

July 23, 1946.

H. B. DEAL

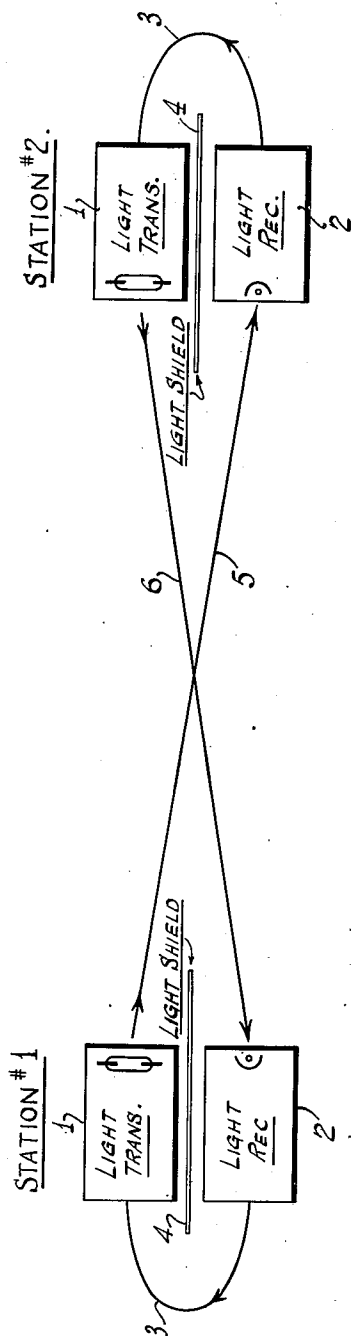
2,404,696

COMMUNICATION AND RECOGNITION SYSTEM

Filed Oct. 12, 1942

2 Sheets-Sheet 1

Fig. 1.



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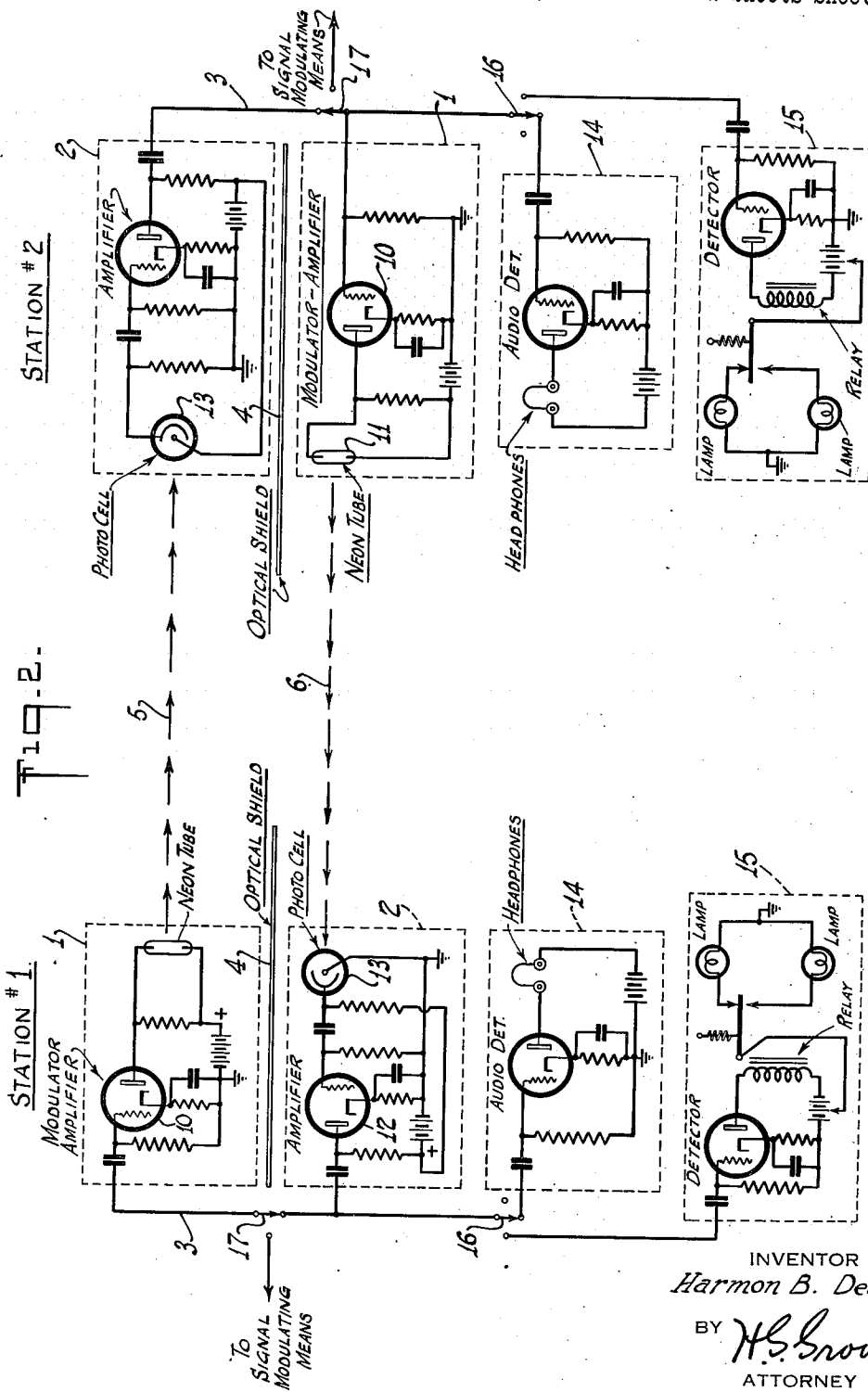
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2 Sheets-Sheet 2



