

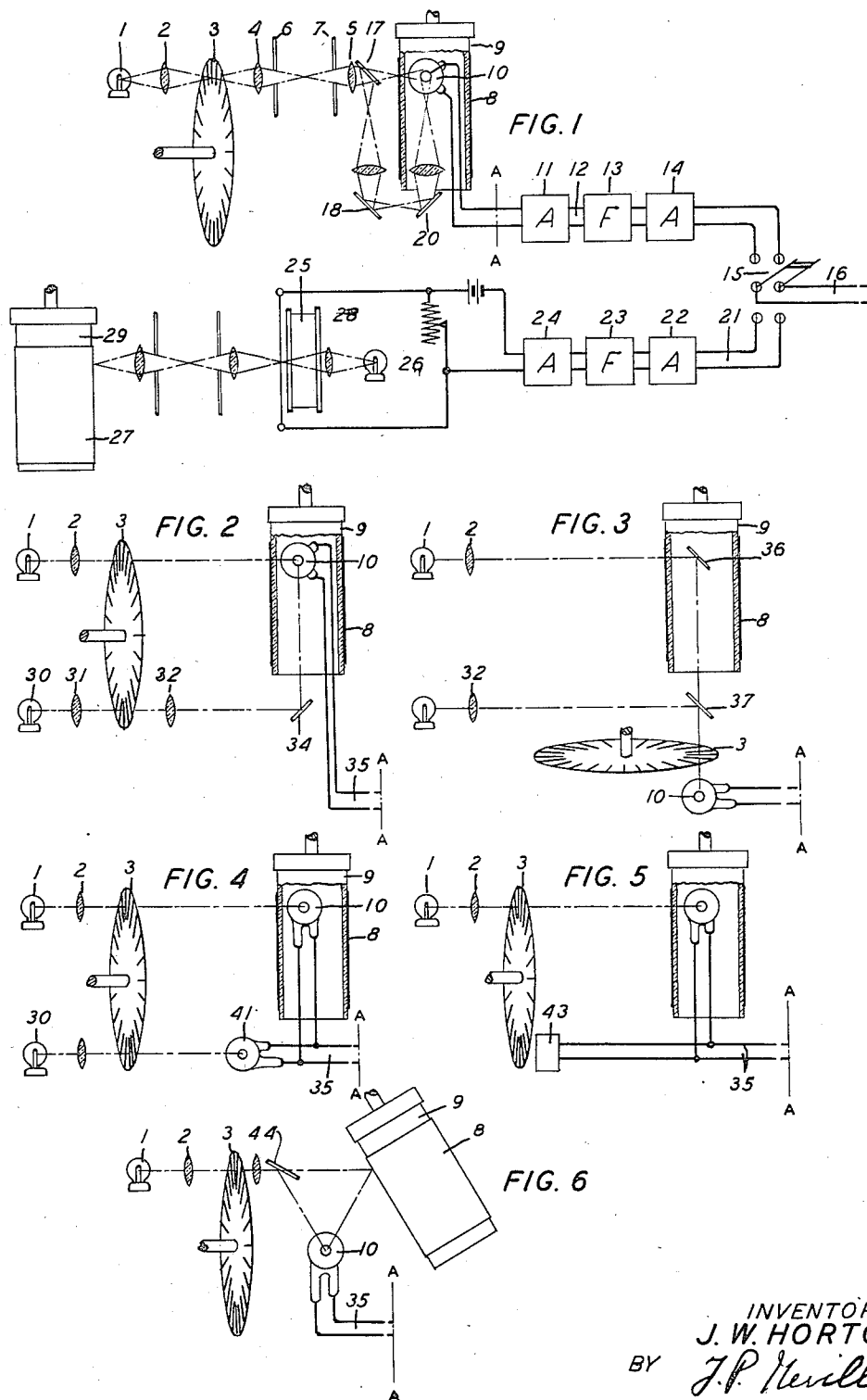
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ELECTROOPTICAL SYSTEM

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ELECTROOPTICAL SYSTEM

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This invention relates to electro-optical systems and more particularly to systems for electrically producing pictures or images of an object.

