July 25, 1933. C. W. HOUGH 1,919,888

MULTIPLE SIGNALING SYSTEM

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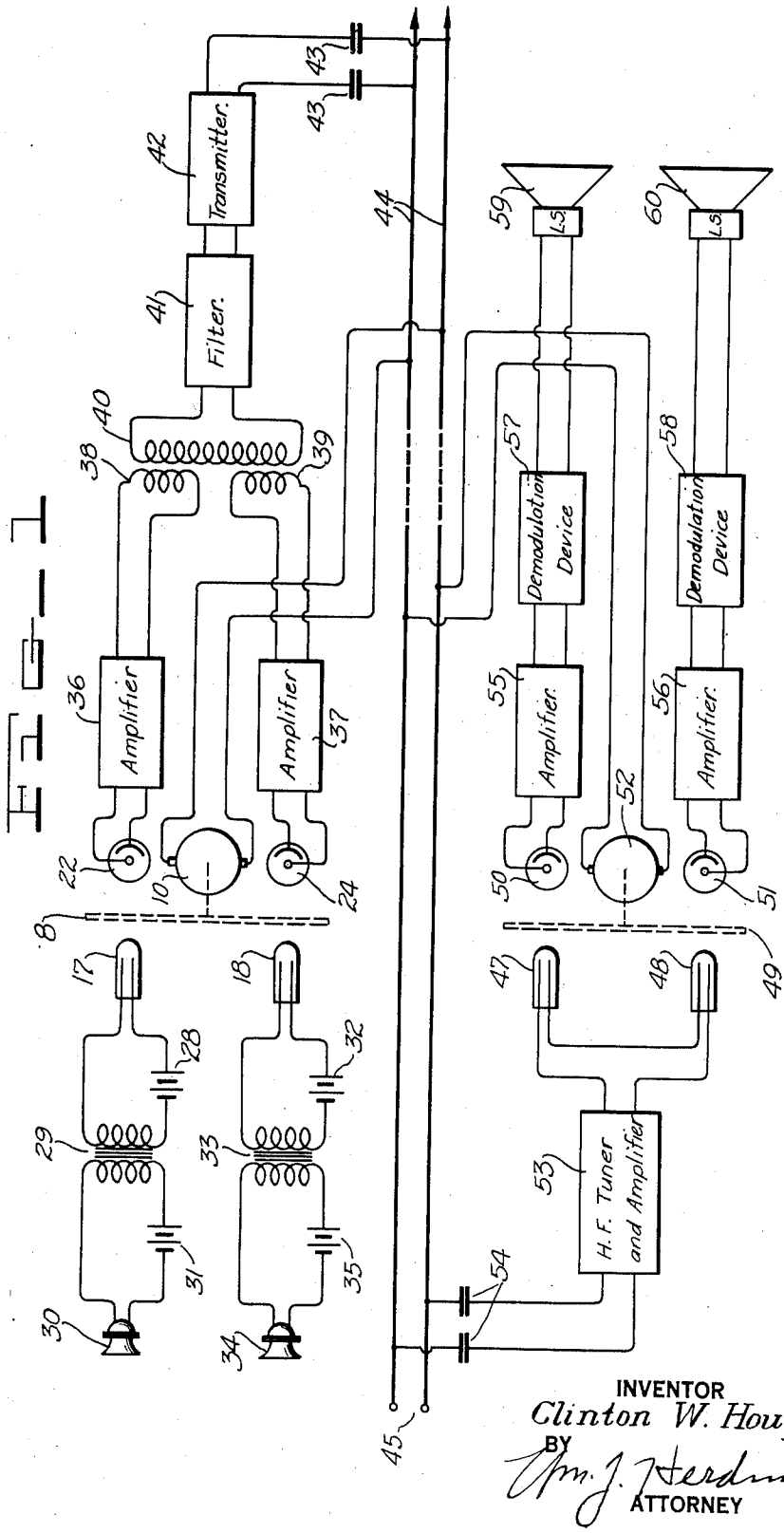