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COMMUNICATION AND RECOGNITION
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6 Claims. (Cl. 250—7)

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This invention relates to a recognition or identifying system for use between two or more movable vehicles or between a vehicle and a land station.

The invention is particularly applicable for military purposes where it is necessary for friendly aircraft and ships to identify one another during maneuvers. Intercommunication between ships or planes in a single squadron becomes involved because of the need of secrecy and the requirement that there be no interference from and with other units of friendly and hostile craft.

Radio communication has the disadvantage of producing interference and violating the secrecy requirement. Further, certain radio systems require highly directive equipment which are rarely so good that the transmitter and receiver can be shielded from each other, as a result of which "singing" or undesirable feed back occurs between the transmitter and receiver of the same craft. Although singing can be avoided in such radio systems by employing different frequencies for both the transmitter and receiver of the same station, such an arrangement requires that different stations have different frequencies, and recognition can then only be attained when the frequencies are complementary.

The present invention overcomes the foregoing difficulties by providing a recognition and intercommunication system employing light waves in a regenerative feed back circuit. These light waves can be visible or invisible and can be used many miles within the optical range. Essentially, the system of the invention is a "singing" or regenerative chain for use between two stations, wherein the regenerative circuit is completed by virtue of the radiation of light waves between the light transmitter of each station and the light receiver of the other station. It is important in the practice of the invention that the light transmitter of each station be optically shielded from the light receiver apparatus of the same station.

A better understanding of the invention may be had by referring to the following detailed description in conjunction with the drawings, wherein:

Fig. 1 illustrates diagrammatically, in box form, a system embodying the principles of the present invention; and

Fig. 2 illustrates in more detail the apparatus of a preferred circuit embodiment.

Referring to Fig. 1, there are shown two stations, #1 and #2, representative of movable vehicles capable of transporting the apparatus of

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the invention. These vehicles, by way of example, may be airplanes, tanks, trucks, ships, animals or persons. At each station, there is provided a light transmitter 1, for sending out light waves either of the visible or invisible type, and a light receiver 2 for receiving the light waves transmitted from another station. The light transmitter 1 is optically shielded from light receiver 2 by any suitable opaque shield 4, as a result of which the light transmitted by apparatus 1 of either station cannot be received by the receiver 2 of the same station. The light transmitter at each station is shown equipped with a light emitting tube, while the light receiver at each station is shown equipped with a light sensitive cell. The output of the light receiver is coupled to the input of the light transmitter of the same station over a path indicated by 3. It is preferred that both the light transmitter and the light receiver each be equipped with suitable vacuum tube amplifying apparatus. The system is so arranged that the light waves radiated by transmitter 1 of station #1 over a path 5 is received by light receiver 2 of station #2, amplified therein, and passed on to light transmitter 1 of station #2 in order to increase the illumination of the light emitted from the transmitter of station #2, after which the light therefrom is sent out over path 6 to be received by light receiver 2 of station #1. It will be seen that this system provides a regenerative circuit involving the transmitter of one station and the receiver of the other station. When a regenerative circuit of the type described above is established, the system will break into oscillation at a period determined by the constants of the condenser, inductor and resistor elements associated with the amplifiers of the transmitter and receiving apparatus. Such oscillations may be made sub-audible, audible, or super-audible, as desired, and may be detected in suitable fashion at the receiver, in a manner described more in detail hereinafter in connection with Fig. 2.

