for wireless or wired transmission.

In order to synchronize scanning at transmitting and receiving stations, it is possible to modulate a transmitter in accordance with the pulsations of electric currents used in creating the moving magnetic fields by which this passage of small portions of light is effected. The transmitted pulsations may then modify the circuit of a receiver from which, by amplification, a sufficient current of exactly the same characteristics and in exactly the same relation as that of the original impulses, may be used for image scanning or composition.

The moving magnetic field, is, in this case, produced by effecting a sharp discharge of electricity through a conductor positioned transversely of the polarized light to be affected. The charge may be caused to flow back and forth across a screen of conductors, all of which are substantially parallel and in the same plane, and by the use of choke coils, and other well known means, the charge may be confined to one only of these conductors, and to but a small portion of that one, at any distinct moment.

For the purpose of producing conductors of sufficient size to reduce resistance to the passage of current to a minimum, as well as to eliminate, to as great an extent as possible, their light interruptive effects, these conductors may be formed by depositing photographically, or in some similar fashion, a thin fine ridge of metal upon a light transmitting member, preferably of considerable refractivity. In order to increase the magnetic rotative effect upon the light, in addition to the use of refractive material upon which the conductors are deposited, the face of the material may be coated, or otherwise provided, with a plating or deposit of iron smoke, or the smoke of some similar magnetic metal, such as nickel, cobalt, or the like, by subjecting the face of the refractive member to a smoke derived from an electric arc having electrodes of that particular metal.

Other objects of this invention will be hereinafter set forth, or will be apparent from the description and the drawings, in which are illustrated a number of embodiments of apparatus for carrying out the invention.

The invention, however, is not intended to be restricted to particular constructions and arrangements of parts, nor to particular applications of such constructions, nor to specific methods of operation, nor to various steps or details thereof, herein shown and described, as the same

may be modified in various particulars or be applied in many varied relations without departing from the spirit and scope of the invention, the practical embodiments herein illustrated and described merely attempting to show some of the various forms and modifications in which the invention might be applied.

For the attainment of these objects and of such other objects as may hereinafter appear or be pointed out, I have illustrated an embodiment of my invention in the drawings wherein:—

Fig. 1 is a diagrammatic representation in perspective of a light transmitting system embodying the invention;

Fig. 2 is a similar view of a receiving system;

Fig. 3 is a view in elevation of a modified form of transmitting system;

Fig. 4 is a transverse section through a portion of a scanning screen;

Fig. 5 is an elevational view of the scanning screens, in superimposed relationship, illustrating the arrangement of current lagging members and the direction of the moving dots;

Figs. 6 and 7 are curves illustrating characteristics of the current flow through representative screens; and

Fig. 8 is a sectional view of a modified light valve.

In transmitting the light rays emanating from an object 10, it is first desirable to concentrate the rays by means of a lens 12 so they may be polarized by a prism 14. The light thus polarized is then diverged by a lens 16 for passage through the scanning screen 18, hereinafter to be described. Light, after having been affected by the scanning screen and then converged by a lens 20, passes through an analyzer 22, which serves to blot out any light not rotated by current passing through screen 18.

Light passed by the analyzer may again be diverged by a lens 24 for passage through another scanning screen 26, the functioning of which will be set forth hereinafter. After this scanning screen, light may be converged by a lens 28 for passage through a second analyzer 30, which serves to blot out all light passed by analyzer 22 and not affected by the field set up at the screen 26.

Light passed by analyzer 30 is then passed through a lens 32 for concentration upon the light sensitive portion of a light sensitive cell or similar member 34. The electrical variations, produced by these varying light sensations at the light sensitive cell 34, may then be used to modulate the wave sent forth by a transmitter 36 from an aerial-ground circuit 38. However, it is to be understood that the variations from cell 34 may be used in any other well known manner for transmitting to any point an electric current, varying in accordance with pulsations at this cell.

