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G. M. WRIGHT ET AL

2,031,198

PHOTOPHONE

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Fig. 1

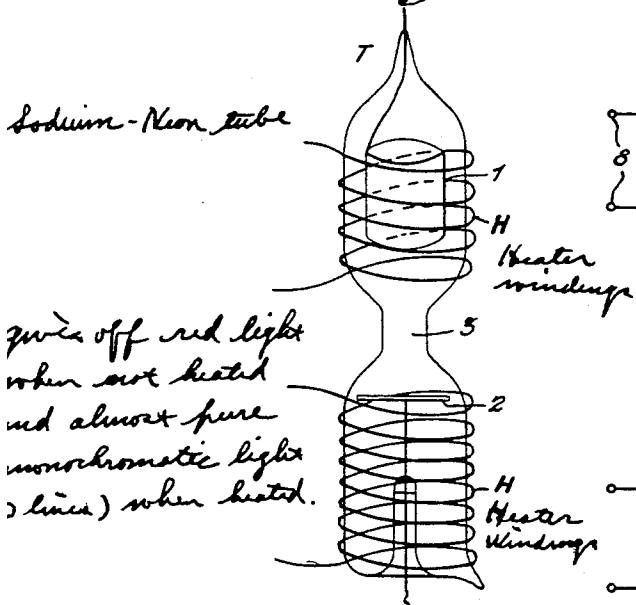


Fig. 2

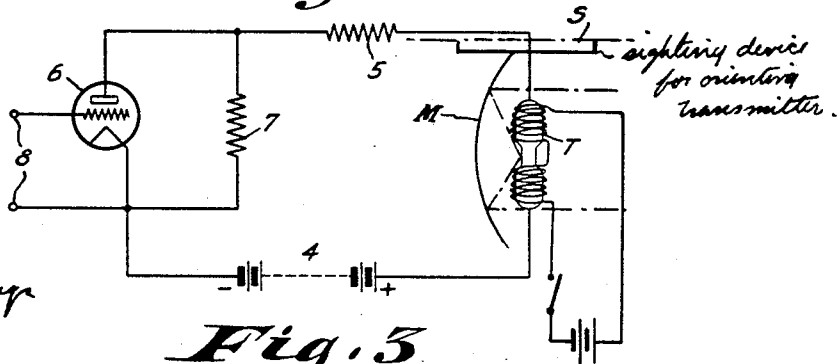


Fig. 3

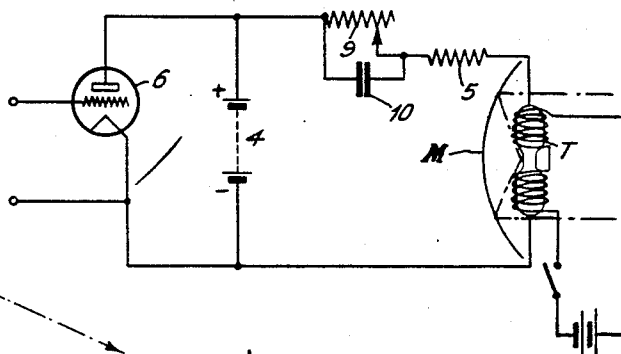
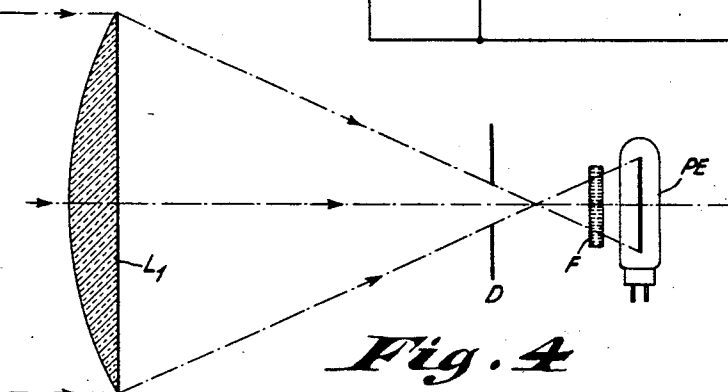