FIG. 1

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FIG. 2

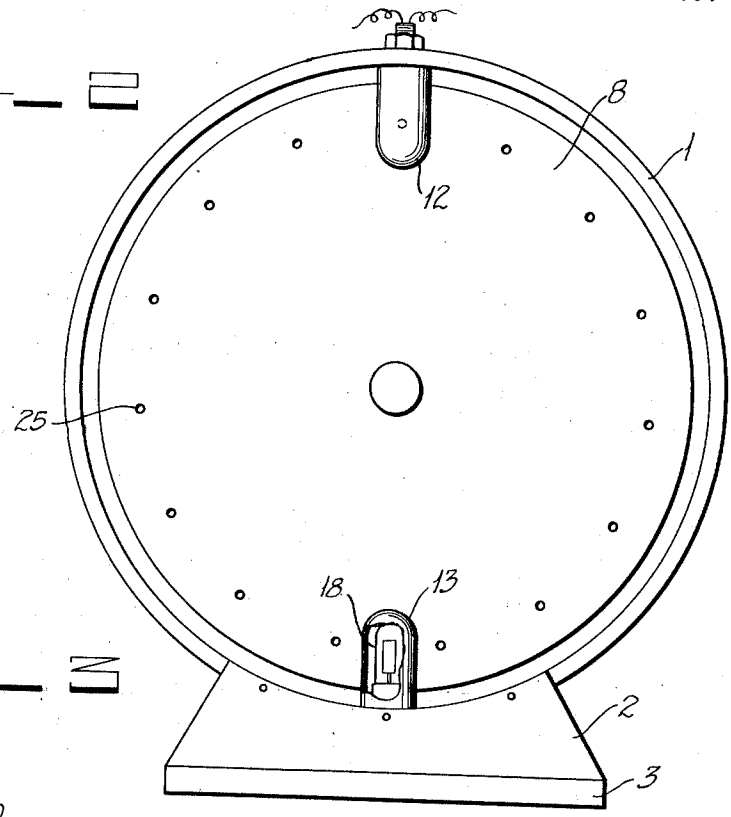


FIG. 3

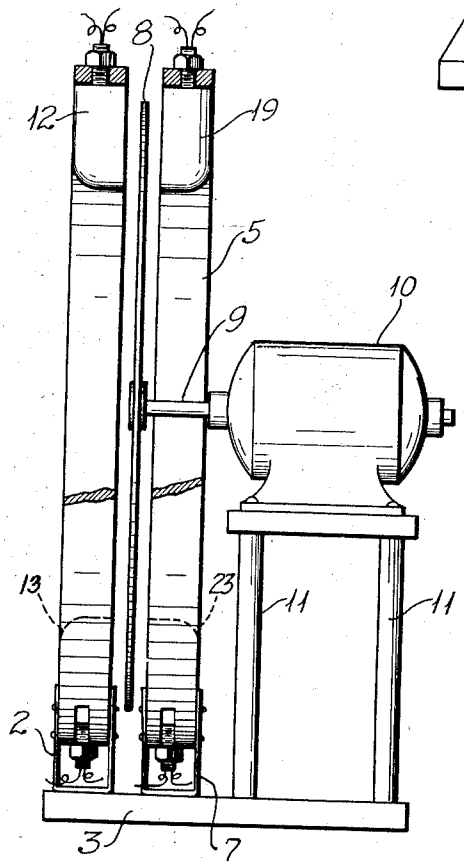
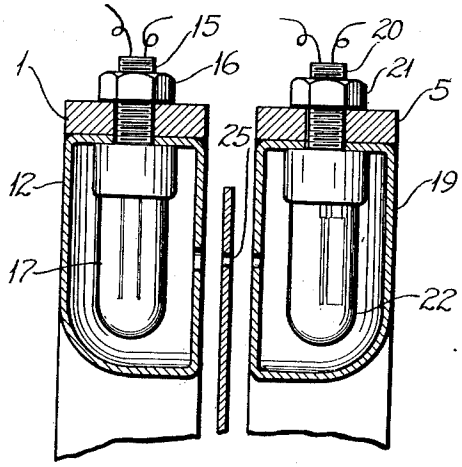


