

June 15, 1948.

N. E. LINDENBLAD

2,443,258

OPTICAL SIGNALING SYSTEM INCLUDING MEANS FOR
DISPERSING AND RECOMBINING A LIGHT BEAM

Filed April 30, 1942

3 Sheets-Sheet 1

Fig. 1.

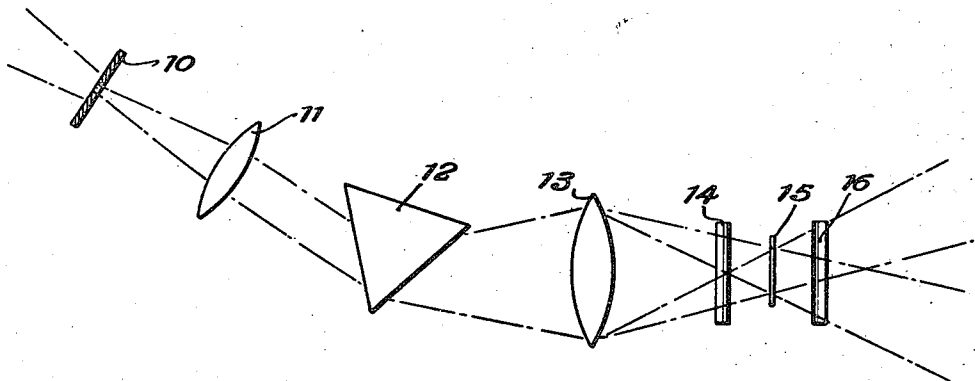


Fig. 2.

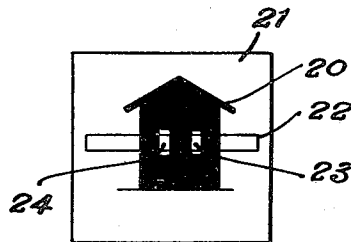
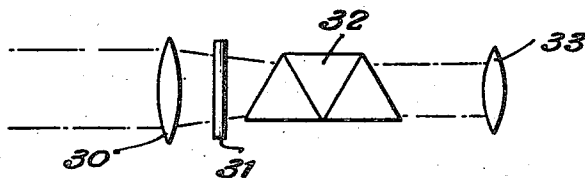


Fig. 3.