In order to rotate light at screens 18 and 26 in distinctly small portions, in order that such small portions of light may act as distinct elements in affecting the light sensitive member of cell 34, screens 18 and 26 may be made up of a plurality of conductors 40, disposed transversely of, and preferably in parallel relation on, the face of a plate 42 of refractive light conducting material. The conductors preferably are formed by depositing photographically upon a surface, a metal, such as silver or the like, this deposit being built up to a substantial ridge 44 as appears in Fig. 4. The height of the ridge would be determined, in particular cases, by the conductivity desired. The conductors 40, thus formed, may

have their ends connected so that, in effect, a continuous conductor would be produced; that is, the individual conductors would be connected in series.

However, in that it becomes necessary to segregate the effects of the successive conductors, it may be necessary to connect, between the ends of successive conductors, choke coils 46, or similar means for producing a predetermined lag as current flows between successive conductors. This construction is well known in the art, and requires no further explanation at this time, it merely being desired that current, at any distinct time point, be restricted to affecting light passing by one only of the conductors in a particular plane. The conductors, in the respective screens 18 and 26, are angularly, and preferably perpendicularly arranged with reference to each other, rather than parallelly, as are the conductors in each distinct plane, for a purpose hereinafter appearing.

In order to create desired current impulses in screens 18 and 26, a device 48 is provided, and is energized from a power source 50, preferably delivering alternating current. This source, which may be of any well known construction, preferably utilizes the action of a cathode ray oscillograph or like element for timing. It is intended to discharge, through one of the screens, and preferably, as indicated here, screen 26, and at predetermined time intervals, an electric charge of definite quantity. As is well known, a charge of electric current may be created to have the properties of a wave, such as shown in Fig. 6. In moving along the conductors, this electric charge would, at any instant be present at a particular point along the conductor, and effect the production, at that point, of an electromagnetic field, in accordance with its intensity. However, the charge moves along quickly, and leaves behind it a non-magnetic field. The charge may also be defined so that but a small portion at a time of the conductor will be affected by the charge flowing through it and, therefore, but a small magnetic field will be produced, and a magnetic effect of limited scope, upon light crossing the path of the charge, will result.

By a second circuit 52, a multiplier 54 may be energized to discharge, through screen 18, a charge of current similar in characteristics to that passing through screen 26, but which may consume a greater time period in effecting its passage through screen 18. The passage of the charges through the respective screens is intended to be regulated, by such means as the controlling cathode ray oscillograph, choke coils and the length of the conductors, so that the charge passing through screen 18 will be transmitted faster than that through screen 26, and also so that a charge in screen 18, at particular moments of its magnetizing effect, will be located to affect light which also will be affected by the relatively slower charge flowing through screen 26, a relationship being raised between the speeds of the two charges and their periods of activity such as appears in the two curves of Figs. 6 and 7.

In Fig. 5, the two screens have been superimposed so that the relation of their respective conductors may be understood. The horizontal lines are intended to indicate the conductors of the screen 26 or 64 and the vertical lines, the conductors of screens 18 or 72, the external loops merely representing choke coils or otherlag producing media. Now when charges are projected into the two screens, they may be timed, in some

such relations, as indicated in Figs. 6 and 7, so that as one traverses, say the conductors of screen 26 or 64, a plurality of other charges in the same time period will be made to traverse the other screen. The time control may be such that the point at which charges are simultaneously effective will follow the heavy line in Fig. 5, extending diagonally across the lines of the conductors. In other words, as one charge slowly traverses one screen, the other swiftly moving charges, in a definitely timed relation, will be caused to cross its path to provide a regular pattern of points at which both charges will have rotated the light rays.

It will of course be understood that by varying the characteristics of the charges, and timing their interactions, the scanning effects may be widely varied, but the discussion of such effects is unnecessary to an understanding of my invention, as long as the basic principle thereof is understood.