Fig. 4

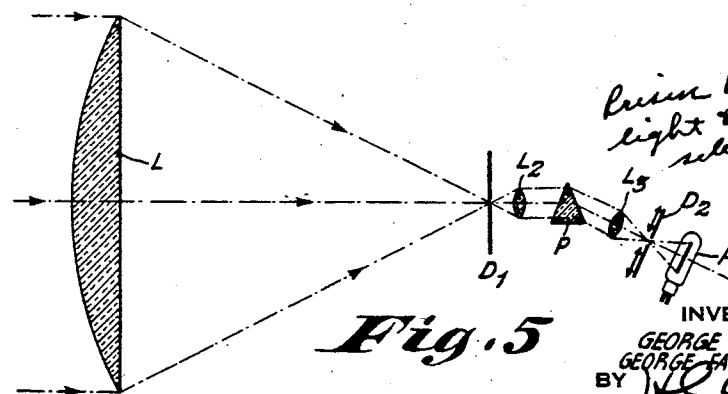


Fig. 5

lens P spectroscopically spec
light + slotted diaphragm
selects particular portion
desired

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PHOTOPHONE

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In Great Britain April 23, 1932

1 Claim. (Cl. 250—7)

This invention relates to photophones, i. e., to devices for transmitting speech or other intelligence as variations or modulations of a beam of light. As applied to sound pictures, the beam may be modulated by a photographic sound record or the like.

The invention has for its main object to provide an improved photophone system whereby the sensitivity of the receiver to the transmitted light relative to its sensitivity to stray light shall be increased.

According to this invention a photophone system comprises, at the transmitter, means for generating monochromatic or approximately monochromatic light, means for modulating or varying said light in accordance with the intelligence desired to be transmitted, and means for directing the modulated light towards the receiver, and, at the receiver, a photoelectric cell or equivalent means for translating received light variations into electrical variations and means in the light path to said photoelectric cell or its equivalent, for separating out from the total light incident upon the receiver light of a wave length corresponding or approximately corresponding to that transmitted from the transmitter, the arrangement being such that substantially only this separated light is allowed to reach the translating device.

The invention is illustrated in the accompanying schematic drawing in which Figure 1 shows a preferred form of sodium-neon glow discharge tube suitable for use in a transmitter; Figures 2 and 3 show different forms of modulating circuit for use in a transmitter; and Figures 4 and 5 show different forms of receiver.

In one way of carrying out the invention, the light transmitting device at the transmitter is constituted by a sodium vapour tube, for example, a so-called cold cathode sodium vapour tube, which is maintained at a temperature of about 200° C., in any convenient way, such for example as by a heater coil. In place of using an externally heated so-called cold cathode sodium vapour tube, a tube having a so-called hot cathode (e. g. a filament) may be employed. A convenient form of sodium-neon tube (generally designated T) is shown in Figure 1 and comprises a glass envelope of dumb-bell shape containing, in one enlarged portion, a cylindrical cathode 1 and in the other, a disc like anode 2. The enlarged portions of the envelope communicate with one another as shown through a constriction 3 in which the positive light column occurs when the tube is in use. The envelope is neon filled and sodium is deposited

on the inner walls of the envelope. Heater windings H are wound round the enlarged portions of the envelope. When the heater is not in action this tube gives an ordinary reddish neon glow but when the heater is brought into use (to give a working temperature of somewhere about 200° C.) almost pure monochromatic light (D lines) is obtained. The tube, which gives a brilliant and localized light, is associated with a parabolic mirror M whereby a fairly parallel beam of light for transmission is obtained. The tube is included in the output circuit of a thermionic valve to whose grid circuit the speech or other intelligence to be transmitted is applied, if desired, after amplification.