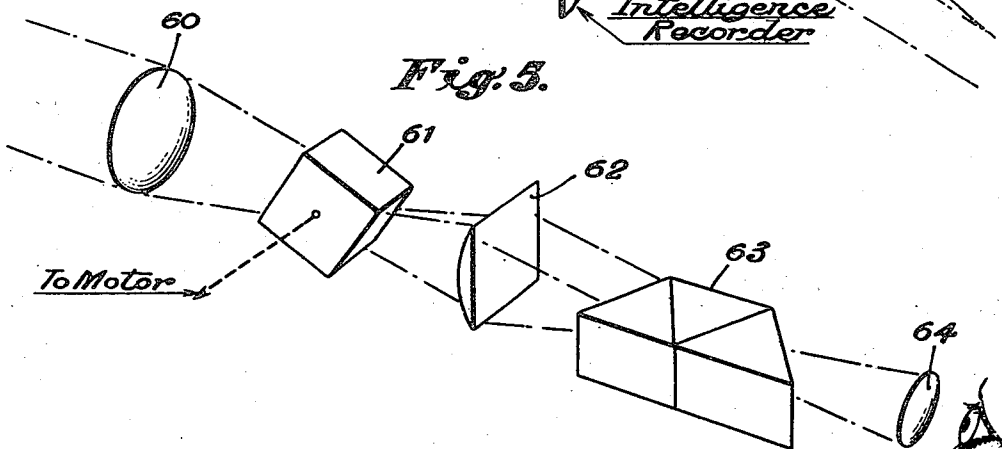
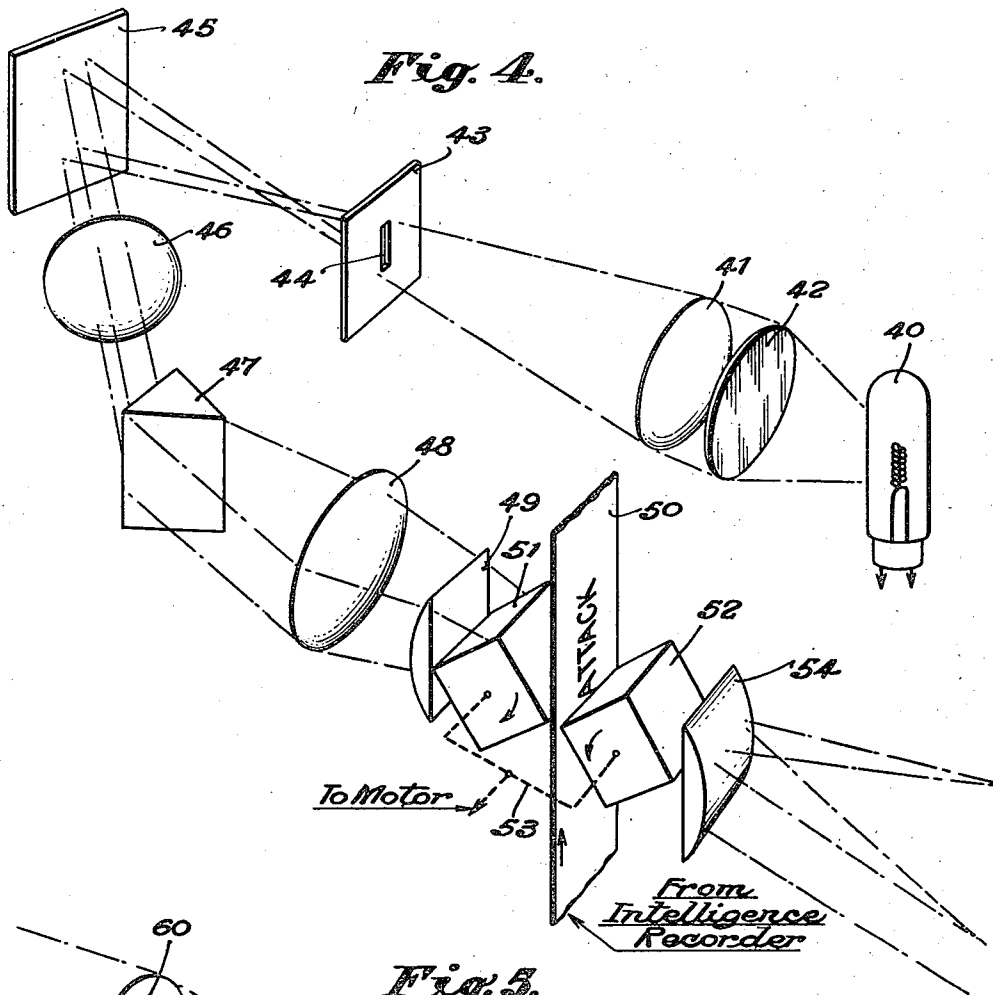
INVENTOR
Nils E. Lindenblad
BY *H. S. Snover*
ATTORNEY

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3 Sheets-Sheet 2



INVENTOR
Nils E. Lindenblad
BY *H. S. Grover*
ATTORNEY

June 15, 1948.

N. E. LINDENBLAD

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3 Sheets-Sheet 3

Fig. 6.

