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Modulating a Laser Beam

THIS MONTH, LET'S TURN OUR ATTENTION TO A DIFFERENT TYPE OF LASER APPLICATION—USING A LASER TO TRANSMIT SOUND. WE WILL LOOK AT A COUPLE OF DIFFERENT APPROACHES TO DOING THAT. EITHER APPROACH COULD MAKE a great beginning for a winner of a "science-fair" project" or a starting point for further experiments.

Electronic Modulator

Our initial effort uses electronic modulation to send an audio signal over a laser beam. The technique we'll use provides a free-air transmission with a range of several hundred feet.

Of course, we need some way to decode the received beam and retrieve the signal. Take a look at the basic LM386 amplifier circuit shown in Fig. 1. To use that circuit as our laser "receiver," connect a silicon solar cell across the input and a small 8-ohm speaker or headset across the output. Now enclose the circuit in a project box, and your receiver is ready. If you need to increase the range add a collimator tube at the input. It will also help improve audio clarity.

Now, how are we going to modulate the laser in the first place? The answer is another LM386 circuit. This time, we'll connect a microphone or another audio source to the input of the circuit in Fig. 1. To modulate the laser, we'll use the scheme illustrated in Fig. 2. As that circuit shows, the amp's output is connected to the 8-ohm winding of a small audio transformer. The 2000-ohm winding is connected between the laser's anode and the high-voltage power supply as shown.

With that set-up, the power fed to the laser will vary with the audio output of the LM386 circuit. Place the receiver so that the laser illuminates its solar-cell input, and whatever audio signal is introduced to the electronic modulator will be picked up and decoded by the receiver. Note that any audio-amplifier circuit could be used for this application, but the LM386 circuit is simple, compact, and inexpensive—both units can be built for under five dollars.

Try using mirrors to deflect the beam around objects, or bend it around a corner. The laser beam can also be sent out to a reflector and back to the receiver. However you set it up, the system makes for an interesting demonstration.

Build the Photophone

Our second demonstration/experiment involves a mechanical modulation device often referred to as the Photophone. Invented by Alexander Graham Bell in 1880, he often expressed the opin-

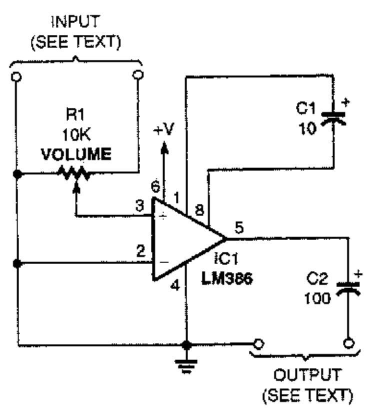

FIG. 1—THIS SIMPLE LM386 AMPLIFIER forms the basis for both a laser receiver and a laser modulator.

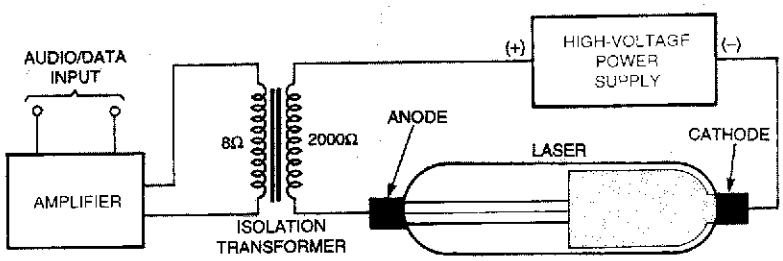

FIG. 2—USE THIS SCHEME when using the LM386 amplifier to modulate a laser.