FIG. 4



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FIG. 5

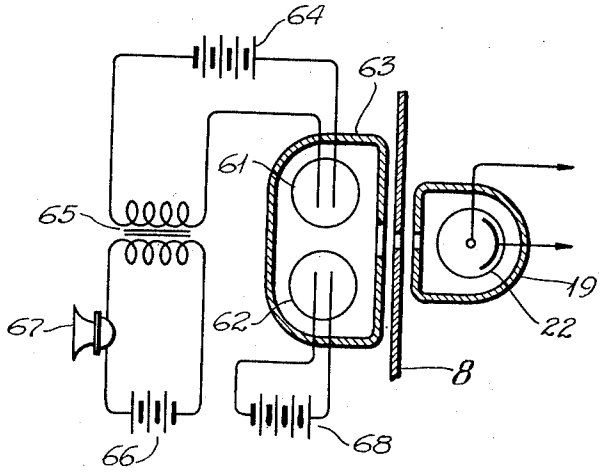
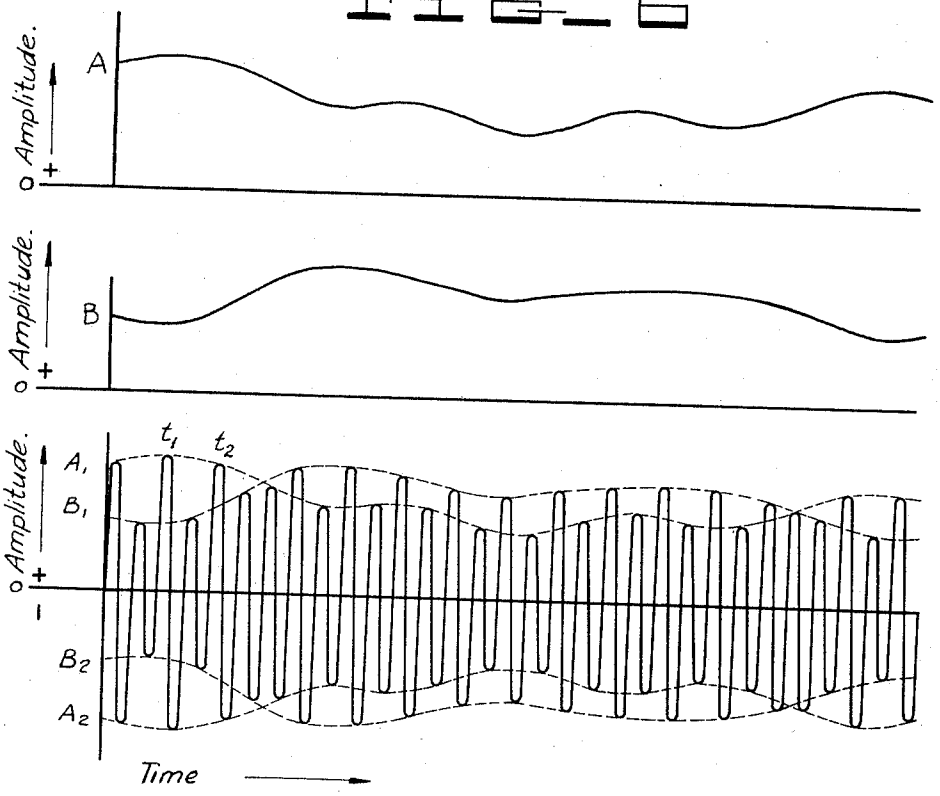


FIG. 6



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UNITED STATES PATENT OFFICE

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MULTIPLE SIGNALING SYSTEM

Application filed December 27, 1930. Serial No. 505,055.

My invention pertains in general to signaling systems and specifically relates to signaling systems for simultaneously transmitting and receiving a plurality of messages or programs.

One of the objects of my invention consists in providing a multiple signaling system in which means are provided for simultaneously transmitting and receiving more than one message or program by carrier current at a single frequency.

Another object consists in producing a system for the simultaneous transmission and reception of more than one program by carrier frequency current at one frequency produced by the interruption of irradiations incident upon photosensitive means.