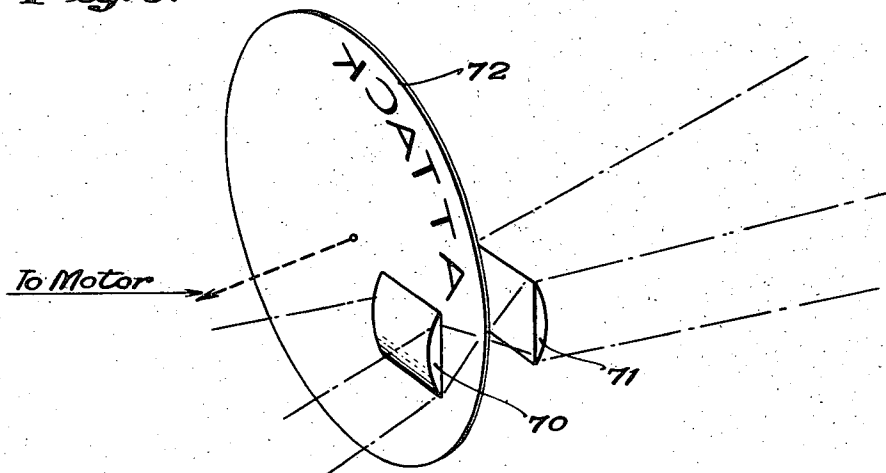
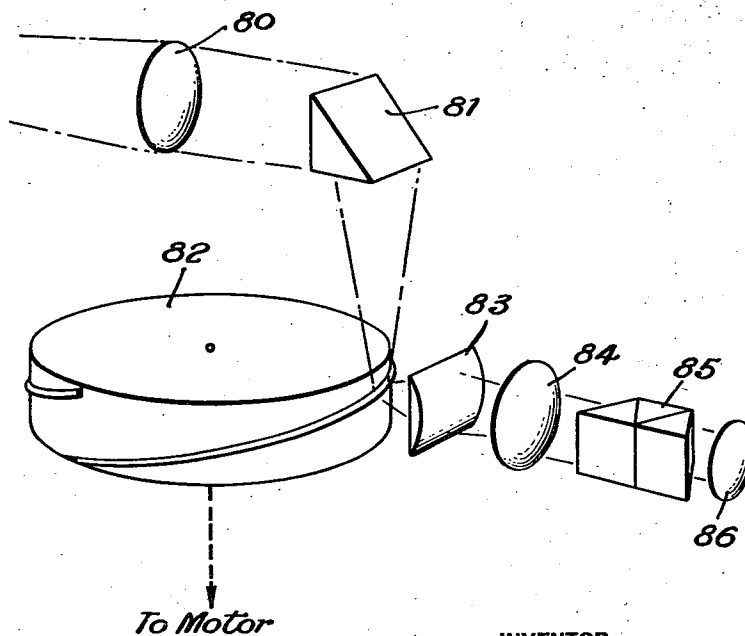


Fig. 7.



INVENTOR
Nils E. Lindenblad
BY *H. S. Brooker*
ATTORNEY

UNITED STATES PATENT OFFICE

2,443,258

OPTICAL SIGNALING SYSTEM, INCLUDING
MEANS FOR DISPERSING AND RECOMBIN-
ING A LIGHT BEAMNils E. Lindenblad, Rocky Point, N. Y., assignor
to Radio Corporation of America, a corporation
of Delaware

Application April 30, 1942, Serial No. 441,101

2 Claims. (Cl. 88—1)

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My invention relates in general to optical devices, and in part more particularly to optical signalling devices for the transmission of intelligence.

Signalling devices of a nature wherein intelligence is converted into electrical signals and the electrical signals then are transmitted are many and varied in form. Such signalling devices include audio transmitters of various types, facsimile transmitters of various types, and television transmitters of various types. Representations of the intelligence which is to be transmitted are used to modulate a carrier wave, and the modulation thereof may be either of the amplitude modulation type or the frequency modulation type. The transmission of such intelligence has, at the present time, assumed a position of paramount importance in military maneuvers wherein observation devices transmit messages to so-called motorized units, or where observers located in various positions must of necessity transmit intelligence to air units for their maneuvers. One of the disadvantages inherent in the use of electrical signalling of this nature is that the message must be in code to prevent its interception, or if sent by facsimile, may be too slow in some instances, or may be somewhat jammed by interference from other transmitters. Accordingly, it is one of the objects of my invention to provide an intelligence transmission device which will be adaptable to the uses of the military forces, and which will not suffer from these disadvantages.

So-called secret message or intelligence transmission apparatuses usually are not particularly satisfactory for use with military equipment, since the adjustments of the receiver relative to the transmitter are somewhat critical, and in a number of instances the equipment may be very bulky. Accordingly, it is another of the objects of my invention to provide an arrangement whereby intelligence may be transmitted wherein not only is the apparatus comparatively simple, but message interception may be avoided.

Since the intelligence to be transmitted may be in the nature of a written or printed optical image form, or a form in which it is desired to transmit a facsimile of a picture, it is necessary that some arrangement be provided for scanning the picture or message to be transmitted. Accordingly, it is another of the objects of my invention to provide an apparatus which will optically scan an image or message to be transmitted and, further, optically transmit the intelligence.

