TRANSMISSION OF SOUND BY A LIGHT BEAM

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In the May 1942 issue of the amateur radio magazine QST was an article by Stevens and Stevens on the transmission of sound by means of a modulated light beam. The light beam source was a flashlight or pilot light bulb modulated by a low power audio amplifier; the receiver, an audio amplifier with a photo-electric cell in-put.

This diagram shows suggested circuits for the transmitter and receiver. When a sound wave strikes the microphone, a minute electric current is set up in the microphone circuit. This current alters the potential on the grid of the 6J7 tube. The change in potential causes a change in the number of electrons reaching the plate from the filament. This results in a corresponding change in plate current which is of the same pattern as the current in the grid circuit but of much greater amplitude. The final amplifier tube further amplifies the signal in the same way. The current in the plate circuit of the 6L6G tube must pass through the primary of the out-put transformer. When it does so, it causes a varying magnetic field to be built up around that coil. As this magnetic field moves out from the primary and then collapses, it is cut by the secondary and induces an electro-motive force in that winding. This e.m.f. is added to or subtracted from the battery voltage which is lighting the filament of the flashlight bulb. Thus the voltage across the flashlight bulb varies in the same pattern as the sound waves which strike the microphone. Somehow this modulates the light. The light from the bulb is focused by means of suitable lenses on the photoelectric cell of the receiver. The cesium cathode of the photo tube sets free electrons when light shines on it. The greater the intensity of the light, the greater the number of electrons set free. The shorter the wave length of the light, the greater is the energy of the electrons which are set free. The electrons are drawn to the positively charged anode so that when light shines on the cathode a current flows in the photoelectric cell circuit. The magnitude of the current varies with the intensity of the light, and also with the frequency of the light. The light from the transmitter, varying as it does in the same pattern as the sound waves which originally fell upon the microphone, causes corresponding changes in the photo cell current which in turn changes the potential on the grid of the first amplifier tube. The signal is amplified just as it was in the transmitting amplifier and finally is reproduced by the speaker as sound.

Insofar as I have been able to determine, no one has yet proved just what takes place in the flashlight bulb when its light is modulated. The intensity of the light given off by an incandescent filament depends upon the temperature of the filament. In order that the light beam be modulated at a frequency of 5000 cycles per second, for example, and it can be modulated at that frequency, it would apparently be necessary that the temperature of the filament vary, over a rather wide range, 5000 times in one second. To some experimenters it seems unlikely that this could take place.

One theory is that mechanical vibration of the filament caused the modulation in some way. If one taps the light source, a bell-like sound is heard in the receiver showing that mechanical vibration of the filament will in some way modulate the light. However, at the headquarters of the American Radio Relay League, the lamp was placed in a strong varying magnetic field which should have produced the same result. No sound was heard. It is the opinion of the headquarters staff there that some form of frequency modulation takes place, that the wave length of the light changes with variations in voltage.

My own opinion is that the temperature of the filament actually does change sufficiently to cause variation in the intensity of the light. I have found that if a low DC voltage is used to light the bulb modulation is very unsatisfactory even though the added signal voltage increases the average intensity of the light to full brilliance. However, if I put as high a voltage as the light can stand, then add a comparatively low signal voltage, the modulation is good. This seems to be in accordance with the law for radiation which states that the rate of radiation is proportional to the fourth power of the absolute temperature. If the DC filament voltage is such that the temperature of the light is high the rate of radiation is greatly increased, so that it may be possible for the filament to change its temperature sufficiently to modulate the bulb at high audio frequencies.

It may be that someone has determined just how the modulation takes place, but I have been unable to find a conclusive explanation. If I have the opportunity I plan to investigate further into the matter.