Aug. 16, 1932. H. A. IAMS 1,871,994

LIGHT SENSITIVE DEVICE

Filed Jan. 18, 1929

Fig. 1.

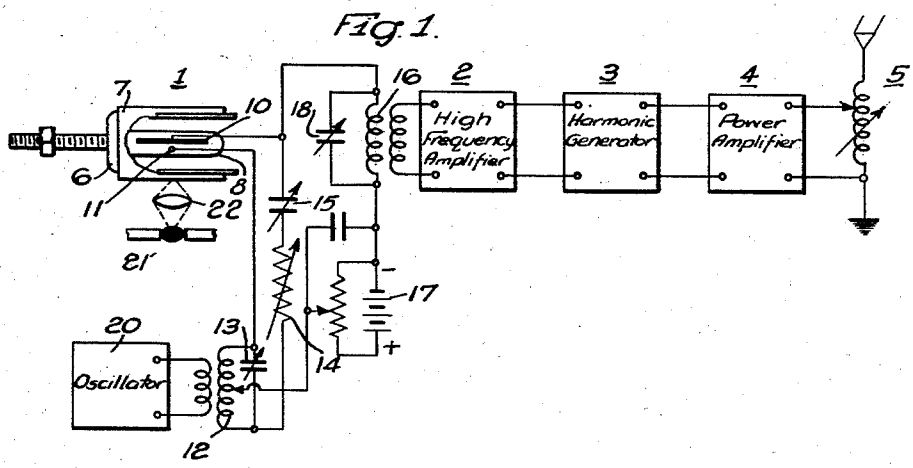


Fig. 2.

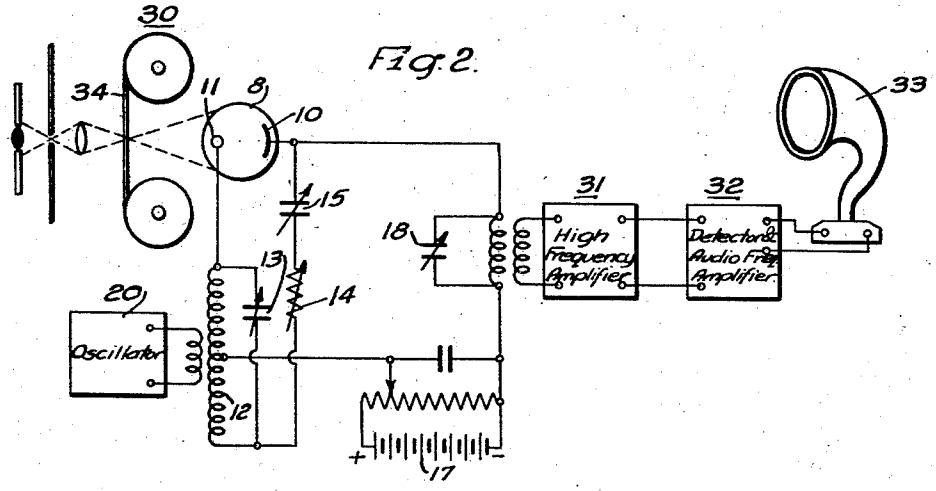
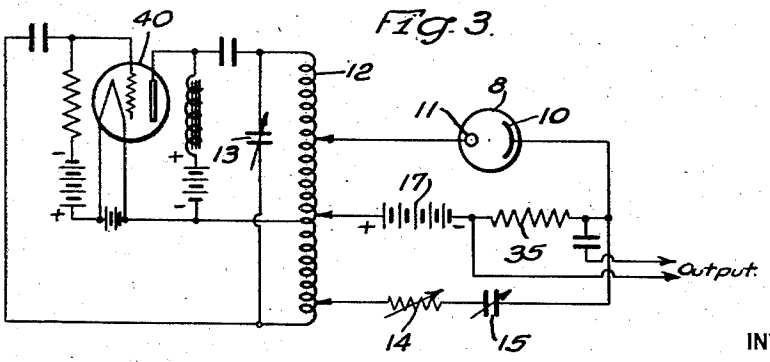


Fig. 3.



INVENTOR

Harley A. Iams.

BY

Wesley G. Barr

ATTORNEY

Patented Aug. 16, 1932 1,871,994

UNITED STATES PATENT OFFICE

HARLEY A. IAMS, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

LIGHT-SENSITIVE DEVICE

Application filed January 18, 1929. Serial No. 333,470.