It will be apparent from the disclosure hereinafter made in this specification that a spreading

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of white light into a continuous spectrum takes place, and that a part or the whole of this spectrum is used in the transmission of intelligence.

In any transmission of images scanning in two directions is necessary. If line scanning is used, the scanning along the line will usually be very rapid and the transverse moving from line to line will be of slower character.

In mechanical television the rapid line scanning is a real handicap and in electronic scanning it calls for wide band circuits. Therefore, another of the objects of the invention is to use the color discrimination possible through spectroscopic means to replace the rapid scanning along the lines of an image undergoing scansion. If a band or a portion of a band of color is blocked out of a spectrum, and if the remaining light is recombined, it will always be possible to detect the missing color band in a second spectroscope wherever the recombined light may be seen. If such a spectrum is narrowed up transversely to its spread to form a line which is, say, red at one end and blue at the other, and if such a line can be moved parallel to itself across the image on a slide, or other plane medium, the essential elements of transmission of the image on this slide have been described. The spectrum in a receiving spectroscope need then only be scanned through a slit which moves in synchronism with the "line" spectrum at the transmitter. As can be seen, only the slow scanning requires mechanical means. The fast scanning is replaced by color discrimination. Accordingly, it is another of the objects of my invention to provide an apparatus for the transmission of intelligence and which utilizes the color discrimination method of scansion and transmission.

The objects hereinbefore stated are merely illustrative, but other objects will be apparent from the material hereinafter set forth.

My invention in general contemplates the provision of a source of substantially white light which is formed into a beam, the rays of which may be substantially parallel each to the other. This is passed through a refracting medium so that the light is broken up into its color components. These color components are then focused onto a particular focal plane and there is provided a slit arrangement so that the individual component colors together form a line of elemental width. Now, if an interception of a part or the whole of one or more of the components takes place the white light will have been robbed of some of its component parts. Now, if for scanning purposes a message or other type

of optical image which is recorded on a transparent medium be placed in the focal plane of the linear spectrum of light, the light will be robbed of some of its component parts either partially or wholly by the intercepting action of the opaque or translucent portions of a line of the image. Hence, the line of differing colors may be caused to scan the image to be transmitted. Now, if the remaining components of the linear spectrum be recombined after the interception of a portion thereof the light so formed may approximate white light or a light of a shade differing therefrom, but there will be no indication that a portion of the component parts of the source has been intercepted and eliminated from the beam. If the beam formed by the recombined portions of light is observed through a spectroscopic, then there will appear the original line with an indication of the sections thereof which have been intercepted. By moving the image past the focused line of light or, vice versa, by moving the light by the image at a definite rate and by moving the slit or a scanning prism in the receiving spectroscopic at an equivalent rate, it will be appreciated that a scanning and a translating action will be obtained although this will not be obvious to the unaided eye. This arrangement, then, has amongst other features the advantage that it requires only a slow speed mechanical scanning device and a device which necessitates no decoding of a message and also provides a practicable secret transmission arrangement.

My invention will best be understood by reference to the drawings, in which:

Fig. 1 is a schematic illustration showing some of the principles of my invention.

Fig. 2 is an illustrative showing of some of the principles of my invention.

Fig. 3 is a schematic representation of a receiving element according to my invention.

Fig. 4 is a schematic representation of one embodiment of a transmitting arrangement according to my invention.

Fig. 5 illustrates schematically a receiver according to my invention.

Fig. 6 shows an embodiment of one portion, in a modified form of my invention.

Fig. 7 is an alternative form of receiving apparatus according to my invention.

It has been stated hereinbefore that my invention embodies the idea of breaking a light beam down into its component spectral portions, which spectral portions are caused to be passed through a transparent holder which has recorded thereon or affixed thereto an optical image to be scanned. The opaque portions of the optical image interrupt portions of the spectrum and, upon the recombining of the light after passing through the transparent holder, light is obtained which approximates white light. Having been robbed of a portion of its components, however, the light can never again be absolutely white in color, but approaches a pastel.

