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March 28, 1944. B. F. ATWOOD 2,345,445

TRANSMISSION AND MODULATION OF LIGHT BEAMS

Filed May 22, 1941 2 Sheets-Sheet 1

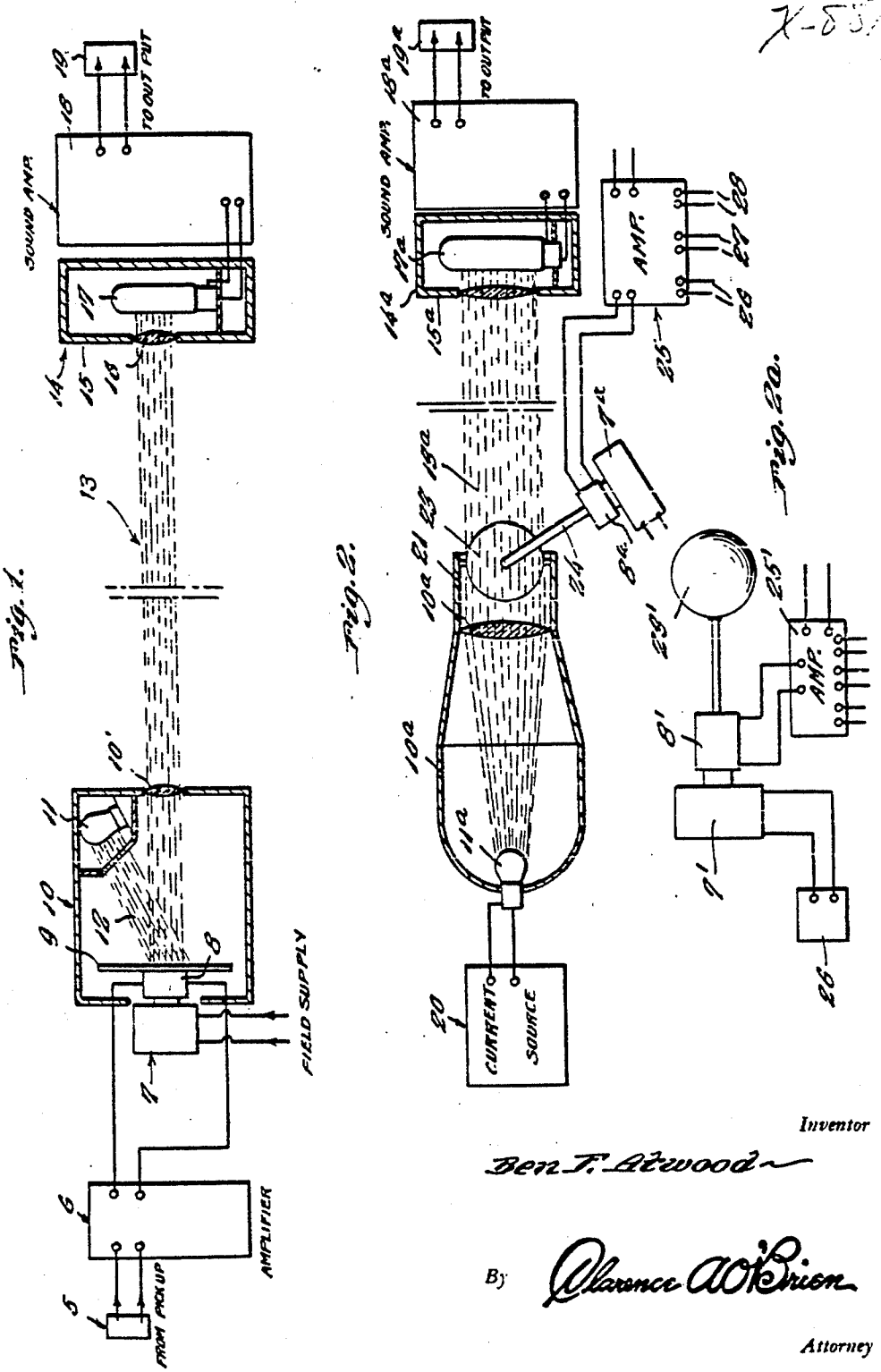


Fig. 1.