In other words, while the charge flowing through screen 18 will affect much more light in a distinct time interval than the charge flowing through screen 26, all of that light which passes analyzer 22, but does not become affected by the charge passing through screen 26, will be blotted out by second analyzer 30 so that substantially but a point of light will be brought to bear upon cell 34.

In Fig. 2 has been shown a receiver, the screens of which must be identical with the screens of transmitters such as shown in Fig. 1. This receiving apparatus includes a light source 56 which may be an electric arc, tungsten bulb, or any other illuminating device. Light from this source is concentrated by a lens 58 upon a polarizer 60, from which it passes to a lens 62 to be diverged and spread over a scanning screen 64, the construction of which must follow closely that of scanning screen 26 of the transmitter. Light, after passing screen 64, is condensed by a lens 66 for passage through an analyzer 68. This analyzer serves to blot out all light flowing through the screen and not affected by the current flowing through that screen. Light passed by the analyzer is again diverged by a lens system 70, so that it may pass through scanning screen 72, after which it is converged by a lens 74 to pass through a second analyzer 76. This analyzer is set to refuse all light coming from analyzer 68, except that which has been affected by current flowing through screen 72. Light from this analyzer now passes through a light valve 78, the construction of which will be more fully set forth hereinafter, the current affecting which is derived from a receiving unit 80, the signal for which is produced by effects in an antenna-ground circuit 82. After passage through the light valve, light is now acted upon by the analyzer 84, set to refuse or to pass light, in accordance with a scheme hereinafter appearing. Light passed by this analyzer may then be viewed through a lens 86, or such light may, by such lens, be directed upon a screen 88, there to be visualized.

In order to coordinate screens 72 and 64, which, as above indicated, must be substantially identical in their structure with screens 18 and 26 of the transmitter, respectively, the current for screen 26 may be used to modulate the wave sent forth from an antenna-ground circuit 90 by a transmitter 92. This wave would then be picked up by a receiver 94 having an antenna-ground circuit 96. Receiver 94 would then be utilized

to pass, through screen 64, which is substantially a duplicate of screen 26, a current of identically the same properties and at the same rate as that flowing through screen 26. A multiplier 98 having the same factors as multiplier 54, may be used to pass, through screen 72, a current substantially identical with that passing through screen 18. The multiplication of frequencies effected by multipliers 54 and 98, can, as is well known, be effected by vacuum tube relays. In other words, the charges flowing through the respective screens would thus be synchronized absolutely without the necessity for pulling the two stations into phase, and with the total elimination of the possibility of the two stations getting out of phase at any time during operation.

Light valve 78 preferably consists of some light conductive, highly refractive material around which is wound a coil 100, energy for which is derived from a receiving unit 80, which, in turn, is affected by the wave in the aerial-ground circuit 38. In other words, the pulsations of current through the light valve will be directly proportioned to the light effects at light sensitive cell 34. Analyzer 84 may be set either to blot out light passed by second analyzer 76, or to pass light passed by this analyzer by so positioning it that rotation of the light, so passed, will effect a reduction in its intensity, and possibly complete refusal. In other words, the effect of current flowing through coil 100 may be used to effect the passage of light past analyzer 84, as did the currents in screens 64 and 72, or to blot out light which normally would pass this analyzer. A moving dot of varying intensity would thus be produced in the light passing analyzer 84. This moving dot would then be spread over a definite area of a screen 88 by, or could be seen through, a lens 86. The movement of the dot would be so swift, and its variations so instantaneous, that it would reproduce to the eye a picture corresponding to that shown at 10 from which the original light emanated.

In Fig. 3 is shown a modified transmitting arrangement, in which a body or scene 102 emanates light which is condensed by a lens 104. This light then is polarized by a prism 106 to be spread over a screen 108 by a lens 110. Light passing the screen is then condensed by a lens 112 for passage through an analyzer 114, set to refuse light unaffected by the screen. Light passed by the analyzer is condensed by a lens 116 and focused upon the light sensitive element of a light sensitive cell 118, the electrical disturbances of which are used to modulate the wave radiated by an aerial ground-circuit 120 of a transmitter 122.