Referring to Fig. 1, there is shown a schematic representation by which my invention may be understood. Light from a source not shown is passed through a slit in an opaque member 10, and passes to a convex lens 11 which directs the light to a prism 12. This prism then breaks the light down into its spectral components, beginning with red and going through violet. This is accomplished because of the refracting qualities of the prism 12 and the light will be broken down so that effectively each color in the spec-

trum is positioned in its normal spectral position. The arrangement of the colors of the visible spectrum are common knowledge, and need not be discussed here. The light which is broken down then is passed to a lens 13 and thence through a cylindrical lens 14 and is focused onto an objective plane. The image to be scanned is placed at this objective plane. The light in its course from the source through the various lenses and through the prism 12 has dispersed even though it may be conveyed through a slit in an opaque member which limits the dimensions, and accordingly the light impinging on the objective plane would, in normal circumstances, have considerably more depth than a linear portion of the image to be scanned, that is to say, the dimensions of the light strip in the co-ordinate perpendicular to the length of the line would be considerably greater than the elementary dimension of the line. The purpose of the cylindrical lens 14, therefore, is to compress the light, so to speak, in one co-ordinate so that the light which falls on the objective plane comprises the colors of the visible spectrum and of sufficient width to cover the image to be scanned, and the light is of elementary depth, that is to say, the light in general is the depth of an elemental or linear section of the image, and by depth is meant the dimension of the light in the co-ordinate perpendicular to the length of the linear section of the optical image. The light then will pass through the transparent member on which the intelligence or optical image to be transmitted is recorded, and portions thereof will be intercepted or blocked by the action of the opaque or translucent parts of the optical image undergoing scan. In other words, the white light has been robbed of a portion of its component parts. The light continuing on through the transparent member 15 then is passed to another cylindrical lens 16 which allows the light to disperse and also allows the light to recombine. This is true because portions of the red section of the spectrum, for instance, will pass through the lens in a direction so that some portions of the violet part of the spectrum eventually will intersect with the red portions of the light, and hence will combine therewith. This example is used as the red section is the most extreme in position away from the violet section. As a matter of fact, the entire portions of the light which remain after discrete sections thereof have been intercepted by the optical image will recombine so that ordinarily where white light has been used as a source, the recombined light will assume a shade somewhat like pastel. It will be appreciated that since the light has recombined, and since the spectrum of the recombined light is a function of the portions of the original spectrum which have been intercepted, there has been provided what is effectively at a distance a spot of light which, when broken down into its spectral portions by a prism, will indicate which portions have been intercepted, or in other words, will give a representation of the opaque or translucent sections along a single line of the image scanned. This will be shown in somewhat greater detail and will be more apparent from the showing of Fig. 4.

Referring to Fig. 2, there is illustrated schematically the action of an opaque image which has been recorded on a transparent medium on a light which comprises the visible spectrum or a portion thereof, and which is of elemental

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depth, and which is passed through a transparent member on which opaque sections are recorded or affixed thereto. In this figure it is assumed that an optical image such as a house 20 is recorded on a transparent member 21. The light of elemental depth is indicated at 22 and, for purposes of simplicity, the particular portions thereof comprising the visible spectrum have not been indicated since these portions are well known. However, the window of the house identified as 23 probably would be approximately at the yellow section of the spectrum, whereas the second window 24 would overlap probably the green portion. The opaque section adjacent the window 23 and near the red end of the spectrum would intercept some of the orange portion of the line, and probably some of the yellow portion. It will be appreciated that this is an approximation only. However, it will be seen that if an image provided enough in the way of detail along a single line thereof portions of some of the colors of the spectrum might be intercepted while entire parts of other portions of the spectrum also might be intercepted along the same line. It will be apparent, also, from this figure that the light which passes through the transparent member 21 and which is not intercepted by the opaque portions of the image will, if recombined, form a light which, while not white in color, nevertheless will not give an indication as to just what in the nature of constituent portions has been intercepted or removed therefrom.

