June 26, 1934. G. M. WRIGHT ET AL 1,964,375

RADIOTRANSMISSION AND RECEPTION OF PICTURES

Filed Feb. 20, 1926

Fig. 1

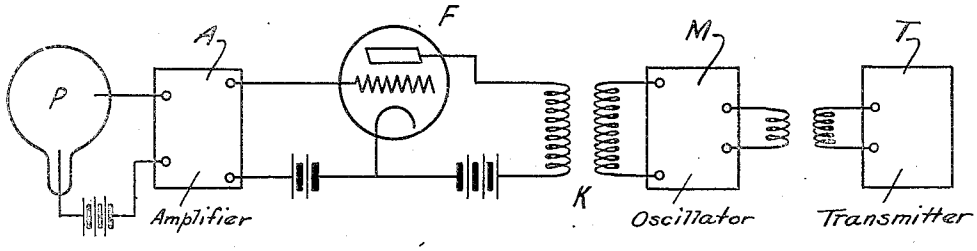
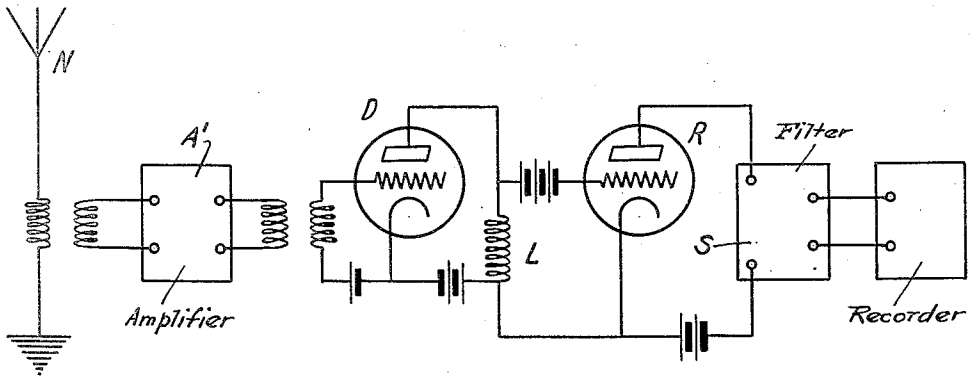


Fig. 2



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RADIO TRANSMISSION AND RECEPTION OF PICTURES

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18 Claims. (Cl. 178—6)

An object of our invention is to provide a tele-photographic system adapted to operate with a radio signal channel.

Another object of our invention is to provide a radio tele-photographic system containing means for reducing the effects of fading, static and strays.

Another object of our invention is to provide a tele-photographic system in cooperation with a radio frequency transmission channel in which the light variations are caused to vary the frequency of the carrier oscillations rather than the amplitude thereof.

A further object of my present invention is to provide a receiving system for removing undesired amplitude variations from a received wave varied in frequency or otherwise modulated, except in amplitude, in accordance with signals to be transmitted and in which the waves from which the amplitude modulations have been removed are changed into an amplitude modulated wave whose amplitude varies in accordance with the desired modulations of the received wave and in which the amplitude modulated waves so produced are detected, and the detected component utilized for translation purposes.

Previous attempts at the transmission of pictures by means of radio frequency oscillations have been conducted with systems in which the light intensity of given points in the picture is represented by oscillations of a given amplitude, and a change in light intensity is represented by a change in amplitude of oscillation. This system has proven practical for line wire transmission where the phenomena of fading and static do not occur. But attempts to use similar systems with a radio channel link between sending and receiving stations the system failed. This failure is due in part to the well-known phenomenon of fading, which changes the amplitude of the received signals independently of the transmitted signals, causing there-by deviations in the received picture from the light and shade values of the original picture. Likewise the presence of energy impulses from static and strays resulted in other changes in the amplitude of the received signals, independently of the variation at the sending station thereby causing the production of patches in the received print of incorrect light and shade value.

According to our invention we transmit the lights and shadows of a picture by converting a given light value into oscillations of a given frequency, and producing a change in frequency in accordance with changes in the light value of a picture.

In one method of carrying out this invention the wave length of a valve transmitter is varied by varying the resistance connected across a few turns wound round an inductance forming the oscillatory circuit of a master oscillator. Such a varying resistance may consist of a suitable three electrode valve or bank of valves. The resistance of these valves may be controlled by a photo-electric cell which varies the potential of their grids in accordance with the amount of light incident upon the cell. The illumination of the cell is controlled by the density of the picture being transmitted. The picture preferably in the form of a transparent film, is moved rhythmically in front of the cell and a similar rhythmic movement is imparted to the reception surface at the receiver.