A further object comprises producing a multiple signaling system in which signal modulation occurs before high frequency oscillation generation.

I accomplish the above desirable objects in a novel signaling system employing light interrupting means for transmitting and receiving a plurality of programs or messages by the multiple modulation of carrier frequency current at a single-frequency.

In the drawings which accompany and form a part of this specification and in which like reference numerals designate corresponding parts throughout:

Fig. 1 is a diagrammatic respresentation of one embodiment of the multiple signaling system of my invention showing the transmitter and receiver;

Fig. 2 is a front evelation of the light interrupting means employed in my system;

Fig. 3 is a side elevation, partially sectioned, of the light interrupting means of Fig. 2;

Fig. 4 is a sectional view of a photoelectric cell housing and a lamp housing employed in the apparatus of Fig. 2;

Fig. 5 is an alternative form of the arrangement of Fig. 4; and

Fig. 6 is a graphical representation of two different signal modulated currents with a representation of their relation to the carrier frequency current according to the system of my invention.

In my co-pending application, serial number 469,725, filed July 22, 1930, patented November 1, 1932, No. 1,886,188 and entitled "High frequency generator and modulator," I have disclosed a system in which the intensities of a plurality of light beams are varied in accordance with modulating currents and periodically intercepted at super-audible frequencies by mechanical means to produce modulated multi-frequency polyphase alternating currents. My present invention contemplates providing signal transmission means for varying the intensities of a plurality of light beams in accordance with modulating currents and, sequentially exposing photosensitive devices to these light beams at super-audible frequencies to produce high frequency oscillations at a single frequency which will be modulated with several simultaneous messages or programs. My invention further contemplates providing signal reception means for sequentially exposing other photosensitive devices to a source of irradiations under control of the aforementioned high frequency oscillations to affect the selective energization of a plurality of translating devices for reproducing, in effect, a plurality of simultaneous programs, or messages.

Referring to the drawings in detail, and particularly to Fig. 2, a mounting ring 1 is positioned upon a bracket 2 which is in turn secured to a base 3. Referring to Fig. 3, another mounting ring 5 similar in construction to and coextensive with the mounting ring 1 is positioned on the bracket 7 which is secured to the base 3, as shown. An opaque disk 8 is interposed between the mounting ring 1 and 5 and is secured to the armature shaft 9 of a motor 10. The motor 10 is secured to standards 11 which are mounted on the base 3.

Two lamp housings 12 and 13 are positioned upon the mounting ring 1. Referring to Fig. 4, it will be seen that the lamp housing 12 is secured to the ring 1 by a hollow stud 15 which extends through an annular slot in the ring 1 and is secured by a nut 16. A neon glow lamp 17 is mounted within a lamp housing 12. Connection wires from

the lamp 17 are extended through the hollow stud 15. A lamp housing 13, similar in construction to the lamp housing 12, is provided with a neon glow lamp 18 which is similar to the neon glow lamp 17. As indicated in Fig. 4, a photoelectric cell housing 19 is positioned upon the ring 5 opposite the lamp housing 12. The photoelectric cell housing 19 is secured to the mounting ring 5 by means of a hollow stud 20 extending through an annular slot in the ring 5 and secured by a nut 21. A photoelectric cell 22 is positioned within the housing 19 so that the photosensitive cathode thereof is directed towards the adjacent neon lamp 17. Another photoelectric cell housing 23 similar to the housing 19 is mounted upon the ring 5 adjacent the lamp housing 13 and is provided with a photoelectric cell 24 diagrammatically illustrated in Fig. 1. Apertures are provided in both the photoelectric cell housings and in the lamp housings so that light will be directed from the glow lamp contained within each lamp housing to the sensitized cathode of the adjacent photoelectric cell.