Referring to Fig. 3, there is shown probably the simplest form of arrangement for determining which portions of the spectrum have been removed or blocked from a line which is made up of at least some of the colors of the spectrum, the line usually being of elemental depth. It has been stated hereinbefore that the various portions of the spectrum which passed through the transparent member on which is recorded the intelligence to be scanned, are recombined in such a fashion as to form what amounts to a spot of light approximating white in color, but usually of a pastel shade. It is apparent, therefore, that to the naked eye this spot of light will be meaningless other than merely showing what color the spot comprises. In this figure, therefore, the light from the spot, which may be viewed by an observer, is brought in through lens 30, and is reconstricted into a spot of elemental depth by the cylindrical lens 31, similarly as was done by lens 14 in Fig. 1. This light then is passed to a triple prism arrangement 32 which breaks the light down into its spectral components. It will be appreciated, therefore, that any spectral components which are missing or partially missing, will not be reconstructed and hence an indication is given of the opaque or translucent sections along the line of the optical image scanned, since it is these opaque sections which have robbed the spectrum of either a portion or all of some of its component colors. This line of what remains of the spectrum, and which represents what has been originally white light which has had some of the portions of its constituent parts removed due to the particular spacing of opaque or translucent sections of a linear portion of an optical image, may be viewed through lens 33. It will be apparent, therefore, that a complete frame of an optical image cannot be viewed by this arrangement. However, since one line may be viewed, additional means may be provided for moving the viewing elements in synchronism with a moving element at the transmitter which has

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been represented schematically in Fig. 1, so that a complete optical frame may be viewed. What is important is that the usually high speed scanning which takes place along the linear sections of an optical image in normal television practice has been entirely eliminated in the present arrangement.

Referring to Fig. 4, there is shown a transmitting arrangement for transmitting or showing a complete frame of a scanned optical image with a novel scanning arrangement. In this figure the elements comprising the various portions of the apparatus have been indicated as being positioned without an apparent direct operation of all of the parts with respect to each other in some portions, and this has been for the purpose of providing compactness, since the entire arrangement could be built in such a fashion that each element followed the other in position so that the entire apparatus would be mounted more or less on the same axis. An apparatus arranged in the manner shown, however, has been made very compact.

In this figure a source of light 40 indicated here as an electric lamp (the energizing arrangement of which has been omitted for purposes of simplicity) directs light through the condensing lens arrangement comprising lenses 41 and 42, and the light is directed to an opaque member 43 which has cut therein an aperture 44 in the form of a slit. The light passing through the slit is directed onto a surfaced reflecting member 45, which in actual use has been a front surfaced mirror, and the light reflected from the member 45 will be directed by means of lens 46 to a prism 47. This light of elemental width then will be broken down into its spectral components, and since the slit 44 has some depth, the light that leaves the prism 47 will comprise a beam of light of appreciable width, and whose color varies across this width, and also of some depth. The light then passes to lens 48 and thence to lens 49. The purpose of the latter lens is to constrict the light along its axis of depth so that what is formed is an appreciably intense line of light which varies in color along the line and which is of elemental depth. It will be seen then that this line can be utilized to scan a single line of the optical image undergoing scansion, since the optical image may rob this single line of some of the portions of the component colors by the interception thereof by the opaque or translucent sections along a particular line of the image. The line of light is directed and focused on a focal plane at which is placed the optical image to be scanned, in this case represented by a transparent member 50 having recorded thereon or affixed thereto intelligence to be transmitted.

Positioned between the lens 49 and the focal plane, at which is placed the transparent element or tape 50, is a rectangular prism 51. It will be appreciated that as this prism revolves the line of light which is passed through the lens 49 and into the prism 51 will be moved along the focal plane at which is positioned the tape 50 and along the axis of the tape for a distance which bears a relationship to the size of the prism 51. This will occur until one edge of the prism becomes positioned adjacent the line of light, and the line will start again at an original position to scan along the tape. Scanning, therefore, may be made continuous, and the return of the scanning line to an initial scanning position is substantially instantaneous.