Screen 108, in this case, consists of a plurality of conductors 124, preferably parallelly arranged; their arrangement, however, is not of any distinct importance. Current for creating the moving electric charge is derived from apparatus 126 similar to that used in the systems previously described, taking current from a source 128, and changing it into a sharply pulsating current.

It is intended that the current pulsating in this manner should, in its extent at any particular moment along the conductors 124, be of such small proportions that but a point of light passing the screen, at any moment, will be affected magnetically. All other light not so affected would then be blotted out by analyzer 114. In this manner, light sensitive cell 118 would be affected only by the point of light, the intensity of which would be determined by the intensity

of the same relative points in object 102. It will be understood that the receiver for the signal, such as that sent out by this unit, would require a scanning screen of identically the same electrical characteristics as that used for the transmitter. Also, it would be necessary to energize the screen of the transmitter in synchronism with the screen of the receiver. For this purpose, transmitter 130 functions in substantially the same manner as transmitter 92.

In the use of apparatus of this character, due to the necessarily small current which will flow through the screen, it is necessary to provide some arrangement whereby large magnetic effects will be produced upon light by relatively small currents. For this purpose, highly refractive material is necessary for plates 42. The iron smoke coating is also an element in producing this desired effect. But, as another element, it has been found that, when the plane of polarization of the light is disposed at an angle to the lines of conductors 40, and not either parallel or perpendicular thereto, a greater magnetic reaction upon the light results. It was found that the greatest effect upon such light was obtained when this angular disposition was approximately 45°.

It has been found that materials of refractive properties, when associated with magnetic fields to affect light, produce different rotative effects. For instance, one material of high refractive property, when used for affecting light by means of electromagnetic means, displayed the property of producing a very sharp change in the rotation of light only when the current had reached a certain peak. Other materials of relatively low refractivity show a substantially even gradient in the variation of light as the magnetic fields vary. In other words, for use in scanning screens, it would be highly desirable that the first type of material be used, while for use in the light valve, the second type of material would be desirable.

While, in many cases herein, a plurality of analyzers have been shown as separate and distinct units, it is to be understood that it is possible to blot out light at more than one plane either by using a single compound analyzer of suitable properties, or a set of series-arranged analyzers, the light passing continuously and successively from analyzer to analyzer without the intermediate effect of lenses. For instance, in the structure of Fig. 2, after scanning screen 64, the lens 65 and lens system 70 may be eliminated and the analyzer 68 positioned before the second analyzer 76. In fact, these analyzers may then be arranged in any desired order, the respective blotting-out functions remaining the same.

In the modification of Fig. 8, a light valve 132 is illustrated. This light valve is made of refracting material of the same character as the light valve 78. However, the rays of light coming from the screens preferably are condensed by suitable lenses, before entry into the light valve body, to as small a compass as possible. The rays then pass through the body from the entry end 134 to strike upon the face 136 at the other end from which it is reflected back through the body. Likewise, another reflecting face 138 may be provided at the end 134 to turn the rays back in their original direction. This reflection may be repeated any desired number of times, the rotation of the plane of polarization due to the magnetic field of the coil increasing proportion-

ately with the number of reflections. The rotation, in each case, would be cumulative in the same direction according to the well known law discovered by Faraday.

While the elements 12, 16, 20, 24, 28, 32, 58, 62, 66, 70, 74, 86, 104, 110, 112, and 116 are variously called "lens", or "lens system", or by similar terminology, it is to be understood that, in any case, the depiction of a lens on the drawings or the description herein is merely intended to indicate any optical system for diverging, converging and/or paralleling light rays, as such may become necessary at particular stages.

