

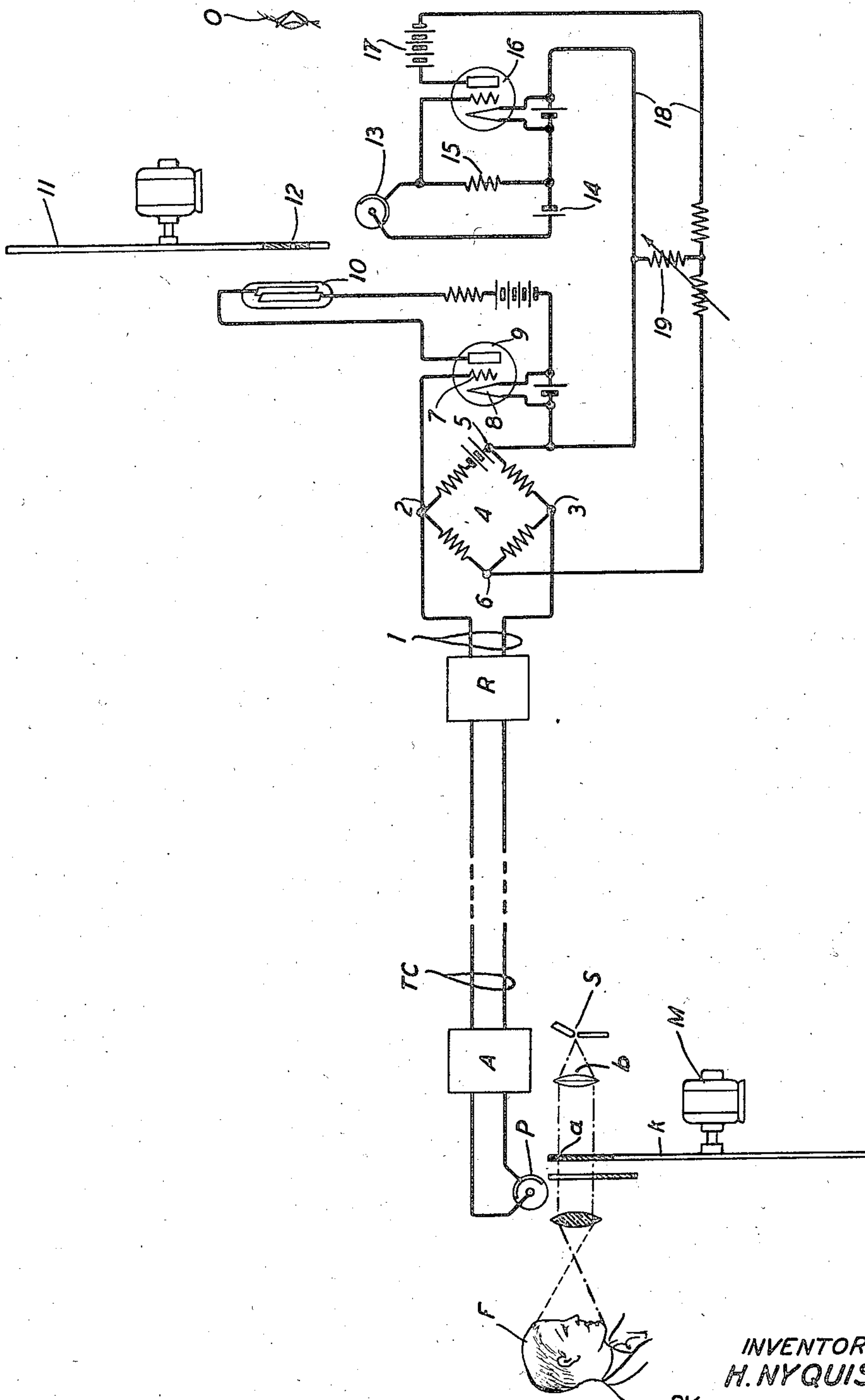
Feb. 25, 1936.

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2,031,728

ELECTROOPTICAL SYSTEM

Filed Aug. 22, 1933



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2,031,728

ELECTROOPTICAL SYSTEM

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Application August 22, 1933, Serial No. 686,306

7 Claims. (Cl. 178—6)

The present invention relates to electro-optical systems and more particularly to receiving means for use in television.