Fig. 2.

Fig. 2a.

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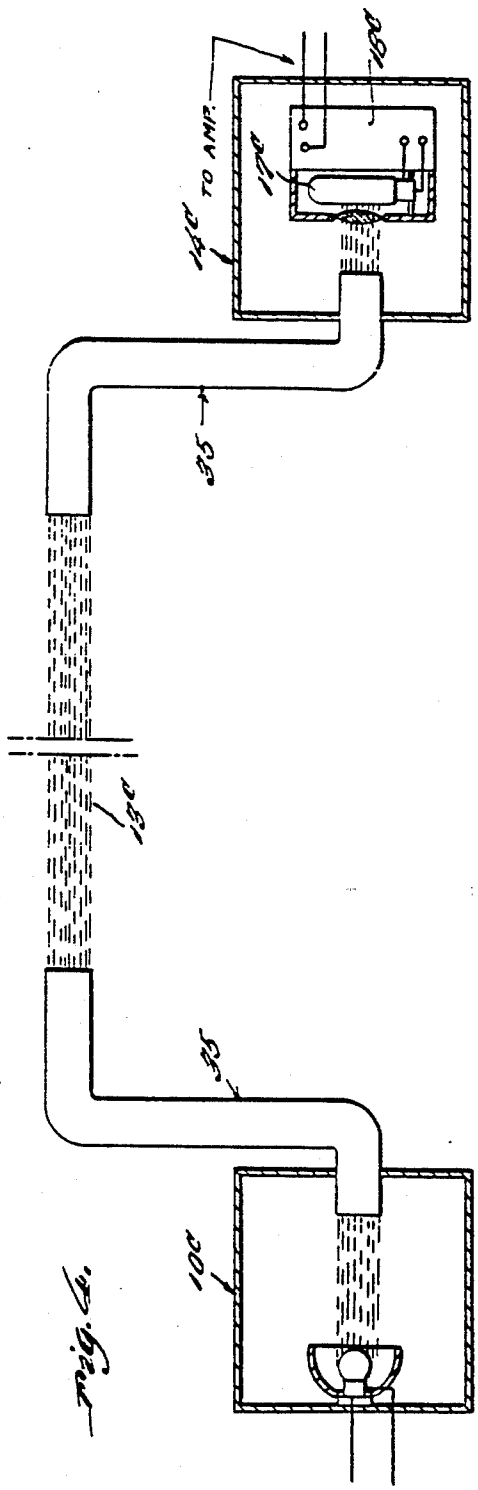


Fig. 5.

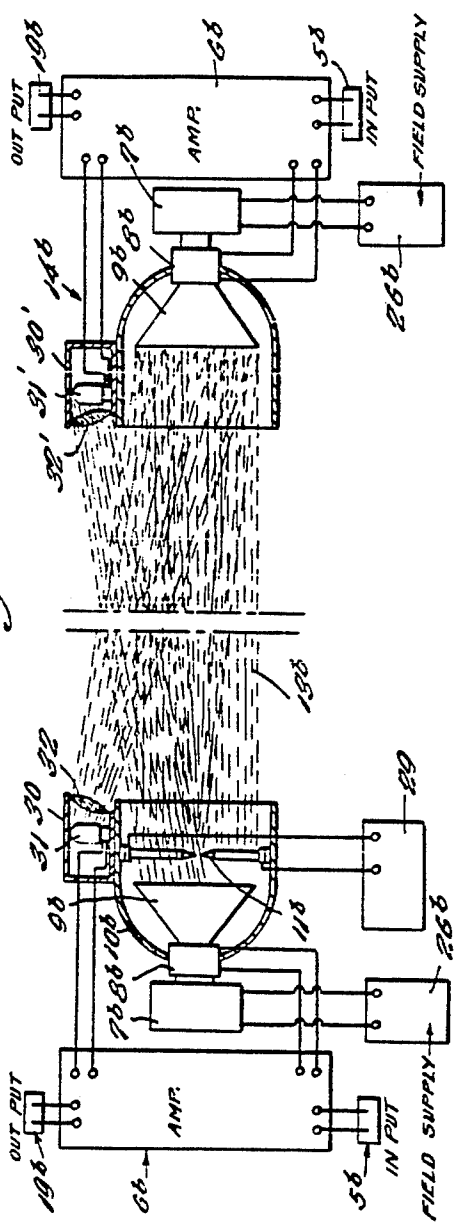


Fig. 6.