Referring to Fig. 2 in more detail, the apparatus at each station is shown as comprising a light transmitter 1 having a modulator amplifier tube 10 and associated with the output of the modulator amplifier tube a light emitting tube 11, here shown by way of example as a neon tube. At each station, there is also provided a light receiver 2 having a vacuum tube amplifier 12 whose input is associated with a light sensitive photo-cell 13 and whose output is coupled back to the input of the transmitter 1 of the same station by means of a feed back path 3.

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It should be noted that the amplifiers of the transmitters and receivers have condensers and resistors associated therewith. By virtue of the condenser coupling between the different stages, the amplifiers will not amplify direct currents, but only variable currents. The space radiation path between the transmitter 1 of station #1 and the receiver 2 of station #2 is indicated by the dash lines 5. Similarly, the light radiation path from the transmitter 1 of station #2 and the receiver 2 of station #1 is indicated by the dash lines 6. The arrows on the dash lines indicate the direction of travel of the light waves. An optical shield 4 at each station serves to prevent coupling between the output of the transmitter and the input of the receiver at the same station. Associated with each station, there may be provided, if desired, an audio detector system indicated by the apparatus in box 14, and a visual system indicated by the apparatus in box 15. A suitable switch 16 at each station can couple the output of the receiver 2 either to the audible indicating apparatus 14 or the visual indicating apparatus 15. It should be understood that the audible apparatus 14 would only be provided in the event that the period of oscillation around the regenerative circuit of both stations is of an audio frequency. A switch 17 is also provided in the feed back path 3 between the output of the receiver 2 and the input of its associated transmitter 1 in order to utilize some of the apparatus at each station in a two-way intercommunication system. This can be done by throwing the switch 17 at one station to the contact associated with the signal modulating means, in which event, of course, the regenerative circuit will be interrupted.

The operation of the system of Fig. 2 will now be described. The light emitting tubes 11 at both stations are adjusted so that some light is emitted therefrom by adjustment of the associated batteries and resistors. Assuming that the photo-cell 13 of one station picks up some of the light emitted from the neon tube 11 of the other station, there will be a change in the photo-cell voltage at the receiver, which voltage will be amplified and operate to increase the illumination from the light emitting tube 11 directly associated with the receiver collecting the light radiated from the other station. This increase in illumination at one station will increase the response of the receiving amplifier at the other station to further increase the illumination of the light emitting tube at the other station, which further increase will cause an increase in the light emitted from both stations until saturation is reached and no further increase of illumination and/or response is possible. This condition of steadily maintained saturation is unstable because the amplifiers at both stations are incapable of passing direct current, which is the condition represented by the steady light maximum value, at which time the light of both photo-cells will start to fall off, upon reaching the saturation condition mentioned above. The decrease in illumination is transmitted to the complementary photo-cell which operates to diminish the light radiated from its associated light emitting tube which further decreases the response of the complementary photo-cell until relative darkness of one or both light emitting tubes results. When this condition is reached, the regenerative path between both stations is broken and both lights try to resume their original half-lighted condition, but this increase in

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illumination results in the earlier mentioned effect to continue to increase the illumination until saturation is again reached and so the entire system "sings" or "oscillates." The period of oscillation of the system is controlled by the magnitude of the condensers and their associated resistors in the amplifier circuits.

In the event that the magnitudes of the condensers, inductors and resistors are so chosen that the period of oscillation is an audible frequency, let us say, 500 cycle tone, then the regenerative feed back system may be detected by means of the audio detection system 14 where it is heard in the headphones. If a visual indication is desired, the switch 16 can be thrown to couple the output of the receiver 2 to the apparatus 15, in which case the detector in visual apparatus 15 will function to operate the relay in its output circuit and light one of the lamps representative of the operative condition. This lamp may have a characteristic color, such as amber, to indicate that the regenerative path is closed, whereas if the path is open the relay in apparatus 15 will be in an unoperated condition and the other lamp will be lit. This last lamp will, of course, have a different color from the amber lamp. Obviously, if desired, means may be provided for the attendant to observe the modulations of his own light emitting tube 11, in which case there may be no need for the apparatus 14 and/or 15.

If the switch 17 is thrown to a position where the transmitter 1 of any one station is connected to the signal modulating means, which may be a microphone or a telegraph key, such modulating means may be used to modulate the light source and the same equipment may be used for voice or telegraphic intercommunication by a suitable selection of the switches at both stations.