One form of present day television receivers comprises an optical system including a light source supplying light of constant intensity which is controlled by means actuated by the incoming image current to vary the light supplied to the eye of an observer, or projected on a screen, in accordance with the tone values of successive elemental areas of the field of view scanned at a transmitter, or a light source supplied with received image current which causes the intensity of the light supplied by it to vary as the tone values of the successive elemental areas of the scanned field, in combination with a moving member provided with a series of apertures arranged in a spiral, operated in synchronism and in phase with the scanning member of the transmitter and at a rate such that the complete scanning cycle is effected within the period of persistence of vision, whereby the light of varying intensity is utilized to set up on the retina of the eye of an observer, or on a receiving screen, an image of the field of view scanned at the transmitter.

For high quality image production, the image current necessarily consists of a band of current components which extend from approximately zero frequency to an upper limiting frequency of several thousand cycles. In the operation of such image producers, wherein a light source is supplied with image current through amplifiers, a certain amount of distortion is introduced, caused by the non-linear relation between current supplied to the lamp and the brightness of the light, i. e., due to the failure of the lamp to faithfully follow the current variations, and the sensitivity of the lamp and image current amplifiers to variations of the energizing voltages supplied to them.

As the art develops and increased definition is resorted to, the upper limiting frequency of the image current may well be of the order of a million cycles, in which event the distortion due to the above mentioned causes may be greater than can be tolerated and may be so great that it will be impossible to produce an intelligible image.

An object of the present invention is to overcome the above noted disadvantages by supplying the signal variations through a balanced bridge network, one arm of which is connected to a light source, using radiations from the light source to control the production of current variations and apply these variations to the bridge so that they are in phase opposition to signal variations supplied to the light source.

A detail description of the invention follows and is illustrated on the attached drawing, which

is a diagrammatic showing of one form of television receiver involving the invention.

A television transmitting apparatus of the type disclosed in application of Frank Gray, Serial No. 227,649, filed October 21, 1927, may be used to supply an image current, varying as the tone values of elemental areas of the field of view or object at the transmitting station, for transmission over a channel, i. e., either a wire line, or a line carrier or radio channel.

Such transmitting apparatus is diagrammatically shown in the drawing as comprising an optical system including a source S supplying light of constant intensity, a lens b, a disc k, driven by a motor M and provided with apertures arranged in a spiral for producing a moving beam of light of high intensity for illuminating successive elemental areas of an object or field of view F, and a light sensitive device P, adapted to receive light reflected by the object to be thereby activated to cause the production of an image current, which is amplified by the device A and supplied to a transmission circuit TC. This circuit may be connected to a transmission line or to the input of a carrier transmitting apparatus, the output circuit of which may be connected to a carrier line or radio transmitter. The field of view is completely scanned during one revolution of the disc k, which should be rotated at such speed that complete scanning is effected within the period of persistence of vision. For a more detailed disclosure of the transmitting apparatus, reference may be made to the above-mentioned Gray application.

At the receiving station the incoming image current is received by the device R. For direct transmission over a wire line, this device may include a selecting and amplifying means and, for carrier transmission, the device R may include detecting or demodulating means as well as the necessary selecting and amplifying means. In either case the image current is supplied through the circuit 1 connected to one set of conjugate terminals 2 and 3 of the conjugate network or Wheatstone bridge 4. The signal potentials developed across the arm 2—5 are impressed upon the input electrodes 7 and 8 of the amplifier 9, the output circuit of which includes the glow lamp 10. Associated with the glow lamp 10 is a rotating disc 11 provided with a spiral of apertures. This disc is operated to effect a complete revolution within the period of persistence of vision, in synchronism and in phase with the scanning member at the transmitter. It thereby cooperates with the light source 10 to set up an image of the distant field of view or object, which may be directly viewed by an observer D or projected on a screen by means of a suitable optical system.

Any suitable means may be used for maintaining the discs k and 11 in synchronism and in

phase with each other. For example, the synchronizing system disclosed in U. S. Patent 1,999,376 of H. M. Stoller, issued April 30, 1935, may be used for this purpose.

5 In the field of radiation from the lamp 10 is a light sensitive device 13 herein shown as a photoelectric cell adapted to be energized by a source 14 in series with a resistance 15. This resistance is connected to the input electrodes of a vacuum
10 tube amplifier 16 which is supplied with space current by the source 17.

The output circuit 18 of the amplifier 16 is connected through a variable attenuator 19 to terminals 5—6 of the conjugate network 4. By
15 adjusting the attenuator 19, the amplitude of the current supplied to the network may be controlled and, for the purpose of the present invention, the current supplied to the terminals 5—6 should be of such sign that the current flowing
20 through the arm 2—5 of the network is in phase opposition to the signal current supplied over the line 1.