Many other changes could be effected in the particular apparatus designed, and in the methods of operation set forth, and in the specific details thereof, without substantially departing from the invention intended to be defined in the claims, the specific description herein merely illustrating operative embodiments for carrying out the spirit of the invention.

Having thus described my invention and illustrated its use, what I claim as new and desire to secure by Letters Patent is—

1. In a television system, the method of breaking up the light rays from a source or scene to permit illumination from small portions of such source or scene to pass in consecutive relation to a light sensitive member or to a screen, which includes the steps of: polarizing radiant energy rays from the source or scene, blotting out such polarized rays in the original plane of polarization, and electromagnetically effecting rotation of the polarization plane of successive small portions of the rays in a predetermined consecutive relation before blotting out to permit such rotated rays to pass without being blotted out.

2. In a television system, the method of breaking up the light rays from a source or scene to permit illumination from small portions of such source or scene to pass in consecutive relation to a light sensitive member or to a screen, which includes the steps of: polarizing radiant energy rays from the source or scene, blotting out such polarized rays in the original plane of polarization, and periodically effecting rotation electromagnetically of the plane of polarization of successive small portions of the rays in a predetermined consecutive relation before blotting out to permit such rotated rays to pass without being blotted out.

3. In a television system, the method of breaking up the light rays from a source or scene to permit illumination from small portions of such source or scene to pass in consecutive relation to a light sensitive member or to a screen, which includes the steps of: polarizing radiant energy rays from the source or scene, blotting out such polarized rays in the original plane of polarization, and periodically and magnetically effecting rotation of successive small portions of the rays in a predetermined consecutive relation before blotting out to permit such rotated rays to pass without being blotted out.

4. Apparatus for breaking up light rays from a scene or source into a plurality of consecutively visible small extent areas or points, which includes: means for polarizing the light rays, and means for producing a magnetic field of small extent moving across the field of rays and transversely of the polarized rays and thereby successively changing the plane of polarization of small portions of said rays.

5. In television scansion, the steps of: polarizing light from a scene or source, electromagneti-

cally twisting the plane of polarization of the rays at distinct sectors in a predetermined order and in two stages, and blotting out all rays the plane of polarization of which was not affected in the second twisting stage.

6. In television scansion, the steps of: polarizing light from a scene or source, electromagnetically twisting the plane of polarization of the rays at distinct sectors in a predetermined order and in two successive stages, the frequency of activity of the two stages not being the same, and blotting out all rays the plane of polarization of which was not affected in the second twisting stage.

7. In television apparatus, means for polarizing light rays from a source or scene, means for guiding a magnetizing electric charge transversely through the rays, means for guiding another magnetizing electric charge in angular relation to the first charge and transversely of the rays, and means for passing only light affected by both electric charges.

8. In television apparatus, means for polarizing light rays from a source or scene, means for guiding a magnetizing electric charge across the field of rays and transversely through the rays, means for guiding another magnetizing electric charge along lines in angular relation to the first charge and transversely of the rays, and means for passing only light affected by both electric charges.

9. In television apparatus, means for polarizing light rays from a source or scene, means for guiding a magnetizing electric charge along lines transversely through the rays, means for guiding another magnetizing electric charge along lines in angular relation to the first lines and transversely of the rays, and means for passing only light affected by both electric charges.

10. In television apparatus, means for polarizing light rays from a source or scene, means for guiding a magnetizing electric charge along lines within the field of rays and in a plane transversely of the rays, means for guiding another magnetizing electric charge along lines within the field of rays and in angular relation to the first lines and transversely of the rays, and means for passing only light affected by both electric charges.

11. In television apparatus, means for polarizing light rays from a source or scene, means for guiding a magnetizing electric charge along lines in a plane transversely of the rays, means for guiding another magnetizing electric charge along lines in angular relation to the first lines and in a plane parallel to the first plane, and means for passing only light affected by both electric charges.