5 An object of the invention is to provide a new and improved system for producing signal modulated carrier current by regularly varying a beam of light from a source of constant intensity.

10 The invention is particularly adapted to the electrical transmission of pictures. When the transmission takes place over commercial communication channels, it is desirable to transmit an appreciable amount of unmodulated carrier current along with the signal modulated component in order to obviate interference. Such a
15 condition is also desirable in order to obtain practically distortionless demodulation when a linear rectifier, such as the well known vibrating string light valve, is employed at the receiver and the major portion of one side band is suppressed at
20 the transmitter.

One feature of this invention is an arrangement in which a signal modulated carrier wave having a large component of unmodulated carrier current is transmitted through a filter which
25 suppresses the major portion of one side band, the modulated carrier current being produced by regularly varying a light beam and further controlling its amplitude by means dependent upon the operation of the light beam varying
30 means.

Another feature of the invention is an arrangement for producing signal modulated carrier current in which rotating means is employed for
35 regularly varying a beam of light from a steady source and producing a component of carrier current by means dependent upon said rotating means.

40 The invention may be embodied in various forms. One form, selected by way of illustration, is a picture transmission system employing the well known type of rotating drum with a photoelectric cell located within the drum. Light from a steady source is first interrupted by a
45 rotating chopper disc. The chopped beam is concentrated upon the elemental areas in succession of the picture transparency on the drum, the transmitted light activating the photoelectric cell to produce modulated carrier current, a
50 portion of the chopped beam is by-passed around the picture, by means of reflectors, and applied to the cell which is thereby activated to control the production of an unmodulated component of carrier current.

55 In a second embodiment, two light beams are

employed which are chopped at diametrically opposite points of the chopper disc, after which they are both directed to the photoelectric cell.

Another form, which is preferable from the standpoint of accuracy and ease of adjustment, contemplates combining a picture modulated
5 beam and a steady beam prior to chopping for energizing a photoelectric cell. In this arrangement the phase relationship of the modulated and unmodulated components is inherently correct.
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In a further embodiment, two separate light beams are chopped at separate points of the rotating chopper disc and are used to energize separate photoelectric cells. The currents from these
15 cells are then combined.

In still another form, the rotating chopper disc carries the rotor of an alternating current generator which generates current of a frequency equal to the frequency of the carrier current
20 produced in the photoelectric cell within the picture drum, the cell being energized by the chopped beam. The modulated carrier wave and the wave from this generator are superposed in the transmission circuit.
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This invention also contemplates reflecting light from the picture and a semi-transparent mirror to the cell, which is thereby activated to cause the production of a modulated carrier current including an unmodulated component of
30 carrier frequency.

In each of the illustrative embodiments, the picture modulated carrier wave is transmitted through a filter which suppresses the major portion of one of the side bands. A filter suitable
35 for this purpose is disclosed in U. S. Patent 1,748,186 of H. Nyquist, issued February 25, 1930.

This invention will now be described more in detail, having reference to the accompanying
40 drawing.

Fig. 1 is a schematic arrangement of an embodiment of this invention illustrating the apparatus of one terminal station.

Figs. 2 to 6 show different arrangements of the transmitting apparatus which may be substituted
45 for that shown at the left of section line A—A in Fig. 1.

Fig. 1 illustrates a typical station equipment for use in the system, comprising an apparatus for transmitting and an apparatus for receiving
50 pictures.

The transmitting apparatus includes a light source 1 of constant intensity, a suitable lens 2 for focusing light rays from the source 1 upon an apertured or slotted portion adjacent the
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periphery of a disc 3. This disc is rotated to cause the light beam to pulsate or be chopped at a carrier frequency rate. In other words, source 1, lens 2 and disc 3 cooperate to produce a "carrier" light beam.