As is now well known, the use of glow lamps in connection with the transmission of pictures for
25 television and telephotography has been characterized by a number of disadvantages. First, the relation between input current and the brightness of the light supplied by the lamp is non-linear. This non-linearity effect causes the con-
30 trast in certain tone regions to be compressed and in other regions to be extended. Again, the lamp does not always faithfully follow the current variations, and both the lamp and its attendant amplifier are very sensitive to variations in the
35 supply voltages, so that allowable changes in these voltages must be restricted within very narrow limits in order to obtain satisfactory operation of the reproducing apparatus. Moreover, vac-
40 uum tube amplifiers, used as repeaters, have been found to suffer from non-linearity of response, and sometimes fail to faithfully follow variations of the voltages impressed upon their input elec-
45 trodes. All of these effects tend to cause distortion of the picture or image produced at the receiver with respect to the original scanned at the transmitter.

In the operation of the apparatus described above, the light supplied by the lamp 10 not only
50 varies in accordance with the varying amplitudes of the signal current, but also in accordance with the variations introduced by the undesired or distorting operation of the lamp and amplifiers, etc. This fluctuating light is supplied to the photo-
55 electric cell 13 which is thereby activated to cause the production of a current which varies as the signals and also in accordance with the undesired variations. This current after being am-
60 plified by the device 16 and regulated by the attenuator 19 is fed back to the input electrodes of the amplifier 9 in such manner that its direct
65 current component opposes the direct current component of the signal current supplied by circuit or line 1 to reduce the gain of amplifier 9 and thereby render it more linear in its response and
70 less susceptible to variations of its supply source. A further improvement is obtained, in that by maintaining the loss through the feedback circuit distortionless with respect to frequency for the
75 frequency region of amplification of the repeater, the overall gain of the repeater will be made more nearly constant in that region. These improvements will all increase in proportion to the extent to which the overall gain is reduced by the energy fed back. For practical purposes, it is

desired to keep the suppression effected by the energy fed back independent, at least within reasonable limits, of the impedances of the signal input and output circuits connected to the re-
5 peater or amplifier 9. For a more complete disclosure of the gain suppression amplifier, briefly described above, reference may be made to application, Serial No. 606,871 of H. S. Black, filed April 22, 1932.

While for purposes of illustration, a single stage
10 of amplification including one vacuum tube 9 is shown for repeating the signal and but one repeating tube 16 is shown in the feedback circuit, it is to be understood that more than one tube may be used in either or both of these circuits. 15
However, it is essential that the number of repeater tubes in the respective circuits and their connections be such that the photoelectric current produced by the cell 13 shall be applied to the input electrodes of repeater 9 in such phase
20 relation as to oppose the signal wave supplied thereto over the circuit 1. Obviously if a two-stage amplifier were used in place of tube 9, it would be necessary to either reverse the connec-
25 tions of the photoelectric cell 13 to amplifier 16 or to use two stages of amplification in place of the single stage shown at 16, in order to preserve the correct phase relation between the signal and the energy feedback to the input electrode
30 of the two stage amplifier.

In the arrangement illustrated it is only neces-
sary to use a single conjugate network, i. e., in connection with the input side of the amplifier 9, inasmuch as reasonable precautions can readily
35 be taken to make the optical coupling between the lamp 10 and photoelectric cell 13 independent of the conditions existing on the observer's side of the scanning disc. However, if desired, a conjugate network may be included in the out-
40 put circuit of amplifier 9, as disclosed in the above mentioned Black application.

If it is desired to prevent the circulation of direct current in the conjugate network and if the received signal contains no useful direct cur-
45 rent component, blocking condensers may be inserted in appropriate places in the input bridge.

The system described above possesses the fol-
lowing advantages. The modulation products and harmonics produced by the repeater 9 are re-
50 duced in proportion to the amount of gain suppression, the susceptibility of the lamp to variations in its voltage supply and in the voltage supplied to the amplifier 9 is reduced in propor-
55 tion to the amount of gain suppression and the speed of response of the glow lamp is increased, as will be apparent from the following considera-
tion.