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TRANSMISSION AND MODULATION OF LIGHT BEAMS

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Application May 22, 1941, Serial No. 394,721

6 Claims. (Cl. 250—7)

My invention relates generally to signaling means, and particularly to the use of light beams as carrier media for intelligence, and the primary object of my invention is to provide simple and efficient means for the modulation of and transmission of suitable light beams.

Other important objects and advantages of my invention will be apparent from a reading of the following description taken in connection with the appended drawings, wherein for purposes of illustration I have shown preferred embodiments of my invention.

In the drawings:

Figure 1 is a general schematic view showing the coupling of a conventional amplifier to a dynamic or magnetic reproducing unit having its voice coil or vibrating arm physically connected to a light reflecting medium, such as a diaphragm.

Figure 2 is a similar schematic view of an arrangement in accordance with the present invention involving the projection of a powerful light beam by means of a searchlight or other suitable source of visible or invisible light rays, in a beam in which is interposed edgewise a disk connected to a vibrating arm having physical connection to a voice coil of a dynamic or magnetic output unit, and coupled to a suitable amplifying unit.

Figure 2*a* is a modification of the arrangement shown in Figure 2 of the drawings, employing a translucent bead instead of a disk type diaphragm.

Figure 3 is a schematic illustration of a two-way light beam communication system wherein only one station is provided with a light source and energizing power supply for said light source.

Figure 4 is a schematic representation of a signal system characterized by an arrangement suitable for use with any of the foregoing embodiments of the invention, wherein the light beam is conducted and carried non-axially or bent by a rod or series of rods of light conducting material.

In accordance with the present invention one method of transmitting and receiving employs an amplifier for reproducing voice, music, or other sounds from a suitable pick up, such as a microphone, radio receiver, electrical pick up or other suitable device, the output of which is greatly amplified and strengthened and coupled to a suitable dynamic or magnetic unit whose voice coil or vibrating arm is directly connected to a disk or plate or parabolic or elliptical reflecting medium whose composition and dimensions are such that the greatest efficiency in reflecting and concentrating the beams of visible or invisible light are achieved. Thus when a signal is introduced into the amplifier the reflecting medium coupled to the output is caused to vibrate more vigorously and with greater strength in accordance with the input signal than would be possible with the direct methods heretofore used, wherein the feeble sound waves directly vibrate the diaphragm.

Another method contemplates the employment of a light source and means for energizing the light source, the light source being focused within a rigid reflector similar to an efficient searchlight with a concentrating lens projecting parallel or nearly parallel beams of light onto a disk, bead, or other vibrating arm inserted in the path of light beams and rigidly connected to a voice coil or other operating arm of a dynamic or magnetic output reproduction unit, the unit being in turn coupled to a vacuum tube or other amplifying unit.

A still further arrangement in accordance with the present invention provides for the transmission of means of modulated light falling within the visible or invisible spectrum and the focusing or direction of the same onto the surface of a polished rod of suitable light carrying and transmitting material, such as that now on the market and known by the name of "Lucite" whereby the effective light beams may be bent and distorted so as to be emitted at a point laterally and longitudinally remote from the axial center of propagation of the light rays.

The invention further contemplates any combination or cooperation of the foregoing methods, but for purposes of disclosure and illustration the arrangements shown in the drawings and described herein below are provided in order to make clear the principles of the invention for purposes of this application.