Any of a variety of different types of modulation circuit for the tube may be provided;—for example, as shown in Figure 2 the tube may be included in series with a source 4 of anode potential of say 300 to 500 volts, and a stabilizing resistance 5 of about 500 ohms to 1,000 ohms in the plate circuit of a valve 6 as shown. This circuit may be described as a series modulation circuit and when such a circuit is employed, it is preferable to provide a further resistance 7, for example of about one-quarter of a megohm, in shunt between the anode and cathode of the valve, this resistance serving as a priming resistance and maintaining a small permanent current through the tube, irrespective of the voltage (modulating voltage) applied to the grid of the valve at 8.

In another modulating arrangement shown in Figure 3, which may be referred to as a choke modulation arrangement, the plate of the valve 6 is connected to the cathode through a series circuit consisting of a resistance shunted condenser combination 9—10 (the condenser may be about 2 microfarads capacity and the resistance a variable resistance adjustable between zero and 1000 ohms or thereabouts) a sodium tube T and a stabilizing resistance 5 of about 500–1000 ohms.

In both the modulation circuits described, the stabilizing resistance is not absolutely essential but is preferably provided in order to remove any liability of the tube to break into self-oscillation, due to the fact that tubes of the kind in question exhibit negative resistance effects over a portion of the characteristic. The purpose of providing the priming resistance in Figure 2 (which priming resistance is also not absolutely essential) is to remove any tendency to instability if "deep" modulation is employed, there being (if the priming resistance be omitted in the circuit in question) a tendency to instability owing to the dif-

ference between the working voltage and the striking voltage of a sodium tube.

The whole transmitter is preferably constructed as a unit and is provided with sighting devices S whereby it may be pointed accurately at the receiver. Under certain circumstances the modulated beam may be recorded and the record so produced be utilized to modulate a constant intensity light beam at the receiver.

The receiver comprises the usual photoelectric cell or equivalent device for translating light variations into electrical variations, said cell being associated with a thermionic amplifier and translating device such as a loudspeaker or pair of telephones. The receiver which, like the transmitter, is constructed as a unit is also provided with sighting devices whereby it may be pointed at the transmitter and light received at the receiver is concentrated by means of a suitable lens system upon the photo-electric cell. Between this lens system and the cell is arranged, in accordance with the present invention, means for separating out light of wave length corresponding to that sent from the transmitter, said means being so arranged as to permit only such light or approximately only such light to fall upon the photo-electric cell. Broadly speaking, the required separation of the desired region of the light spectrum may be effected in either of two ways (1) by means of a light filter consisting of a suitably prepared solution or gelatine equivalent passing only the desired region of the spectrum or (2) spectroscopically.

In one way of carrying the former method into practice (see Figure 4) there is provided at the focal plane of a receiving or collecting lens L a diaphragm D having a fairly wide aperture therein and on the other side of this diaphragm is situated a photo-electric cell PE. Between the diaphragm and the cell (or in any other suitable point in the light path to the cell) is situated a filter F consisting of a glass cell containing a suitable solution (alternatively the filter may consist of a gelatine film between glass protecting plates) the filter being as selective as possible and passing only or approximately only light of the color sent from the transmitter. Theoretically the ideal filter would be one opaque to all light except that of a wave length falling within a narrow region in the yellow portion of the spectrum corresponding to the D lines (assuming a sodium vapour transmitter tube). In practice, however, such filters are inefficient owing to their high light absorption, even on the selected wave length but on the other hand, filters which will cut out most of the violet blue and green, and will transmit a high percentage of yellow and red are fairly easy to obtain and efficient to employ. Such a filter of low selectivity would be quite practicable where the unwanted light was chiefly blue and green but where the conditions of use are more stringent, and where the power of the transmitter permits, a highly selective filter should be employed.