Positioned on the side of the tape 50 remote

from the prism 51 is a second prism member 52, which usually is substantially identical in size with the prism 51. This prism is rotated at an equal speed, but in an opposing direction to the rotation of prism 51, and this relation between the rotation of the two prisms is shown schematically by the dashed line 53. Since the line of light moves along the tape in accordance with the movement of prism 51, then this line after passing through the tape and after having been robbed of some of its spectral constituents, will pass through the prism 52, but due to the rotation thereof, the line upon emerging from prism 52 will be substantially fixed in position. Accordingly, although complete frame scanning has taken place, only what appears to be a single line of light emerges from prism 52 in a fixed or substantially unchanged position. This line of light passes through cylindrical lens 54, and since the component parts thereof move outwardly in all directions, there will be some sections where substantially all of the remaining portions of the spectrum are combined or recombined, this forming from the original line what might be termed a penumbral section since, after passing through cylindrical lens 54, the line of light again has assumed depth and is no longer merely a line of elemental depth and some width. Since all of the spectrum of white light except those portions which have been removed by the opacity or translucence along a linear portion of the intelligence to be transmitted are still present, the recombined light will approach white in color but never actually attain white except at those instances where the linear section is completely uninterrupted by any opaque or translucent portions on the image undergoing scansion. Thus, to the naked eye, all that is seen is what appears to be a pastel shaded spot of light which is meaningless. On the other hand, it will be appreciated that what this spot of light represents is the scansion of an optical image with representations which may be translated into intelligence.

One of the advantages of the arrangement according to this figure is the fact that intelligence can be recorded continuously or intermittently or changed during the time of actual transmission as, for instance, the tape 50 could be passed from a device such as a typewriter or other intelligence recording device and thence to the actual scanning arrangement. In this manner the intelligence transmitted can be changed very quickly, and another advantage lies in the fact that since it would take an observer with a device operating in synchronism with the transmitter to be able to read the transmitted message, long periods of time ordinarily spent in coding and decoding can be avoided.

Referring to Fig. 5, there is shown a type of receiver for use with a transmitter such as that indicated in Fig. 4. The observer who wishes to see or to record intelligence which is transmitted may direct the lens 50 toward the light source, represented by the light emerging from cylindrical lens 54, and this light passes from lens 50 to a prism 61 which is similar to, or substantially identical with, prisms 51 and 52. This prism is rotated substantially in synchronism with prisms 51 and 52 by motor means (not indicated), similarly to the manner in which prisms 51 and 52 are rotated by the motor means indicated (but not shown) in Fig. 4. Since such motor means are well known, it is not necessary to illustrate the specific type of motor which

may be utilized. It is suggested that a small spring wound motor might be entirely adequate for use, at least with the arrangement of Fig. 5.

The light which has passed through prism 61 will be moved in accordance with the movement of the light which is passed through prism 51, or in other words, a complete frame of scansion may be covered by this means. The light then is passed through the prism arrangement 63 by means of which the spot of light of elemental depth is broadened into what would be a complete spectrum if the spot of light were white, but what now is a spectrum with portions missing therefrom, these missing portions being indicative of the intelligence recorded on the tape member 50 of Fig. 4. Since the prism 61 rotates, then the line of light passing from the prism arrangement 63 will reproduce the frame which is undergoing scansion by the transmitter, and this reproduced frame is passed through lens 64 to an observer. It will be apparent that this apparatus may be made very compact.

Referring to Fig. 6, there is shown an alternative form of arrangement for scanning intelligence to be transmitted. In the arrangement according to Fig. 4 the intelligence may be recorded on a tape which in itself is moved very slowly, and in which scansion takes place by means of the movement of a line of light along the tape, such movement being caused by the action of a directing prism. On the other hand, the intelligence may be recorded on some member such as a tape and scansion in one co-ordinate could take place due to the speed of the tape itself. This, however, might not prove desirable in all instances, and accordingly one suggested way of performing the scansion operation is to substitute lenses 70 and 71 of this figure for the lenses 49 and 54 of Fig. 4. The intelligence then may be recorded on a transparent disc 72 and this disc may be rotated by an appropriate motor means (not shown). This is limited somewhat, however, as the intelligence has to be pre-recorded, and while in the arrangement according to Fig. 4 the tape may be run through a typing arrangement for the purpose of providing continuous messages, in the arrangement according to this figure the disc actually has to be removed, and a new disc substituted in order to change the intelligence being transmitted.