Lenses 4 and 5 and apertured members 6 and 7 cause the carrier light beam to be focused on a small elemental area of the picture 8. The picture 8 is shown as a film of varying transparency mounted on a transparent drum 9. In accordance with standard practice in picture transmission systems, the drum 9 is given a motion of rotation and of translation to cause the light beam to successively scan the elemental areas of the entire picture. Preferably the picture is scanned as disclosed in Patent 1,706,032, March 19, 1929 of M. B. Long.

The light beam passes through the picture to a light sensitive cell 10, which is thereby activated to cause varying electric currents to be transmitted to an amplifier 11. These currents vary at the frequency of the carrier beam and have an amplitude at any given instant proportional to the light transmitted by the picture.

In the path of the light beam is a semi-transparent mirror 17, which causes some of its rays to be reflected to constitute an auxiliary light beam. This beam is reflected by a mirror 18 and again by the mirror 20 to the light sensitive device 10. A carrier beam is thereby applied to the light sensitive device, which is activated to cause an unmodulated current of carrier frequency to be transmitted to the amplifier 11.

The varying currents applied to the amplifier 11 include two sideband components and an unmodulated component, produced under the control of the carrier beam, consequently they are substantially in phase with each other and will add directly.

Amplifier 11 is connected by an outgoing circuit 12 to filter 13, amplifier 14 and contacts of switch 15. This switch may be thrown to the upper position to connect the output circuit of amplifier 14 to a transmission circuit 16.

Filter 13 is of the special design disclosed in the above mentioned Nyquist patent. Briefly, while it operates to gradually cut off at and near the carrier frequency and thereby tends to distort the very low frequency signal currents, it is so designed that this tendency is equalized and compensated.

At a cooperating receiving station the switch 15 is thrown downwardly to connect the transmission circuit 16 to the incoming circuit 21.

The incoming single sideband picture modulated current and the unmodulated current traverse the circuit 21, are amplified by the amplifier 22, pass through the filter 23, and amplifier 24 to the ribbon of light valve 25. This light valve is designed and operated in the manner disclosed in U. S. Patent 1,667,805, May 1, 1928 of Herbert E. Ives.

The received picture current, impressed upon the ribbon of light valve 25, controls the transmission of light from the source 26 to the photosensitive film 27 in accordance with the light effects of the distant picture. Source 26 supplies light of constant intensity which is focused by the lens 28 on the ribbon of light valve 25.

Film 27 is mounted on a drum 29 which is moved in synchronism and in phase with the picture at the transmitting station, in accordance with standard picture transmission practice. An

optical system similar to 4, 5, 6, and 7 is shown between the light valve 25 and the film 27.

As disclosed in the above mentioned application of Nyquist, it is necessary to transmit a component of carrier frequency of constant amplitude, which is large compared with the amplitude of the side band to effect demodulation. In other words, the ratio of the amplitude of the carrier to that of the side band should be large. This has the advantage that interference, due to distortion introduced by the rectifying action of the light valve, is rendered substantially negligible.

Figs. 2 to 6 illustrate diagrammatically only such elements of the transmitting apparatus as is essential to a disclosure of their mode of operation as distinguished from that of the transmitter of Fig. 1. All of these embodiments include the constant light source 1, lens 2, rotating chopper 3, cylinder 9, photoelectric cell 10, which operate as described in connection with Figure 1, for producing the modulated carrier wave.

In Figure 2, the modulated component is produced by using an auxiliary steady light source 30 and lens 31 for concentrating the light rays from source 30 upon the apertured or slotted portion of the rotary disc 3 for producing a carrier light beam. A suitable optical system, indicated as a lens 32, may be used to direct the light beam to the mirror 34 which reflects it to the light sensitive device 10. Device 10 is thereby activated to cause an unmodulated alternating current of carrier frequency to be produced in its output circuit 35.