Referring in detail to the drawings, and first to Figure 1 thereof the numeral 5 generally designates a conventional suitable form of microphone, phonograph or electrical pick up, radio or television transmitting medium the vibrations from which are amplified by the amplifier 6 whose output is connected to the magnetic or dynamic reproducing unit 7, such as a reproducing unit used for high quality radio or sound system output. The voice coil or vibrating element 8 of this unit is rigidly attached to a reflecting diaphragm 9 within any suitable housing 10. The diaphragm 9 may be of any suitable reflecting material and have any suitable or desirable shape in accordance with circumstances. A light source 11 is mounted in the housing 10

at one side of the axis of the transmitter beam and properly adjusted to concentrate or direct the light rays 12 onto the reflector 9 from which rays are reflected or transmitted in a parallel beam 13 through lens 10' to a remotely located photo-electric receiving and amplifying unit which is generally designated 14 and may suitably comprise a housing 15 having a concentrating lens 16 in its forward wall for concentrating the light beam on the photronic element 17 within the housing which is connected to the amplifying element 18 of suitable type whose output is conventionally connected to a suitable utilization means 19. The light rays 12 falling upon the reflector 9 which is vibrated by the amplified signal coming from the pick-up will be diffused or modulated in accordance with the vibrations, so that the beam 13 will be characterized by the modulation and correspondingly affect the photronic element 17, so that the amplified output thereof available at the point 19 is in a powerful and readily adaptable form.

Referring now to the arrangement of the invention shown in Figures 2 and 2a the numeral 20 generally designates a suitable current source for a powerful light producing element 11a producing visible or invisible light within a suitable reflecting and concentrating casing 10a involving the concentrating lens 10a in advance of a tubular portion 21 having the general cross section of the transmitted beam 13a. In this tubular portion 21 is supported a disk 23, placed edgewise, in the light beam 13a and having rigidly connected thereto the vibratory arm 24 which is operatively connected to the voice coil 8a of an electro-magnetic output unit 7a, the voice coil being electrically connected to the amplifying unit 25 having a plurality of input elements such as those indicated by the numerals 26, 27 and 28. In this arrangement the operation of the amplifier unit 25 causes the voice coil 8a to very powerfully vibrate the arm 24 and consequently the disk 23, and correspondingly greatly modulate the light beam 13a as it moves toward the receiving unit 14a which may be similar to the photronic unit of the first described embodiment.

Referring to Figure 2a of the drawings, this is an arrangement substantially similar to that shown in Figure 2 of the drawings, but employs a glass or other translucent material bead 23' instead of the edgewise disk 23, with substantially similar operative effects, a suitable field supply 26 being connected in both cases to the field of the unit 7a or 7', and a suitable source of current (not shown) being provided for the amplifying units 25 and 25'.

Referring now to the embodiment of the invention shown in Figure 3 of the drawings showing a two-way light beam communication system, a single light source 11b, such as an electric arc, is provided at the home station and mounted in a suitable housing 10b, the housing being of a light concentrating and reflecting type having mounted axially therein a conical vibrating reflector diaphragm 9b operatively connected to the voice coil 8b of a reproducing unit 7b, the crater of the arc being located in axially alignment with the axis of the reflector 9b and a suitable source of energy 29 being provided for energizing the arc.

A field supply for the unit 7b is designated 26b. A suitable amplifying unit 6b has its input varied by a microphone or other similar arrangement, as in the above described embodiments of the invention, and has its output connected to a suitable utilization means 19b. In this instance also the amplifier 6b is connected to the coil 8b. The remote away station 14b is constructed similarly to the home station described.

In both stations the housings 10b and 10' have mounted thereon the sub-housings 30 and 30' containing photronic receiving element 31 in conjunction with concentrating lens 32 and 32', the same being laterally displaced with respect to the main light beam 13b. It is to be noted, however, that the remote station 14b does not have a light source 11b like the home station.