Referring to Fig. 7, there is shown an alternative form of receiver or translator which may be used. In this arrangement an observer would direct the lens 80 toward the spot of light emerging from the cylindrical lens 54 of Fig. 4. This then could be passed to the totally reflecting surface of a prism 81, and thence directed to a drum member 82 having formed on the periphery thereof one or more reflecting spirals. This drum may be motor driven, and since the light as it impinges onto the face of a spiral will be in the form of a spot, it will appear as though this spot moves upwardly or downwardly, as might be desired, due to the change in position of the reflecting surface as the spiral is rotated by the drum. This spot, when reflected from the spirally arranged reflecting surface, is directed through a cylindrical lens 83 which constricts the light from the spiral to a spot of elemental depth. The spot then passes through lens 84 to the prism arrangement 85, the latter breaking the spot down into its spectral components and hence, since at any instant the spot represents one line of a scanned image, this line will be reconstructed from the spot by the prism arrangement 85. An

observer then may look through the eye-piece 86. This may be used, of course, even where the transmitter embodies the use of the rotating prism members 51 and 52 as shown in Fig. 4, since the spiral reflecting surface will furnish the other co-ordinate of movement of the scansion when it is rotated by its driving motor.

Since the light provided in the illustrated examples is divided into its distinct color components, it may be said that the spectrum so formed consists of light having significant identifiable sections. If, in any fashion, it is possible to provide a beam of light having some width and which had been formed by merely directing lights of different colors into an optical path whereby the colors are positioned each adjacent to the other, then an arrangement would have been provided which was similar to a spectral arrangement and again it might be said that the light so formed had significant identifiable sections, since the colors in themselves are different each from the other and may be separated by well known optical means.

This specification has been directed primarily to the idea of scanning optical images in what is considered an entirely new fashion. On the other hand, it will be readily apparent that this invention may be used for purposes which may be considered even remote from this idea. One such application of the principles involved in this specification could be the studying of various shades and the producing of various shades of colors and colored light by robbing white light of various portions of its component parts. By altering the proportionate amounts by which the light is robbed and then recombining what remains after the robbing takes place, entirely new shades of color should be producible. It will be readily apparent that the number of permutations of various proportions of light from the spectrum which are usable are many in number. The result is, then, that there has been opened to investigators work of an almost unlimited range for determining the color components of various shades of colors. It is not at all impossible that new shades of colors may evolve from investigations along these lines.

Also, it might be noted that the slot in the element 43 of Fig. 4 which is between the front silvered reflector 45 and the meniscus lens is not only for the purpose of forming the light into a line of light, but also is for the purpose of trimming the light.

Another notable example may be the use of color dispersion alone without the addition of mechanical scanning. In this way a very simple

code device may be obtained where the code combination consists merely of black bars which may be placed in pre-agreed sections of the spectrum.

It will be apparent, therefore, that there may be many departures which still remain within the spirit and scope of my invention, and accordingly I claim all such departures as may fall fairly within the provisions of the hereinafter appended claims.

What I claim is:

1. A system for the transmission and reception of at least a portion of an optical image, comprising means for providing light having significant sections identifiable by color, prismatic means, means for moving said prismatic means, means for directing the light having the significant identifiable sections through the moving prismatic means and thence onto the optical image whereby at least a part of at least one of the significant identifiable sections is diminished in value, means for combining the remaining significant identifiable sections after impingement onto the optical image to be transmitted, and receiving means for dividing the combined light into its significant identifiable colored sections.

2. An apparatus in accordance with claim 1 wherein there is provided in addition, a second prismatic means to which the light is directed after its impingement on the optical image.

NILS E. LINDENBLAD.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,204,771	Hopkins	Nov. 14, 1916
1,462,348	Lyons	July 17, 1923
1,858,361	Desirello	May 17, 1932
1,968,977	Wainwright	Aug. 7, 1934
1,981,999	French	Nov. 27, 1934
2,010,307	Leishman	Aug. 6, 1935
2,078,768	Meler	Apr. 27, 1937
2,193,606	Ulrey	Mar. 12, 1940
2,206,521	Akker et al.	July 2, 1940
2,222,937	Dimmick	Nov. 26, 1940

FOREIGN PATENTS

Number	Country	Date
129,747	Great Britain	July 24, 1919
672,692	France	Sept. 23, 1929
684,995	France	Mar. 25, 1930
108,177	Australia	Mar. 17, 1939