These two movements are synchronized, and in the case of a short wave picture telegraph it is preferable to provide a special wave band much narrower than that required for the picture, solely for the purpose of maintaining this synchronism.

At the receiver the alternating currents of varying frequency are first limited in any of the usual ways down to an amplitude below which the signal strength is never reduced by night effect, fading or the like, and then may be passed, either before or after heterodyning, through a suitable reactive impedance (inductance, transformer or condenser). The root mean square potential across this impedance will then be a function of the frequency of the arriving signal only.

This root mean square voltage will then be a function of the light and shade of the original transmitted picture and may be made to reproduce the graduations of that picture on a sensitive surface.

The reproduction may be effected by amplifying the potentials rectifying or detecting them and applying them to a picture reproducing means such as a suitable lamp, whose filament is focussed on the receptive surface which may consist of a piece of photographic paper. The intensity of the light on the various parts of the paper is thus governed by the voltage applied to the lamp.

A convenient source of light comprises a lamp having a very fine metal filament in a gas filled bulb, in order to secure the maximum rapidity of action.

The reproduction may be effected by any other convenient form of picture reproducing means.

Other objects and structural details of our in-

vention will be apparent from the following description when read in connection with the accompanying drawing, wherein:

The invention is illustrated in the accompanying drawing of which Figures 1 and 2 show schematically suitable circuit arrangements for transmitting and receiving respectively.

Referring first to Figure 1, P is a photo-electric cell which receives varying light, due to the light and shade of the picture to be transmitted, the said picture being caused to move between a source of light and the cell in any well-known way. A is an amplifier to which the output from the photo-electric cell is fed, the magnified output from the said amplifier being applied between the grid and cathode of a frequency modulator valve F. Included in the anode circuit of the valve F is a coil which is coupled at K to part of the oscillatory circuit of a master oscillator M. The variations in potential between the grid and cathode of the modulator valve F cause corresponding variations in the anode cathode resistance of the said valve and these in turn cause corresponding variations of frequency in the master oscillator M. These frequency variations are magnified in the circuits of a wireless transmitter T, and are radiated as waves of varying length.

It has been found that by suitably adjusting the value of the coupling K and by selecting for the oscillator M a valve of suitable characteristics, a linear relationship between the intensity of light falling upon the photo-electric cell and the frequency of the radiated wave may be obtained.

Referring to Figure 2, N is a receiving aerial which is coupled to an amplifier A' arranged in any known manner to limit the high frequency currents down to the minimum intensity occurring during a fading period, so that the output from the said amplifier has substantially the same amplitude for all frequencies. This output is applied, through a transformer, between the grid and cathode of a valve D in whose anode circuit is included an inductance L of low impedance to the fluctuating currents flowing through it, which is small as compared to the anode cathode impedance of the valve.

With this arrangement the potential differences across the inductance L will be substantially proportional only to the frequency of the incoming signal. These potential differences are applied to a rectifier R in known manner, and the currents resulting therefrom are passed through a low pass filter S which removes high frequency components. The output from the filter S will then be direct current of intensity substantially proportional to the frequency of the received wave, and may be applied to any known form of light control, such as a gas filled lamp having a very fine metal filament, whereby a picture or the like may be formed upon a sensitized receptive surface, the movements of which are synchronized in known manner with the movements of the picture to be transmitted.

By the apparatus as above described we are enabled to transmit, by a radio frequency signal channel, the changes in light intensity corresponding to the light values of a picture and reproduce them in the form of a copy of the original picture at a remote point, and simultaneously therewith to avoid the interference with the pictorial accuracy by the phenomena of fading, and the interference of static and strays.

We are further able to transmit the changing light values of a picture by means of changes in frequency of oscillation independently of changes in ampliture of oscillation.

While we have shown but one embodiment of our invention in the foregoing drawing and descriptions it is capable of various modifications therefrom without departing from the spirit thereof, and it is desired therefore that only such limitations shall be imposed thereon as are required by the prior art or indicated by the appended claims.