The remote station shown to the right in Figure 3 is the drawings, utilizing the beam 13b from the transmitting home station, can reflect and retransmit the beam 13b by means of the collecting and transmitting reflector 9' to the receiving section 30 of the original transmitting station, the remote station causing the reflector 9' to suitably modulate the reflected light beam so as to convey intelligence to the receiving section 30 and its component parts at the home station. Similarly the modulated beam from the light transmitter 9b which is modulated by the modulating unit 7b is picked up at the remote station by the light detecting and reproducing unit 30'. The elements 30 and 30' and the photronic elements 31 and 31', energized from the respective amplifiers 6b and 6' are so placed that the local beams from their own transmitting stations cannot be detected by them. When a signal from a suitable amplifier is caused to flow through the dynamic or magnetic reproducing unit 7b in reproducing sound or vibrations or other frequencies and whose voice coil or vibrating arrangement 8b, 9b has its arm securely attached to the modulating reflector 9b, the energized or modulated light from the arc 11b falling upon the mirror light surface of the vibrator reflector 9b will be projected in a correspondingly modulated form to impinge on the vibratory reflector 9' of the remote unit which is arranged to reflect some of the light to operate the unit 30 on the home station. It will be understood that the remote station does not have a light source of its own, but depends for transmission to the home station upon reflecting and modulating a portion of the light beam originating at the home station, and at such times as the light beam is projected to the remote station in unmodulated condition.

Referring now to the embodiment of the invention shown in Figure 4 of the drawings, the numeral 10c generally designates a modulated light beam transmitter and the numeral 35 a rod, tube or section of "Lucite" or other similar light conducting material. When the light transmitted from the unit 10b impinges on the element 35, the opposite end of the element, wherever located with respect to the original axis of projection of the light, will emit the transmitted light so that it is capable of being detected and amplified by a suitable photronic amplifying unit which is generally designated 14. In this way the transmission of a light beam is possible without the transmitting station being within visual range or axial alignment, and without the use of reflectors, prisms, or similar light bending devices.

Although I have shown and described herein preferred embodiments of my invention, it is to be definitely understood that I do not wish to limit the application of the invention thereto except as may be required by the scope of the subjoined claims.

Having described the invention, what is claimed as new is:

1. A transmitting and receiving system comprising a home station and at least one remote station, said home station comprising a light source, electrically vibrated light reflecting means adapted to be operatively connected to a source of the vibrations embodying the intelligence to be transmitted, means operated by said light source for producing a beam of the light from said source and projecting the same to the remote station modulated by the operation of said light reflecting means, and light affected means at the remote station operated by the said light beam while unmodulated, means at the remote station for reflecting back to the home station a portion of the original light beam, means at said remote station for modulating said reflected portion of the original beam, and additional light affected means at said home station operated by the modulated reflected portion of the original light beam.

2. A transmitting and receiving system comprising a pair of transmitting and receiving stations, light beam producing means at one of the stations for projecting a light beam toward the other station, each station comprising high frequency means for modulating the light beam, amplifying means including light affected means for exposure for actuation to a modulated light beam coming from the other station, the station without light beam producing means having light reflecting means operative to receive and reflect the light beam from the other station back to the light affected means of said other station only while said light beam is unmodulated, the station devoid of light beam producing means having its high frequency modulating means arranged to modulate the beam reflected back to the other station while the modulating means of said other station is inoperative.

3. A transmitting and receiving system comprising a home station comprising light beam producing and projecting means for directing a beam of light toward the remote station, high frequency means for modulating said light beam, and light affected means including amplifying means for recording and amplifying a modulated light beam proceeding from said remote station, said remote station comprising light reflecting means for reflecting the light beam back to the light affected means of the home station while the light beam is in unmodulated condition, said remote station further comprising means for high frequency modulating the light beam reflected to the light affected means of the home station.

4. A system as recited by claim 3 wherein said high frequency modulating means is responsive to sound vibrations.

5. In a method of transmission utilizing axial modulation of a unidirectional light beam as the medium of transmission to a remote station and electro-mechanical means for axially modulating the light beam, the steps of imposing the normal amplitudes and frequencies of the intelligence to be transmitted directly upon a medium responsive thereto, substantially amplifying the output of such medium, and operating said electro-mechanical means by means of the amplified output, the resultant modulation of the light beam merely being controllable by controlling the amplification of the original intelligence.

6. The method of transmitting intelligence by means of a modulated light beam directed toward a remote receiving station which consists in directly imposing the normal frequency and amplitudes of the intelligence to be transmitted upon a medium responsive thereto, amplifying the output of such medium, and electro-mechanically imposing the amplified resultant upon the light beam in a manner to modulate the main portion of the light beam principally axially.

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