The arrangement of Fig. 3 comprises the steady light source 1 and lens 2 which supplies a light beam for scanning the elemental areas of the picture 8 mounted on the drum 9. Inside the drum 9 is a light deflecting element 36 which may be a mirror or prism for directing the light beam, varying in intensity in accordance with the tone values of the unit areas of the picture, longitudinally of the drum 9.

The longitudinally directed beam passes through a semi-transparent mirror 37 to the photoelectric cell 10. An auxiliary source 30 and optical system 32 operate to provide a beam of light of constant intensity which is reflected by the semi-transparent mirror 37 to the photoelectric cell 10.

The varying and constant light beams are combined by the semi-transparent mirror 37, and the combined beam, after being chopped by the rotating apertured or slotted disc 3, activates the cell 10 to produce in its output circuit two sidebands and an unmodulated carrier frequency component.

Two photoelectric cells could be used to produce the respective picture modulated and unmodulated carrier components. An arrangement of this type is shown in Fig. 4.

Light source 1 and lens 2 cooperate to provide a beam of light of constant intensity which is chopped by the rotating element 3 to produce a carrier beam, which passes through the successive elemental areas of the picture, carried by the drum 9, to the photoelectric cell 10 which causes the production of signal modulated carrier current.

Element 3 also operates to chop a light beam of constant intensity supplied by an auxiliary source 30 to the photoelectric cell 41 which is thereby actuated to control the production of an unmodulated carrier frequency current.

The picture modulated and unmodulated com-

ponents are superimposed in the portion of the output circuit 35 common to the cells 10 and 41.

The embodiment of Fig. 5 is very similar to that shown in Fig. 4. It differs therefrom, in that no auxiliary light source is used, and the rotating element 3, in addition to chopping the beam supplied by the steady light source 1, functions as a rotor, which cooperates with a stator 43 to constitute a generator for producing a current component of carrier frequency. This component and the picture modulated components produced by the cell 10 are superposed in the common output circuit 35.

In Fig. 6, a beam of light of constant intensity is supplied by the source 1 and lens 2, is chopped by the rotating element 3 and transmitted to the semi-transparent mirror 44 and picture 8 carried by the cylinder 9. In this case an opaque picture should be used.

A certain amount of the light constituting the carrier beam is reflected by the mirror 44 to the photoelectric cell 10, which is thereby activated to cause an unmodulated carrier current to flow through its output circuit.

The remainder of the light of the carrier beam is reflected from successive elemental areas of the picture. The reflected beam, therefore, fluctuates at a carrier frequency rate and in accordance with the tone values of the picture.

The doubly modified beam is applied to the photoelectric cell 10 which is thereby activated to cause current comprising two sidebands to be produced and superposed on the unmodulated current in the output circuit 35 of the cell.

The paths of the scanning beams shown in each of Figs. 2 to 5 will preferably include an optical system, comprising lenses 4 and 5 and aperture members 6 and 7, as shown in Fig. 1. A suitable optical system should be included in the auxiliary carrier beam paths of Figs. 2 to 4 inclusive.

As stated above, any one of the transmitters herein described may be used to produce picture modulated sidebands and an unmodulated carrier current to be supplied through the amplifier 11, circuit 12 to the filter 13, which selects one sideband and the carrier current for transmission through the amplifier 14, switch 15 and circuit 16 to a distant station. At this station the switch 15 will be thrown to the lower position to provide a path for the incoming currents through the circuit 21 to a receiver of the type shown in Fig. 1.

The apparatus shown in Fig. 3 operates to produce a carrier and modulated components which are always in phase with each other, consequently its use is preferred.

The vibrating string light valve may be replaced by any other device having the desired operating characteristics, including, for example, a demodulator of the desired type for supplying image currents to a suitable light source.

The transmission circuit may be connected to a line or over a radio link and the invention may be applied to television and other electro-optical systems.

From the preceding description, it will be apparent that an unmodulated carrier frequency component, having an amplitude controlled by the light chopper 3 and independent of the modulated current component, is produced and supplied to the transmission circuit.