The disk 8 is provided with an annular series of apertures 25 each of which will permit the passage of light therethrough. These apertures are spaced in a manner such that, in the rotation of the disk 8, only one aperture will register with either of the apertures in the housing 12 or 13. For example, in the position of the disk 8, shown in Fig. 2, one of the apertures 25 is in register with the lamp housing 12 permitting light to pass to the adjacent photoelectric cell, while light from the lamp housing 13 is entirely cut off by the disk 8, there being no one of the apertures 25 in register therewith. Rotation of the disk will permit light to pass, alternately, from the lamp housings 12 and 13 to the adjacent photoelectric cells. It will be evident, then, that these photoelectric cells will be sequentially exposed to the light rays emergent from the lamp housings 12 and 13.

The motor 10 is preferably of the synchronous type for keeping in step with an alternating current and is adapted to rotate the disk 8 at high speeds so that the sequential excitation of the photoelectric cells opposite the lamp housings 12 and 13 will take place at super-audible frequencies.

Fig. 1 diagrammatically represents means for the transmission and reception of multiple programs according to my invention. Referring in detail to Fig. 1, the neon glow lamp 17 is connected through battery 28 to the secondary of a transformer 29. A microphone 30 is connected through battery 31 to the primary of transformer 29. The neon glow lamp 18 is connected through battery 32 to the secondary of a transformer 33, while a microphone 34 is connected through battery 35 to the primary of the transformer 33. Sound waves incident upon the microphone 30, acting through the transformer 29, control the intensity of illumination of the lamp 17 in accordance with the sound waves. Other sound waves incident upon the microphone 34 act through transformer 33 to similarly control the intensity of illumination of the lamp 18 in accordance with the sound waves. The microphones 30 and 34, and their associated circuits, are representative of different sources of modulating currents. According to my invention these sources of modulating currents are entirely independent of each other and may constitute two distinct program or message channels. It will be obvious that the illumination intensities of the lamps 17 and 18 could be controlled from other sources of modulating currents, such as from a television scanning system, without departing from the intended scope of my invention.

The photoelectric cells 22 and 24 are connected to amplifiers 36 and 37. The amplifiers 36 and 37 may be any suitable type of conventional amplifier well known in the art. In the present embodiment of my invention I employ a multi-stage resistance coupled thermionic amplifier. The output from amplifier 36 is connected to an inductance 38 while the output from transformer 37 is connected to inductance 39. The inductances 38 and 39 form independent primaries of a transformer having a common secondary inductance 40. The inductance 40 is connected to a filter 41. The filter 41 is a network of the band pass type, well known in the art, and is adapted to substantially attenuate alternating currents at all frequencies other than those lying within a band above the rate of the interceptions of the disk 8 minus the modulating frequency range and below the rate of the interceptions of the disk 8 plus the modulating frequency range. The output from the filter 41 is directed to a transmitter 42 which comprises means well known in the art for suitably increasing the energy value of high frequency signaling currents for transmission over distances. In the present embodiment of my invention the output of the transmitter 42 is directed through capacitive couplings 43 to power lines 44. High frequency oscillations from the transmitter 42 are therefore impressed, as carrier current, upon the lines 44. The lines 44 are connected at the terminals 45 to a source of commercial alternating current.

According to my invention, I provide neon glow lamps 47 and 48, disk 49, photoelectric cells 50 and 51, and motor 52, which are similar to the neon glow lamps 17 and 18, the disk 8, the photoelectric cells 22 and 24, and the motor 10. These elements are arranged in a mechanical construction similar

to that shown in Figs. 2, 3, and 4. A high frequency tuner and amplifier 53 is provided as a source of energy for the lamps 47 and 48. The high frequency tuner and amplifier 53 is of a conventional structure well known in the art comprising a tuning system for reception of high frequency signals substantially within the frequency range transmitted by the filter 41 and, also, a multistage amplifying system for the amplification of these signals. The input to the tuner 53 is connected through capacitive couplings 54 to the power lines 44 for the reception of carrier frequency energy from the transmitter 42.

The photoelectric cells 50 and 51 are respectively connected to amplifiers 55 and 56. The amplifiers 55 and 56 are similar in construction to amplifiers 36 and 37. The output of the amplifiers 55 and 56 are directed to the demodulation device 57 and the demodulation device 58, respectively. The demodulation devices 57 and 58 each comprise a vacuum tube detector system well known in the art for demodulation of the modulated high frequency energy. The output of the demodulation devices 57 and 58 is directed to two loud speakers 59 and 60, respectively, which comprise means for translating electrical signaling energy into equivalent acoustical energy.

