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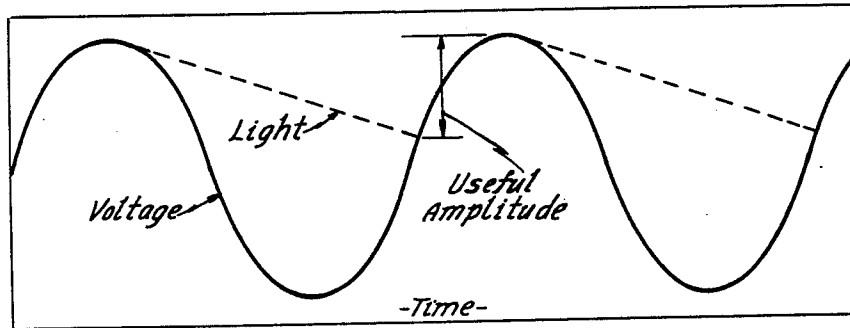
E. C. MUTSCHLER
LIGHT COMMUNICATION SYSTEM

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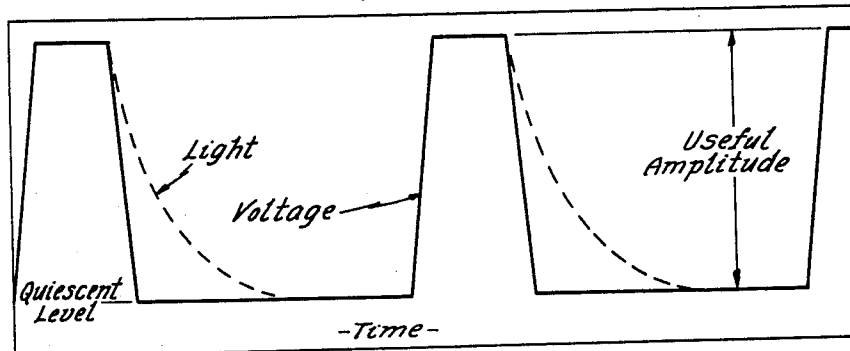
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FIG. 1



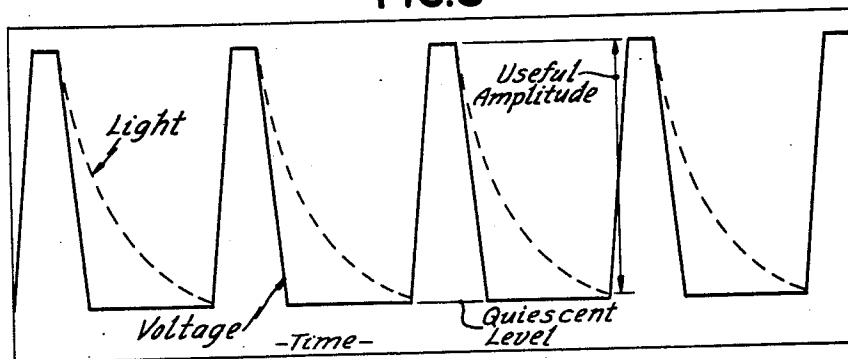
Sinusoidal Voltage Input (5000 C.P.S.)

FIG. 2



Pulsating Voltage Input (5000 P.P.S.)

FIG. 3



Pulsating Voltage Input (10,000 P.P.S.)