It should be understood that in the case of the light beam system described above, the system will not oscillate at any rate higher than that at which the light source can be modulated. This rate of oscillation is limited by the deionization time, if a neon light modulator is used, or the highest response rate if a light source and light gate arrangement is used for modulation.

The system of the present invention is very effective and may be used between vehicles or between a moving vehicle and the land station for a distance of several miles. In this way the pilot of a plane can determine within a short time before an approaching craft comes within firing range whether the approaching craft is a friend or a foe. If the regenerative system operates, the pilot will know that the approaching craft is a friend equipped with identical apparatus, whereas if the system does not operate, the pilot may be assured that the approaching craft is an enemy. It should be evident, of course, that the light emitting tube and the light receiving cell of each station should be directive in character and suitably arranged to point at the station which the pilot desired to identify or communicate with.

It is further possible to build secrecy into the equipment so that enemy craft equipped with similar recognition apparatus would fail to give proper recognition response. Such secrecy would be afforded by inserting in the regenerative chain (for example between the receiver and transmitter of the same station) a band pass filter, so that stations not so equipped would fail to complete the singing chain or would complete it in an improper and hence revealing manner.

Such secrecy apparatus could be readily changed so that the proper recognition would be one thing at one time and another sort of thing at some later time.

What is claimed is:

1. An identification system for use between a pair of vehicles, each of said vehicles having a transmitter for directly sending out light waves and a receiver arranged to receive and amplify light waves, a circuit at each vehicle coupling the output of the receiver to the input of the transmitter, means optically shielding the transmitter and receiver of each vehicle from each other, whereby the apparatus at said pair of vehicles within a distance in the optical range from each other constitute a regenerative circuit by virtue of the space radiation between the light transmitter of each vehicle and the light receiver of the other vehicle.

2. A communication system for use between a pair of vehicles, each of said vehicles having a transmitter for directly sending out light waves and a receiver arranged to receive and amplify light waves, a circuit at each vehicle coupling the output of the receiver to the input of the transmitter, means optically shielding the transmitter and receiver of each vehicle from each other, whereby the apparatus at said pair of vehicles within a distance in the optical range from each other constitute a regenerative circuit by virtue of the space radiation between the light transmitter of each vehicle and the light receiver of the other vehicle, a light modulating circuit at each vehicle, and switching means at each vehicle for breaking the circuit between the transmitter and receiver and for connecting the light modulating circuit to the input of the transmitter.

3. An identification system for use between a pair of stations, each of said stations having a transmitter for directly sending out light waves, said transmitter including a vacuum tube amplifier and a light emitting tube, and a receiver arranged to receive and amplify light waves, said receiver including a photo-cell and a vacuum tube amplifier, a circuit at each station coupling the output of the receiver to the input of the transmitter, means optically shielding the transmitter and receiver of each vehicle from each other, whereby the apparatus at said pair of sta-

tions within a predetermined distance from each other in the optical range constitute a regenerative circuit by virtue of the light radiated by the light emitting tube of each station and received by the photo-cell of the other station.

4. An identification system for use between a pair of stations, each of said stations having a transmitter for directly sending out light waves, said transmitter including a variable current vacuum tube amplifier and a light emitting tube, and a receiver arranged to receive and amplify light waves, said receiver including a photo-cell and a vacuum tube amplifier, a circuit at each station coupling the output of the receiver to the input of the transmitter, means optically shielding the transmitter and receiver of each station from each other, whereby the apparatus at said pair of stations within a predetermined distance from each other in the optical range constitute a regenerative circuit by virtue of the light radiated by the light emitting tube of each station and received by the photo-cell of the other station, the constants of the circuit elements of the transmitters and receivers determining the period of oscillation of the system.

5. An identification system for use between a pair of stations at least one of which is a vehicle, each of said stations having a transmitter for directly sending out light waves, there being a variable current amplifier having condenser and resistor elements and also a light emitting tube at each transmitter, a light receiver at each station including a photo-cell and a variable current amplifier also having condenser and resistor elements, a circuit at each station coupling the output of the receiver to the input of the transmitter, an audio detector at each station coupled to the output of the receiver, whereby the apparatus at said pair of stations within a distance in the optical range from each other constitute a regenerative circuit by virtue of the space radiation between the light transmitter of each station and the light receiver of the other station, the magnitudes of the condenser and resistor elements at said stations being such that the period of oscillation of the system is audible.

6. A system in accordance with claim 3, characterized in this that said light emitting tube is a neon tube.

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