Fig. 5 represents an alternative method of modulating illumination intensity which differs from that shown in Fig. 1 in that a source of biasing illumination is provided in addition to the modulated light source. In this arrangement two neon lamps 61 and 62 are positioned within an elongated lamp housing 63. The neon lamp 61 is connected through battery 64 to the secondary of transformer 65, the primary of which is connected through a battery 66 to microphone 67. The neon lamp 62 is connected to battery 68 and is maintained at a steady illumination intensity. The intensity of illumination produced by the lamp 61 is varied in accordance with modulating currents under control of the microphone 67. The photoelectric cell 22 is, therefore, under control of the additive intensities of the two lamps 61 and 62. The intensity of the lamp 62 serves to bias the operation of the photoelectric cell 22. Such an arrangement for modulation may be very desirable for some purposes, such as when it is desired to modulate upon a higher part of the characteristic curve of the photoelectric cell.

The operation of my multiple signaling system for the effective transmission and reception of simultaneous programs, or messages, is as follows:

Sound waves, comprising a program or message, impinging upon the microphone 30 act through the transformer 29 to control the intensity of the illumination of the lamp 17. At the same time, other sound waves comprising a different program or message and impinging upon the microphone 34 act through the transformer 33 to control the intensity of the illumination of the lamp 18. The motor 10 is made to rotate the disk 8 at a constant high speed whereby the photoelectric cells 22 and 24 are alternately, or sequentially, exposed to the lamps 17 and 18, respectively, at super-audible frequencies, as before explained. Each of the photoelectric cells 22 and 24 will then receive a series of light impulses, the illumination intensity of each of which will be substantially proportional to the instantaneous amplitude of the modulating current controlling the adjacent neon lamp. These high frequency light impulses produce photoelectric currents in the cells 22 and 24 which are respectively amplified by the amplifiers 36 and 37. The inductances 38 and 39 alternately act to induce, in the inductance 40, electromotive forces corresponding to the sequence of modulated impulses from the two amplifiers 36 and 37. The filter 41 substantially attenuates all frequencies other than those desired and eliminates harmonics and other objectionable extraneous frequency effects. The transmitter 42 increases the energy value of the output from the filter 41 for transmission through the capacitive couplings 43, over the power lines 44.

The transmitted high frequency currents are directed from the capacitive coupling 54 to the high frequency amplifier and tuner 53. The lamps 47 and 48 produce illumination intensities substantially proportional to the amplitude of the high frequency oscillations which are received and amplified by the high frequency tuner and amplifier 53. The motor 52, being connected through the power lines 44 to the same source of alternating current which supplies the motor 10, will rotate the disk 49 at substantially the same speed as the disk 8. It will, of course, be understood that the motors 10 and 52 are not necessarily connected to the same source of current supply but may be connected to independent sources of current supply and synchronized by other means well known in the art.

The disk 49, rotating at a high speed in synchronism with the disk 8, sequentially exposes the photoelectric cells 50 and 51 to the effects of irradiations from the lamps 47 and 48, respectively. The lamps 47 and 48, being connected in series with the output of the high frequency tuner and amplifier 53, have substantially equal illumination intensities at all times. However, the disk 49 sequentially exposes the photoelectric cells 50 and 51 to the lamps 47 and 48 so that the intensity of the light impulses incident upon the photoelectric cells 50 and 51 will respectively correspond to the intensity of the

light impulses incident upon the photoelectric cells 22 and 24. These high frequency light impluses will produce photoelectric currents in the photoelectric cells 50 and 51 which, when respectively amplified by the amplifiers 55 and 56, and respectively detected by the demodulation devices 57 and 58, will cause the loud speakers 59 and 60 to reproduce, in effect, the sound waves respectively incident upon the microphones 30 and 34.