We claim as our invention:

1. A signaling system comprising a transmission path through which current modulated as to frequency in accordance with signals passes, said transmission path introducing undesirable amplitude variations in the frequency modulated current, a continuously limiting device through which said frequency modulated current passes in order to substantially eliminate the undesirable amplitude variations introduced by the transmission path, means for substantially suppressing the harmonics and other extraneous frequencies introduced by the limiting device, and means for converting the frequency modulations into corresponding current amplitude variations.

2. A receiving system comprising means for receiving a transmitted carrier wave bearing signal modulations other than amplitude modulations and undesired amplitude variations, means for eliminating the undesired amplitude variations in wave energy derived from the received waves, means for producing from the wave energy whose amplitude variations have been eliminated, waves fluctuating in amplitude in accordance with the signal to be transmitted, means for detecting the waves having the desired signal amplitude fluctuations, and means for translating the detected waves.

3. A receiving system comprising means for receiving waves varied in frequency in accordance with signals to be transmitted which waves also have undesired amplitude fluctuations, means for eliminating the amplitude fluctuations in wave energy derived from the received frequency modulated waves, means for producing a wave varying in amplitude from the frequency modulated wave energy whose amplitude fluctuations have been eliminated, means for detecting the produced amplitude modulated wave, and means for translating the detected amplitude modulated wave.

4. In a signaling system, an antenna collecting waves varying in frequency in accordance with signals to be transmitted, a limiting amplifier coupled to said antenna for amplifying and limiting high frequency currents derived from said antenna down to the minimum intensity occurring during a fading period whereby the output from said limiting amplifier has substantially the same amplitude for all frequencies, a circuit coupled to said limiting amplifier producing high frequency waves from the limited waves which vary in amplitude in accordance with the frequency of the output waves from said limiting amplifier, a rectifier rectifying the waves of variable amplitude, and apparatus translating the rectified waves.

5. In a signaling system, an antenna collecting waves varied in frequency in accordance with the signals to be transmitted, a limiter amplifier amplifying waves derived from said antenna to a substantially constant value, a tube circuit including a reactor coupled to said limiting amplifier so that voltages are engendered across said reactor which vary in amplitude in accordance

with the frequency of the waves appearing in the output of said limiter amplifier, a rectifier coupled to said reactor producing currents varying in accordance with the amplitudes of the potentials engendered across said reactor, and means for translating the currents produced by said rectifier.

6. In a signaling system, an antenna collecting waves varied in frequency in accordance with signals to be transmitted, a limiter amplifier coupled to said antenna for producing currents of substantially constant amplitude but varied in frequency in accordance with waves collected upon said antenna, a tube having an inductor between its output electrodes, means coupling the input electrodes of said tube to the output side of said limiter amplifier whereby voltages are generated across said inductor which voltages vary in amplitude in accordance with the frequency of the output of said limiter amplifier, a rectifier, coupled to said inductor, producing currents varying in amplitude in accordance with the amplitudes of the voltages generated across said inductor, and means for translating said currents.

7. In a frequency modulated carrier current signaling system, means at a receiving station for reducing distortion due to fluctuations in amplitude of the transmitted current resulting from variable attenuation properties of the transmitting medium, said means comprising a limiting device, means for impressing received waves upon said limiting device so that the output thereof is always limited by said limiting device whatever the amplitude of the received waves, means for changing the limited waves to amplitude modulated waves, means for rectifying the amplitude modulated waves, and means for translating the rectified waves.

8. In a frequency modulated carrier wave signaling system, means at a receiving station for reducing distortion due to fluctuations in amplitude of the transmitted current resulting from variable attenuation properties of the transmission medium, said means comprising a current limiting device, means for feeding received currents to said current limiting device, means for changing limited currents from said limiting device to currents varying in amplitude in accordance with the frequency modulations of the carrier current, means for rectifying the amplitude modulated current, and means for translating the rectified currents.

9. In a freqency modulated carrier current signaling system, means at a receiving station for reducing distortion due to fluctuations in amplitude of the transmitted current resulting from variable attenuation properties of the transmission medium, said means comprising a current limiting device, means for impressing received current upon said current limiting device, said impressed current being amplified by such an amount that the amplified current is always limited by said current limiting device whatever the amplitude of received current, means for eliminating harmonics caused by said current limiting device, and means for translating the current from which the harmonics have been eliminated.