What is claimed is:

1. In an electro-optical system, means for producing a plurality of beams of light of constant intensity, means for varying one of said beams

in accordance with signals, means for simultaneously varying said plurality of beams of light at a carrier frequency rate, and means controlled by said varying light beams for simultaneously producing a signal modulated carrier current and for superposing thereon an unmodulated component of carrier current in phase with the signal modulated current.

2. In an electro-optical system, means to produce a plurality of steady beams of light, means to vary one of said beams in accordance with signals, means to combine said beams subsequently to the action of said varying means, means to interrupt said combined beams intermittently at a substantially regular rate, and means controlled by said interrupted combined beams for producing a signal modulated carrier current and for superposing thereon an unmodulated component of carrier current in phase with the modulated current.

3. In an electro-optical system, means for producing a beam of light of constant intensity, means for scanning a subject with said beam, means for producing a second beam of light of constant intensity, means for simultaneously varying said scanning beam and said second beam at a carrier frequency rate, and a light sensitive electric means simultaneously activated by said varying light beams for controlling the production of a current of carrier frequency modulated in accordance with the varying tone values of said subject and having superposed thereon an unmodulated current of carrier frequency in phase with said modulated current.

4. In an electro-optical system, means to produce a plurality of steady beams of light, means to vary one of said beams in accordance with the tone values of elemental areas of a picture, means to intermingle the rays of said beams subsequently to the action of said varying means, means to interrupt at a substantially regular rate said beams at a position where the rays thereof are intermingled, and means controlled by said interrupted beams for producing a carrier current modulated in accordance with said tone values having superposed thereon an unmodulated component of carrier current in phase with the modulated current.

5. In a picture transmission system, two sources of steady light, a movable picture, means to concentrate light from one of said sources upon an elemental area of said picture, means to move said picture for scanning the elemental areas thereof, a light sensitive device, means to direct the rays passing through said picture to said light sensitive device, a semi-transparent mirror in the path of said directed rays, means to direct rays from said second source of light to said semi-transparent mirror for reflection to said light sensitive device, the rays from the two sources being intermingled, and means to interrupt the intermingled rays at a substantially regular rate.

6. In an electro-optical system, means for producing a beam of light of constant intensity, means for scanning a subject with said beam, means for producing a second beam of light of constant intensity, means for simultaneously varying said scanning beam and said second beam at a carrier frequency rate, a light sensitive electric means simultaneously activated by said varying light beams for controlling the production of a current of carrier frequency modulated in accordance with the varying tone values of said subject and having superposed thereon an unmodulated current of carrier frequency in phase with said

modulated current, and means including an electrical device utilizing both the modulated and the unmodulated components of said produced current to produce a light beam varying in substantially the same manner as said scanning beam after the scanning operation.

7. In an electro-optical system, means for producing a beam of light of constant intensity, means for scanning a subject with said beam, means for producing a second beam of light of constant intensity, means for simultaneously varying said scanning beam and said second beam at a carrier frequency rate, a light sensitive electric means simultaneously activated by said varying light beams for controlling the production of a current of carrier frequency modulated in accordance with the varying tone values of said subject and having superposed thereon an unmodulated current of carrier frequency in phase with said modulated current, and a string light valve detector upon which both the modu-

lated and unmodulated components of said produced current are impressed to produce a light beam varying in substantially the same manner as the scanning beam varies after the scanning operation.

8. In an electro-optical system, means to produce a steady beam of light, means to modulate the intensity of said beam in accordance with signals, means to produce a second steady beam of light of greater intensity than said modulated beam, means to combine said modulated and unmodulated beams, means to interrupt said combined beams intermittently at a substantially regular rate, and means controlled by said interrupted combined beams for producing a signal modulated carrier current having superposed thereon an unmodulated component of carrier current of greater amplitude than said modulated component and in phase therewith.

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