My invention relates to light-sensitive devices, and it has particular relation to the utilization of such devices for modulating a carrier current by means of light variations.

Substantially all television systems, as at present constructed and arranged, and practically all facsimile-transmission systems, utilize light-sensitive devices of various types in the transmitting portions thereof. In such systems, light, either reflected from an opaque object, or transmitted through an object having varying degrees of transparency, is caused to fall upon a photo-electric cell, the output current from which is then utilized in the transmission.

The relatively feeble photo-electric currents are more readily amplified if they are made to modulate a carrier wave. At the present time, this carrier is most usually supplied by interrupting the beam of light before it reaches the photocell by means of a revolving wheel having numerous apertures.

The use of a fluctuating voltage on the photocell to achieve a result analogous to the interruption of the light beam has been impractical in the past by reason of the capacity between connecting wires between the electrodes in the cell, the percentage of modulation being thereby rendered unsatisfactory.

It is, accordingly, an object of my invention to provide a novel combination of a photo-electric cell with circuit networks and auxiliary apparatus whereby the cell may be more efficiently utilized in television and sound-reproduction systems.

Another object of my invention is to provide a novel combination of a photo-electric cell with circuit networks and auxiliary apparatus whereby a modulated, high-frequency photo-electric current may be generated.

Another, and more specific, object of my invention is to provide, in a novel combination of the type described, means for suppressing a carrier current during non-modulating intervals.

In practicing my invention, I interpose a photo-electric cell in one branch of a circuit network analogous to a Wheatstone bridge, and associate an output transformer or resistor with that portion of the network which corresponds to the diagonal of the bridge. A source of oscillations, of any desired frequency, is connected across the network in such manner that, when the photo-electric cell is not illuminated, the oscillation frequency does not appear in the output reactor. Upon illumination of the cell, the balance of the network is disturbed, however, and the oscillation frequency appears in the output circuit, the amplitude of the oscillations being solely determined by the intensity and character of the illumination.

By my invention, therefore, I am enabled to prevent overloading of an amplifier associated with the photo-electric cell during non-modulation intervals, inasmuch as the carrier frequency is impressed thereon only during such times as the conductivity of the cell is altered under the influence of light.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional applications, objects and advantages thereof, will best be understood from the following description of certain specific embodiments, when read in connection with the accompanying drawing, in which:

Fig. 1 is a diagrammatic view illustrating a facsimile-transmission system in which is incorporated a preferred embodiment of my invention,

Fig. 2 is a diagrammatic view of a sound-reproducing system constructed according to my invention, and

Fig. 3 is a diagrammatic view of an alternative form of my invention which is capable of use in either of the systems shown in Fig. 1 and in Fig. 2.

The facsimile-transmitting system illustrated in Fig. 1 comprises a source 1 of modulated carrier-frequency currents, a carrier-frequency amplifier 2, a harmonic producer or frequency changer 3, a power amplifier 4 and a radiating structure, or antenna, 5. Inasmuch as the specific manner in which the amplifiers and the harmonic generator are

constructed constitutes no part of the present invention, they have not been illustrated in detail.

The modulated carrier-current source comprises a transparent cylinder 6, around which a negative or a positive film 7 may be wrapped and retained in place by suitable means (not shown). The cylinder is mounted for rotation and axial advance, in a manner well known to those skilled in the art.

A light-sensitive device, preferably a photo-electric cell constituted by an evacuated envelope 8 in which are disposed a cathode 10 and an anode 11, is positioned within the cylinder.

The photo-electric cell is so included in a balanced-circuit network as to constitute one of the capacitative elements thereof. The network preferably comprises an input inductor 12, which may or may not be shunted by a tuning condenser 13, a resistor 14 and a balancing condenser 15 connected in the bridge arm opposite the photocell, and an output reactor 16 and biasing battery 17 connected between an intermediate point on the input inductor and the cathode. The output inductor may be shunted by a condenser 18, if desired.

A source 20 of carrier-frequency oscillations is coupled to the input inductor. The source may be an oscillation generator of any desired type, or it may be constructed and arranged as hereinafter described.

A fixed light source 21 is disposed adjacent to the rotatable cylinder, and a lense 22 is provided to focus light therefrom to a point upon the film.

In the operation of the system just described, the biasing battery is so adjusted that it is roughly equal to the peak voltage of the A. C. wave, permitting the voltage on the photocell to swing from zero to approximately twice the A. C. peak voltage. The balancing condenser 15 and balancing resistor 14 are next so adjusted that no potentials appear across the diagonal of the network, comprising the output reactor and the biasing battery, by reason of A. C. potentials impressed across the input inductor from the oscillator, during such time as the photo-electric cell is in darkness, or is exposed to the normal amount of light incident thereon, exclusive of light from the source 21.