10. An electro-optical transmission system comprising means for generating an oscillating carrier current, the frequency of which is modulated in accordance with the light tone values of successively scanned elemental areas of a field of view, means at a receiving station for reducing distortion due to fluctuations in amplitude of the transmitted current resulting from variable attenuation properties of the transmission medium, said means comprising a current limiter, means for applying the received modulated current of varying frequency and fluctuating amplitude upon the current limiter whereby the current output of said limiter is always limited by said current limiter whatever the amplitude of received current, means for eliminating harmonics produced by said current limiter, means controlled by said current of limited amplitude for producing amplitude modulations corresponding to the frequency modulations of the transmitted current, and means controlled by said last mentioned modulations for producing an image of the distant field of view.

11. A signaling system comprising means for receiving carrier waves the frequency of which is modulated in accordance with a signal, a current limiting device, means for impressing wave energy derived from said received waves upon said current limiting device to produce a wave of limited and constant amplitude, means for utilizing said last mentioned wave to produce a wave varying in amplitude in accordance with the frequency of the received carrier waves, means for detecting said last mentioned amplitude modulated wave, and means for translating the detected wave.

12. A signaling system comprising means for receiving a carrier current wave the frequency of which is modulated in accordance with signals, a wave amplitude limiting device, means for impressing the received carrier current wave upon said limiting device to produce a corresponding wave of limited and constant amplitude, means for eliminating from said last mentioned wave harmonic components caused by said current limiting device, and means for utilizing the resultant wave in the reproduction of the signal.

13. A signaling system comprising means for receiving carrier current wave energy the frequency of which is modulated in accordance with signals, an amplitude limiting device, means for impressing received carrier current wave energy upon said limiting device to produce wave energy of limited and constant amplitude, means for changing said limited and constant amplitude wave energy into a wave varying in amplitude in accordance with the frequency of the received carrier current wave energy, means for detecting the amplitude modulated wave so produced, and means for translating the detected wave.

14. In a signal transmission system, transmitting and receiving stations, means at the transmitting station for generating an alternating carrier current, means for modulating the frequency of said current in accordance with signals to be transmitted, means at the receiving station for receiving waves transmitted from the transmitting station, means at receiving station for removing amplitude variations in the received waves introduced by the transmitting medium, means at the receiver to produce a wave varying in amplitude in accordance with the frequency of the transmitted waves from the waves whose amplitude variations have been removed, means for detecting the amplitude modulated waves so produced, to produce a low frequency signaling component, and means utilizing said low frequency signaling component for reproducing the transmitted signal.

15. In combination, a receiving antenna, an amplifier limiter coupled to said antenna for re-

moving amplitude variations in desired waves collected upon said antenna, a reactance, means for feeding waves from said amplifier limiter to said reactance whereby across said reactance voltage waves are developed whose amplitudes vary in accordance with desired modulations in the output waves of said limiter amplifier, a rectifier coupled to said reactance rectifying the amplitude modulated waves engendered across said reactance, a low pass filter coupled to the output of said rectifier, and a translating device coupled to said low pass filter.

16. A receiving system comprising a receiving antenna, a limiting amplifier, means for feeding frequency modulated waves derived from said antenna to said limiting amplifier, a multi-electrode device circuit coupled to said limiting amplifier for producing waves whose amplitudes vary in accordance with the frequency modulations of the received waves, means for rectifying the amplitude modulated waves produced by said multi-electrode device circuit, a filter coupled to the output of said rectifier means, and a recording device coupled to said filter.

17. A receiving system comprising a receiving antenna, a limiting amplifier, means for feeding frequency modulated waves derived from said antenna to said limiting amplifier, a multi-electrode device circuit coupled to said limiting amplifier for producing waves whose amplitudes vary in accordance with the frequency modulations of the received waves, means for rectifying the amplitude modulated waves produced by said multi-electrode device circuit, and means for translating the output of said rectifier.

18. A frequency modulation receiving system comprising an antenna, a limiter amplifier coupled to said antenna, said limiter amplifier acting to produce waves of constant amplitude from waves derived from said antenna, a multi-electrode device having an anode a cathode and a grid, means for applying waves produced by said limiter amplifier to the grid and cathode of said device, an inductance coil connected between the anode and cathode of said device whereby voltage waves are generated across said inductance varying in amplitude in accordance with the frequency of the frequency modulated waves received by said antenna, a rectifier having a plate a grid and a cathode, means coupling said inductance coil to the grid and cathode of said rectifier, and, a translating device coupled to the anode and cathode of said rectifier.

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