INVENTOR.
EDWARD C. MUTSCHLER

BY

Karl Haler
James E. Bryan
ATTORNEYS

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E. C. MUTSCHLER

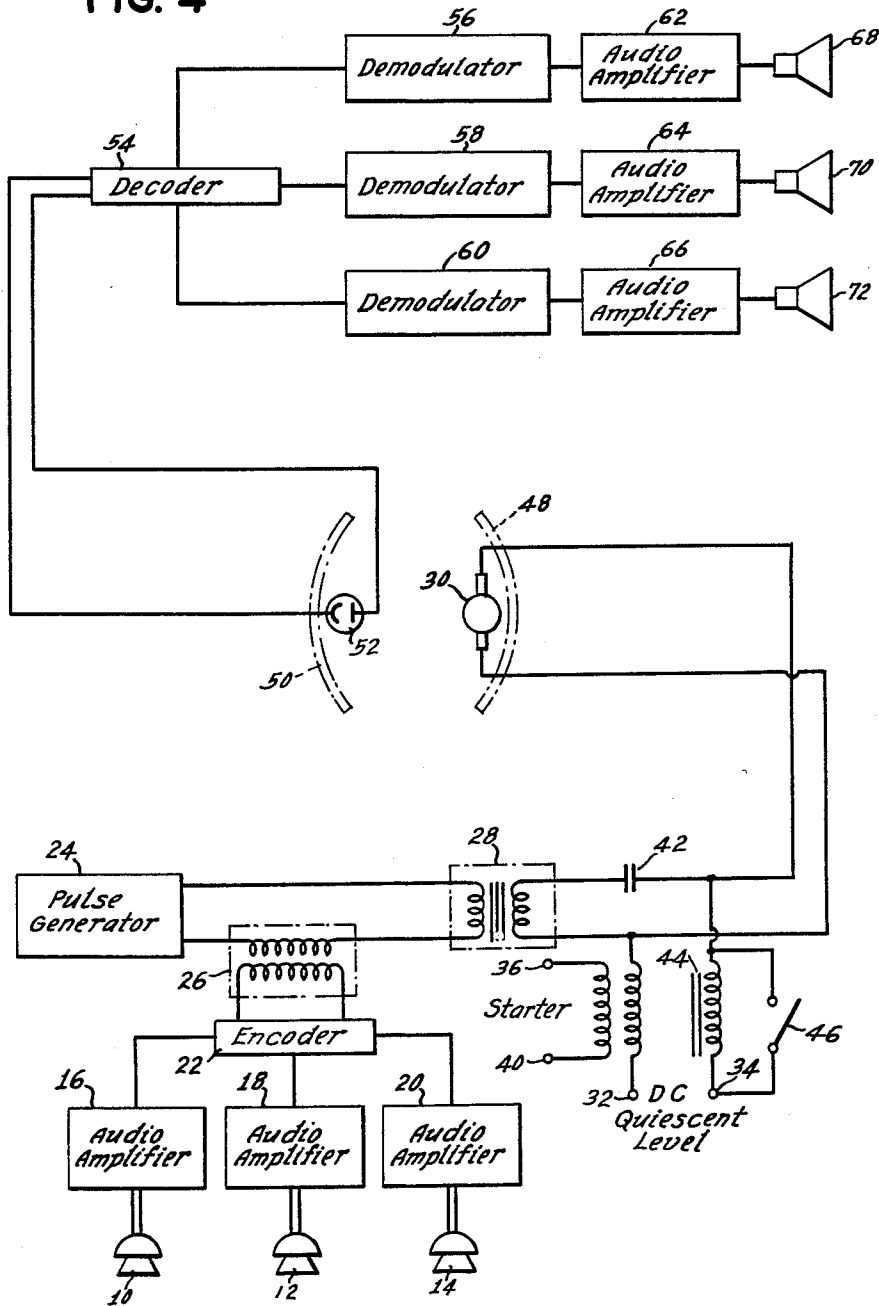
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FIG. 4



INVENTOR.
EDWARD C. MUTSCHLER

BY

Karl Haler
James E. Bryan
ATTORNEYS

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3,087,065

LIGHT COMMUNICATION SYSTEM

Edward C. Mutschler, Maplewood, N.J., assignor to
Engelhard Hanovia, Inc., a corporation of New Jersey
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This invention is concerned with communication systems by means of light and, more particularly, deals with such systems in which an oscillating beam of light is used as the modulated carrier for signal transmission, similar to the carrier wave in wireless telegraphy or broadcasting systems.