12. In an electro-optical system of television, a net work of parallel conductors disposed in the path of a field of polarized light, said conductors being electrically connected alternately at their opposite ends so as to form in effect a single conductor, and means for projecting through said system of conductors, and unidirectionally in relation thereto, an electric charge, whereby said electric charge will be caused to traverse and re-traverse substantially the entire luminous field and alternately in opposite directions in relation thereto.

13. In an electro-optical television system, receiving apparatus for the composition of an image from impulses received from a transmitting station, which comprises a luminous source, a screen for receiving light from said luminous source,

means for affecting the light passing from said source to said screen, said means comprising, in positional sequence, polarizing means adapted to receive and to polarize light proceeding from said luminous source rotating the plane of polarization of portions of said light without affecting its characteristic of plane polarization, analyzing means for blotting out all light rays not affected by said rotating means, means for effecting rotation of the plane of polarization of said light transmitted by said analyzing means without affecting its characteristic of plane polarization, analyzing means for blotting out all rays not affected by the said second rotating means, means for rotating the plane of polarization of rays passed by the second analyzing means, and a third analyzing means for blotting out all rays not affected by said second rotating means and transmitting those affected fractionally in proportion to the intensity of signals received from the transmitting station.

14. Apparatus for breaking up light rays from a scene or source into a plurality of consecutively visible small extent areas or points, which includes: means for polarizing the light rays, a plurality of serially connected spaced conductors positioned adjacent a medium adapted to become birefringent under the influence of a magnetic field, and in a pair of substantially parallel planes and the conductors in each plane being adapted for guiding magnetizing electrical charges transversely of the polarized rays, the conductors in each plane being serially connected and being substantially parallel and the conductors of one plane being angularly disposed with relation to the conductors of the other plane, and means for projecting electrical charges through the conductors in the respective planes in predetermined relation, the conductors being arranged so that the charges in the different planes have different periods of activity and an analyzing means positioned between the conductors of said two planes and adapted to receive the polarized rays passing said conductors in said first plane and to intercept all rays except those of which the plane of polarization has been rotated through a predetermined angle, and a second analyzing means positioned so as to receive the polarized rays passing said conductors in said second plane and to intercept all rays except those of which the plane of polarization has been further changed through a predetermined angle.

15. In a television system, scanning apparatus at the transmitting station and scanning apparatus at the receiving station, each scanning apparatus having a first screen comprising a sheet of light transparent material adapted to become birefringent when subjected to the influence of a magnetic field, a grid of parallel spaced electric conductors positioned adjacent one surface of said screen said conductors being serially connected, a Nicol prism positioned so as to receive polarized light rays passing through said first screen, a second screen similar to said first screen but having its conductors positioned at right angles to the conductors of the first screen, said second screen being positioned so as to receive the polarized light rays transmitted through said Nicol prism, a second Nicol prism positioned so as to receive the polarized light rays passing through said second screen, means for passing similar periodic electrical impulses of one frequency through the first screen of each of said systems in synchronism, and means for passing similar periodic electrical impulses of an-

other and higher frequency, through the two second screens of each of said scanning systems in synchronism, and both of said Nicol prisms of each system being set so as to transmit only those
5 polarized light rays that have been affected in a predetermined manner by said electrical impulses.

16. In a television system, the method of scanning, which comprises breaking up light rays from a source or scene consecutively into small
10 portions, which includes the steps of plane polarizing the field of light rays from said source, effecting rotation of the plane of polarization of successive small portions of the rays of said field in a predetermined consecutive relation without

changing their characteristic of plane polarization, blotting out all the small portions of the rays except those of which the plane of polarization has been rotated through a predetermined angle, subjecting the plane of polarization of successive small portions of the rays that were not
5 blotting out to another rotating treatment, again blotting out all the rays except those whose plane of polarization has been changed through the predetermined angle, and converting the rays not
10 blotting out into electrical impulses for transmission to a receiving station.

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