In the spectroscopic method of obtaining the required light selection at the receiver (see Figure 5), a diaphragm D₁ having a very narrow slit is situated at the focal plans of a large receiving or collecting lens L₁ and also at the focal plans of a second lens L₂ on the side of the said diaphragm remote from the first lens. Received light passing through the narrow slit in the diaphragm and through the lens L₂ is projected through a prism P of the type ordinarily employed in spectroscopes, whence it falls upon a

third lens L₃ which brings the separate color components to their respective line foci in the plane of a second diaphragm D₂ having a slit or pin hole so positioned as to pass the required color component (in the case considered the yellow lines) the photoelectric cell PE being positioned on the far side of this second diaphragm. The slit in the first diaphragm must be narrow—up to about ½ mm. in width—and the said diaphragm must be so adjusted that the required part of the focal plane image i. e. the part containing the transmitted yellow light, falls thereon. The various lenses and diaphragms should be mounted in such a manner as to permit of fine adjustment. The prism spectroscopic system just described, though somewhat expensive practically offers marked advantages in certain cases owing to the high degree of selectivity it provides.

In carrying out the invention "calling" may be simply accomplished by arranging to include the transmitting sodium or other tube as part of a so-called resistance-capacity "blink" circuit i. e. a circuit wherein the tube is illuminated at predetermined intervals which are determined by the capacity, the resistance, and the driving potential employed. The "blink" periodicity is chosen at a value suitable for use at a "ringing" tone and the receiver is provided with a bell, resonant relay, or other frequency responsive device energized from the receiving photoelectric cell so that it is responsive to the "ringing" tone and rings or otherwise indicates when "calling" is occurring.

Although in the above described embodiment a sodium vapour tube has been referred to and the transmission of yellow light has been described the invention is not limited to such arrangements but any monochromatic or approximately monochromatic light transmitting system may be employed. Again although the particular forms of sodium tube described will give substantially only yellow light it is as above implied not necessary that the system should be strictly monochromatic. For example, if the tube of Figure 1 be employed with the heater out of action, the light obtained is then the ordinary neon red, but this light, though not very monochromatic, may be found preferable in certain (usually temporary) circumstances because of its fog and mist penetrating qualities and because it activates most present day photoelectric cells more powerfully than does yellow light. Thus the tube of Figure 1 may be easily switched over to give red or yellow light; with red light transmission the filter F of Figure 4 should, of course, be changed for one passing more red while if a receiver as shown in Figure 5 be employed the aperture in D₂ should be rather larger than for yellow light. Receivers of the type of Figure 4 should, therefore, be provided with readily interchanged filters while a receiver of the type of Figure 5 may be provided with a diaphragm at D₂ having an adjustable aperture when such receivers are to be employed in co-operation with transmitters whose light may be changed in color from time to time. Furthermore, in carrying out the invention any of the broadly known photophone systems may be employed e. g. in order to facilitate amplification at the receiver the transmitted light, in addition to being varied in accordance with the intelligence to be transmitted may be interrupted at a predetermined chosen frequency the interruption frequency acting as a carrier for the intelligence. Again, in place of employing an optically derived carrier, an electrically derived carrier may be

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utilized, i. e., the variations in the light source may be obtained in dependence upon an applied modulated carrier voltage.

5 Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

10 A photophone device including a photoelectric means for translating receiving light variations into electrical variations, means in the light path to said photoelectric means for separating out from the total light incident upon the receiver light of a wave length approximately corresponding to the approximately monochromatic light
15 transmitted from a co-operating transmitter so

that only this separated light is permitted to reach the translating device, and wherein the receiver comprises a prism interposed in the path of the light to the translating device, a diaphragm being positioned between said prism and said translating device to select from the spectroscopically obtained series of colors given by the prism that light corresponding to the monochromatic or approximately monochromatic light emitted from the co-operating transmitter, and wherein the diaphragm interposed between the prism and the translating device is adjustable.

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