In Fig. 6, curve "A" graphically represents, for a given time interval, the amplitude of the modulating current under control of the microphone 30 for typical acoustical conditions during a program. The curve "B" is a graphical representation, for the same time interval, of the amplitude of the modulating current under control of the microphone 34 for typical acoustical conditions of a different program. The curves "A_1" and "A_2" graphically represent the theoretical upper and lower side bands transmitted by the high frequency carrier current produced according to my system under control of the modulating current "A," while the curves "B_1" and "B_2" represent the theoretical upper and lower side bands transmitted by the high frequency carrier current produced according to my system under control of the modulating current "B." The frequency of the carrier current is sufficiently high so that the time intervals between the high frequency wave peaks for a particular side band, such as the difference between t_2 and t_1 for side band A, are considerably less than any frequency audible to the human ear. For example, the carrier frequency used in the present embodiment of my system could be of the order of 30,000 cycles per second which would make the time interval between t_2 and t_1 equal to one fifteenth-thousandth of a second. The effective frequency of the carrier for each modulating current is fifteen kilocycles, while the actual frequency of the carrier current is thirty kilocycles. However, the actual frequency band necessary for the transmission of both the modulating currents "A" and "B" is equal to the frequency of the carrier current plus twice the frequency range within which the modulation occurs. That is, the actual frequency range required according to my system is substantially the same as if but one modulating current, comprising the upper and lower side bands, was being transmitted by the single carrier frequency. It will be obvious that, by using higher frequencies for the carrier current, more than two programs can be, in effect, simultaneously transmitted and received according to my invention. It is, therefore, to be understood that the present embodiment of my invention, showing means for transmitting and receiving two programs, is purely arbitrary and that the number of transmitted and received programs can be increased if desired. It will also be obvious that the aperture disks used in my system may be arranged so that several light impulses in succession are given to each photoelectric cell so that several wave peaks in succession are modulated by one modulating current and then another group of wave peaks are modulated by a different modulating current.

It will now be apparent that I have provided a novel signaling system for the transmission and reception of multiple messages or programs which offers many advantages in its use, principal among which is conservation of frequencies. Although I have shown a preferred embodiment of my multiple signaling system it is, of course, contemplated that changes therein will readily occur to those skilled in the art but which will not depart from the intended scope of my invention. I do not, therefore, desire to limit myself to the foregoing except insofar as may be pointed out in the appended claims.

What I claim as new and original and desire to secure by Letters Patent of the United States is:

1. A multiple signaling system comprising, a plurality of sources of modulating current, a group of different sources of irradiations each of which is composed of a plurality of sources one of which is under control of one of said sources of modulating current, photosensitive means, means for sequentially exposing said photosensitive means to said group of plural sources of irradiations at super-audible frequencies, other means for producing irradiations under control of said photosensitive means, a plurality of photosensitive devices all of which are commonly under control of said last mentioned irradiations, means for sequentially exposing said last mentioned photosensitive devices to said irradiations, and a plurality of translating devices each of which is under control of one of said last mentioned photosensitive devices.

2. A multiple signaling system comprising, a plurality of sources of modulating current, a plurality of sources of light each of which consists of a pair of sources one of which is under control of one of said sources of modulating current, a group of photoelectric cells, a disk interposed between said sources of light and said photoelectric cells and having apertures for sequentially exposing said photoelectric cells to said pairs of sources of light, means for rotating said disk, means for producing irradiations under control of said photoelectric cells, another group of photoelectric cells, a second disk having apertures for sequentially exposing said last mentioned photoelectric

cells to said irradiations, and a plurality of translating devices each of which is under control of one of said last mentioned photoelectric cells.

3. A multiple signaling system comprising, a plurality of microphones, a plurality of sources of light each of which consists of a pair of sources one of which is under control of one of said microphones, photosensitive means, means for sequentially exposing said photosensitive means to said pairs of sources of light at super-audible frequencies, means for producing irradiations under control of said photosensitive means, a plurality of photoelectric cells, a plurality of translating devices each of which is under control of one of said photoelectric cells and means for sequentially exposing said photoelectric cells to said irradiations to sequentially energize said translating devices respectively under control of said sources of modulating current.

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