It is known to use oscillating, modulated light beams for communication systems in which an electrically energized source of light, such as a high pressure arc lamp, is supplied from a current source, whereby the voltage applied to the terminals oscillates in continuous sinusoidal waves. When transmitting solely Morse signals, the supply current circuit is energized and de-energized in the rhythm of the signals to be transmitted which constitutes the most elementary method of modulation, since the useful amplitude switches between only two values: the peak value and zero. Whereas in this case the sinusoidal shape of the supplied voltage does not impair the performance of such a system, transmission of, for example, speech by modulating the carrier amplitude in the rhythm of the signal or multichannel communication cannot be effected successfully, since the light output of electrically energized light sources such as high pressure arc lamps, as an example, does not follow exactly the shape of the sinusoidal voltage input but light emission continues during the voltage downswing. Due to a residual ionization of the atmosphere in the lamp, the light output declines at a rate which is slower than the voltage decline. As a result, the light output at high frequencies, required for the purpose of modulation, approaches an almost steady level which does not permit successful modulation in audio frequencies. Considering that the emission of Morse signals constitutes the most elementary method of modulation, the term modulation is used hereinafter to designate all methods of modifying a carrier wave as a function of signals, i.e. Morse signals and speech as well.

In accordance with the invention and in order to avoid the mentioned shortcomings, an improved system for emitting and receiving signals by means of oscillating, modulated light radiated from an electrically energized light source is obtained by supplying a pulsating current to the light source. The wave form of pulsating currents include a distinct low-leveled period in each cycle during which the light output declines sufficiently to permit modulation in audio frequencies and when using currents pulsating with high frequencies the system may be adapted for time sharing among several channels for multiplex communication, which was not possible heretofore with the conventional sinusoidal current supply.

The invention will be further illustrated by reference to the accompanying drawing in which

FIGURE 1 is a diagram illustrating the light output of a high pressure arc lamp as a function of a continuous wave input voltage,

FIGURE 2 is an analogous diagram for a pulsating input voltage,

FIGURE 3 is a diagram for an input voltage pulsating with a frequency twice as high as that of FIGURE 2 and

FIGURE 4 is a schematic diagram of a communication system.

FIGURE 1 illustrates the relationship between a voltage oscillating as a sine wave at 5000 cycles per second and applied to the terminals of a high pressure arc lamp, and the produced light output. Whereas the voltage

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declines in agreement with the sine curve after each peak, the light output declines at a comparatively slow rate due to the residual ionization of the atmosphere in the lamp and increases again in the next cycle such that the peak value and the lowest value differ insufficiently to permit successful modulation in audio frequencies. The difference between the peak value and the lowest value of the light output constitutes the useful amplitude, shown in FIG. 1 for a sinusoidal voltage input.

The relationship in the case of a pulsating voltage supply to the lamp and with the same frequency is shown in FIG. 2. The voltage declines almost instantaneously from the peak value to the lowest value, which latter constitutes the quiescent uniform operating level of the lamp; the light output decreases sufficiently rapidly to attain the darkness corresponding to the quiescent level before the new cycle begins and a maximum useful amplitude capable of being modulated is the result.

Since in each cycle attainment of the minimum light output as produced by the quiescent level is achieved even when operating the lamp with a voltage pulsating with the frequency of 10,000 pulses per second, as shown in FIG. 3, a system according to the invention for the first time permits the use of the same carrier for several channels in multiplex communication. It has been found in practice that good results are obtained when the duration of the quiescent level at least equals the half-life period of the residual light emission from the lamp, whereby the term half-life period denotes the time required for attainment of half the initial light intensity. However, when using very short pulse durations, for example approximately 20 microseconds, frequencies several times the maximum practical frequency for continuous wave modulation can be used.