When gain suppression is not used, the lag of the lamp may be viewed as a diminution of the
60 response of the lamp with increase of frequency of the applied signal wave. That is, for a given current of pure sine wave supplied to the receiver, the brightness of the glow will decrease as the frequency is increased. However, if the feed-
65 back circuit itself is distortionless with frequency, the use of gain suppression will make the overall characteristic of the apparatus more nearly distortionless, with the result that a given
70 diminution of brightness in response of the lamp from that given for a corresponding direct current applied thereto, will now be reached at a higher frequency than would be the case if the feedback for reducing the gain of the repeater were not used.
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What is claimed is:

1. An electro-optical receiver comprising a conjugate network, means for supplying incoming image current to one set of conjugate terminals of said network, an amplifier supplied with image current variations produced in one arm of said network, a light source included in the output circuit of said amplifier, means for scanning light supplied by said source to control the production of an image of a field of view, and means for causing the response of said light source to be linearly related to said incoming image current, comprising a light sensitive means supplied with light from said source, means for supplying current variations produced by said light sensitive means to the other conjugate terminals of said network, said last-mentioned means including means for causing the varying current flowing through the image current arm of said network and supplied to said amplifier to be in phase opposition to the incoming image current supplied thereto.

2. An electro-optical receiver comprising a Wheatstone bridge, means for supplying incoming image current to one diagonal of said bridge, an amplifier supplied with image current variations produced in one arm of said bridge, a light source included in the output circuit of said amplifier, means for scanning light supplied by said source to control the production of an image of a field of view, and means for causing the response of said light source to be linearly related to said incoming image current, comprising a light sensitive means, activated by light from said source to control the production of current varying as the light variations supplied by said source, means for supplying said varying current to the other diagonal of said bridge, said last-mentioned means including means for causing the varying current, flowing through the image current arm of the bridge and supplied to said amplifier, to be in phase opposition to the incoming image current supplied thereto.

3. An electro-optical receiver comprising a Wheatstone bridge, means for supplying incoming image current to one diagonal of said bridge, an amplifier supplied with image current variations produced in one arm of said bridge, a light source included in the output circuit of said amplifier, a moving member having apertures for scanning the light supplied by said source to control the production of an image of a field of view, and means for causing the response of said light source to be linearly related to said incoming image current, comprising a light sensitive electric means activated by light from said source to control the production of a varying current, means for supplying said varying current to the other diagonal of said bridge, said last-mentioned means including means for causing the image current, flowing through the image current arm of said bridge and supplied to said amplifier, to be in phase opposition to the incoming image current supplied thereto, and an attenuator for controlling the value of the varying current supplied to said bridge.

4. An electro-optical receiver comprising a conjugate network, means for supplying signal current corresponding to a picture or representation to one set of conjugate terminals of said network, an amplifier supplied with signal current variations produced in one arm of said network, a light

source included in the output circuit of said amplifier, means for utilizing light from said source to control the production of an image of the picture or representation, and means for causing said source to faithfully respond to variations of said signal current, comprising a light sensitive means supplied with light from said source, means for supplying current variations produced by said light sensitive means to the other conjugate terminals of said network, and means, included in said last-mentioned means, for causing said current variations flowing through the signal current arm of said network to be in phase opposition to the incoming signal current supplied thereto.

5. An electro-optical receiver comprising a conjugate network, means for supplying signal current corresponding to a picture or representation to one set of conjugate terminals of said network, an amplifier supplied with signal current variations produced in one arm of said network, a light source included in the output circuit of said amplifier, means for utilizing light from said source to control the production of an image of the picture or representation, and means for increasing the speed of response of said source comprising a light sensitive means supplied with light from said source, means for supplying current variations produced by said light sensitive means to the other conjugate terminals of said network, and means, included in said last-mentioned means, for causing said current variations to be in opposite phase to signal current flowing through the signal current arm of said network.

6. An electro-optical receiver comprising a conjugate network, means for supplying signal current corresponding to a picture or representation to one set of conjugate terminals of said network, an amplifier supplied with signal current variations produced in one arm of said network, a light source included in the output circuit of said amplifier, means for utilizing light from said source to control the production of an image of the picture or representation, and means for increasing the range of signal frequencies to which the source will faithfully respond, comprising a light sensitive means supplied with light from said source, means for supplying current variations produced by said light sensitive means to the other conjugate terminals of said network, and means, included in said last-mentioned means, for causing said current variations to be in opposite phase to signal current flowing through the signal current arm of said network.

7. An electro-optical receiver comprising a conjugate network, means for supplying signal current corresponding to a picture or representation to one set of conjugate terminals of said network, an amplifier supplied with signal current variations produced in one arm of said network, a light source included in the output circuit of said amplifier, means for utilizing light from said source to control the production of an image of the picture or representation, and means for rendering the response of said light source substantially constant in the frequency range of said signal current comprising a feed-back circuit which is distortionless in the frequency range of said signal current and includes means for causing the current fed back to be in phase opposition to the signal current flowing through the said one arm of the network.

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