When the balance of the network is disturbed, however, by reason of variations in resistance of the photoelectric cell occasioned by variations in the light falling thereon through the rotating film, the carrier frequency will appear in the output reactor, modulated proportionally to the light variations.

It will, accordingly be apparent that, by my invention, I have provided a system whereby the carrier-frequency is prevented from causing overloading of the amplifier stages of a facsimile transmitter during both modulating and non-modulating intervals. During modulating intervals, the amplitude of the carrier-frequency potentials impressed on the amplifier stages is strictly proportional to the light falling upon the photo-electric cell, and, during non-modulating intervals, the carrier frequency is entirely absent from the coupling reactor and is not impressed at all upon the amplifier.

The application of my invention to systems for the electrical reproduction of photographic sound-records is illustrated in Fig. 2 of the drawing. Such system preferably comprises means 30 for producing a carrier-current modulated in accordance with a sound-record, a carrier-frequency amplifier 31, a detector and audio-frequency amplifier 32, and a suitable loud-speaker 33.

The carrier-current producing and modulating portion of the system is substantially the same as the carrier-current source 1 shown in Fig. 1, conventional means for supporting and advancing a film 34, carrying a photographic sound record, being substituted for the rotating cylinder 6 of the facsimile transmitter.

There are no essential differences in the operation of the two systems. An additional advantage accrues, however, from the use of my invention in the reproduction of sounds photographically recorded on motion-picture films, inasmuch as it provides practical immunity against the detrimental effect of stray electrical potentials "picked up" by the amplifier wiring and by other connections. If the carrier frequency employed is sufficiently high, the coupling-devices in the carrier-frequency amplifier may be so constructed as to be substantially opaque to disturbances at audio-frequencies, with the result that the reproduced sound is singularly free from the back-ground noise inevitably present when all the amplification between the photo-electric cell and the loud-speaker is at audio-frequencies, as heretofore has been customary.

In case it is considered desirable to couple the oscillator to the photo-electric cell directly, instead of inductively, as shown in Figs. 1 and 2, this may readily be accomplished in many different ways. One convenient coupling network is illustrated in Fig. 3, and comprises a thermionic tube 40, the grid and plate of which are so connected to opposite terminals of the input inductor 12 as to constitute the well known shunt-feed Hartly oscillation generator. The photo-electric cell and the balancing circuit, comprising the balancing condenser 15 and the resistor 14, are connected to the inductor 12, as hereinbefore described, and a connection, including the biasing battery 17 and an output resistor 35, extends between an intermediate point on the inductor and the junction between the cathode of the cell and the condenser 15.

It will be apparent, from a consideration of the foregoing description of my invention, that I have made a decided improvement in the utilization of photo-electric cells in carrier-current picture-transmission systems and in systems for the electrical reproduction of photographic sound records. By reason of the fact that, when using my invention in systems of the types referred to, saturation and overloading of the amplifier stages are obviated, the amplifiers may be materially reduced in capacity, with a consequent saving in material cost and upkeep.

Many other advantages of my invention, as well as modifications of the specific embodiments thereof chosen for illustration, will at once be obvious to those skilled in the art to which it pertains. My invention, therefore, is not to be restricted to the apparatus shown and described, but it is to be limited in scope only by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In combination, a light-sensitive device having an anode and a cathode, a condenser, a resistor and an input inductor serially connected between said anode and said cathode, an output impedance device and a potential-source extending between one of said electrodes and an intermediate point on said input inductor, and means for impressing oscillatory energy upon said input inductor.

2. In combination, a light-sensitive device having an anode and a cathode, a condenser, a resistor and an oscillatory input circuit serially connected between said anode and said cathode, an output impedance device and a potential source serially connected between one of said electrodes and a point on said input circuit, and means for impressing oscillatory energy upon said input circuit.

3. In combination, a light-sensitive device having an anode and a cathode, a condenser, a resistor and an oscillatory input circuit connected serially between said anode and said cathode, an oscillatory output circuit and a potential source serially connected between one of said electrodes and a point on said input circuit, means for impressing oscillatory energy upon said input circuit, and means for deriving light-modulated energy from said output circuit.

In testimony whereof, I have hereunto subscribed my name this 16th day of January, 1929.

HARLEY A. IAMS.