A schematic block diagram of an amplitude-modulated three channel communication system according to the invention is shown in FIG. 4. The signals received by the microphones 10, 12 and 14 are amplified by the audio amplifiers 16, 18 and 20, respectively, and subsequently sampled by the encoder 22 in time sequence by means of a commutator or of any other suitable device to achieve the proper synchronization, the encoder including an amplifier. The circuits and the elements used therefor being well known in the art, a more detailed description thereof has been omitted.

The output from the above described device is subsequently impressed upon the carrier current delivered from a pulse generator 24, for example by means of a transformer 26, to cause the desired amplitude-modulation of the pulsating current, the modulated pulsating carrier current being supplied through a transformer 28 to a high pressure arc lamp 30.

Additionally, the lamp 30 is fed with a comparatively low direct current applied to the terminals 32 and 34 which determines the quiescent level indicated in the FIGURES 2 and 3. The lamp is therefore running continuously on a low light level upon which the modulated carrier is super-imposed, as described above. In order to provide the voltage for the initial ionization of the atmosphere in the lamp, a conventional starter is connected to the terminals 36 and 40. A blocking capacitor 42 and a choke 44 serve to separate the direct current from the pulsating current in the usual fashion, whereby the choke 44 can be shunted out over a switch 46 during the starting period of the lamp. A reflector 48 serves to concentrate the light beam emitted by the lamp 30 into the desired direction.

It will be apparent that the emitter so described and shown in FIG. 4 is illustrated only schematically since the circuits and elements thereof are well known in the art. The amplified and encoded signals can be impressed on the pulsating carrier by other means than the trans-

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former 26, for example by capacitive coupling. When transmission of Morse signals is desired, the microphones may be replaced by Morse keys. The light source herein described as a high pressure arc lamp can be replaced by any other suitable electrically energized device emitting ultraviolet, visible or infrared light.

Likewise, the components of the receiver comprise circuits and circuit elements known in the field of electronics, as shown in FIG. 4, the incoming light beam, concentrated by a reflector 59, is received in a photoelectric cell 52 or any other suitable device for transforming oscillating light into electrical energy. The signals are sorted into three channels by the decoder 54, the signal sequence of each channel being supplied to one of the demodulators 56, 58 and 60 to remove the carrier. Subsequently, the signals are amplified by means of the audio amplifiers 62, 64 and 66 and transformed into acoustical signals in the loud-speakers 68, 70 and 72.

Whereas the invention has been illustrated herein in connection with an amplitude-modulated carrier, the extended frequency range by avoiding residual light emission makes it possible to successfully frequency-modulate the pulsating carrier current, the circuits appropriate to achieve frequency modulation and demodulation being well known in the art. The invention can be applied, as well, for systems in which e.g. optical or mechanical means are used for modulating the light output of a source energized by a pulse generator.

Furthermore, the improvement in light communication achieved by using pulsating currents in accordance with the invention include a lower average wattage as compared to conventional systems using a sinusoidal carrier and, consequently, an improved signal-to-noise ratio is obtained, since the low quiescent level in pulsating systems results in an increased useful amplitude of light intensity.

It will be obvious to those skilled in the art that many

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modifications may be made within the scope of the present invention without departing from the spirit thereof, and the invention includes all such modifications.

What is claimed is:

1. In a light communication system, an electrically energized high pressure arc lamp having a residual light emission, means for operating the lamp at a uniform quiescent low light output-low voltage level, means for supplying a periodically pulsating carrier current to said lamp, the duration of the quiescent voltage level in each supplied pulse cycle being at least equal to the duration of the residual light emission, and means for modulating the supplied carrier current.

2. In a light communication system, an electrically energized high pressure arc lamp having a residual light emission, direct current means for operating the lamp at a quiescent low light output-low voltage level, means for supplying a periodically pulsating carrier current to said lamp, the duration of the quiescent voltage level in each supplied pulse cycle being at least equal to the duration of the residual light emission, and means for multi-channel modulating the supplied carrier current.

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