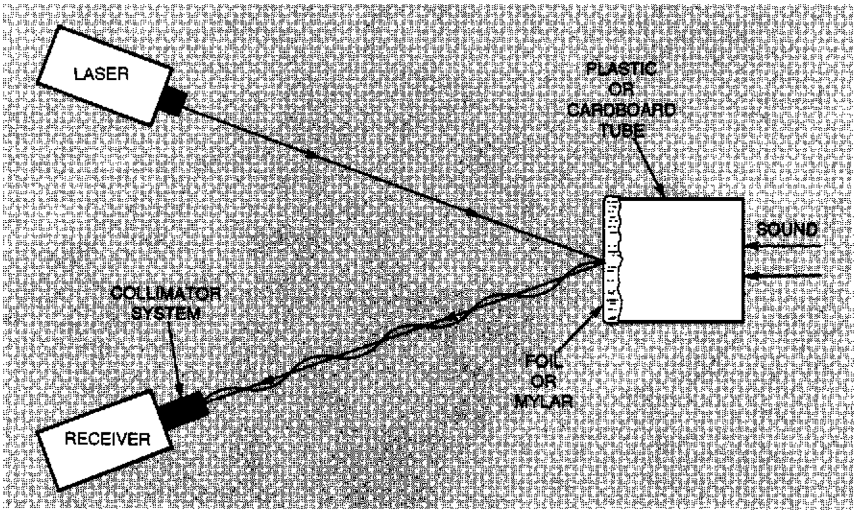

FIG. 3—BASED ON A PRINCIPLE developed by Alexander Graham Bell, this mechanical Photophone will modulate any beam of light, including a laser. The receiver is the same one used in our previous experiment.

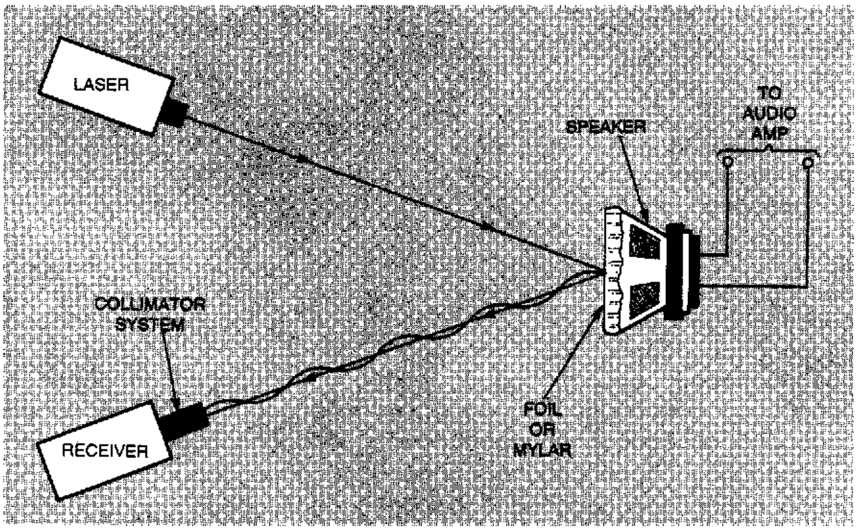

FIG. 4—SIMILAR TO THE MECHANICAL PHOTOPHONE, this electronic version replaces the tube with a speaker.

ion that the photophone was a more important invention than the telephone. Functioning on the same principle as the speaker modulator discussed in earlier installments of this column, the Photophone relies on the vibration of a metallic foil or Mylar diaphragm for the beam modulation.

Bell had two versions of the Photophone, electric and non-electric. Both will be replicated in this demonstration. In both cases, use the LM386 receiver circuit we looked at above. Incidentally, Bell's prototypes used the sun as a light source, but the laser is far superior in reliability, range, and clarity.

For the non-electric model, the transmitter consists of a cardboard or plastic tube with foil or Mylar stretched tightly over one end and secured with tape or contact cement; see Fig. 3. The tube must be fastened to a tripod or other, similar support, so it will remain steady during use.

The laser and receiver are then set up so that the beam bounces off the center of the foil or Mylar and onto the receiver's solar cell. When sound, such as speech, is introduced into the tube, the diaphragm will vibrate and modulate the beam. The modulated beam is decoded by the receiver as before. For best results, a collimator should be used with the receiver.

For the electric version, shown in Fig. 4, everything remains basically the same, except that the cardboard tube is replaced by a speaker/audio amplifier assembly. The foil or Mylar is tightly stretched over the front of the speaker and vibrates in sync with the speaker. Again, for best results, aim the laser at the center of the reflector and use a collimator with the receiver.

While innovative for its time, the Photophone is relatively simple in principle. Since its invention, numerous variations have been used, especially in the communications field. Can you think of any variations or experiments based on this principle? If you can, why not drop us a note and let us know. Write to Laser Editor, **Electronics Now**, 500 Bi-County Blvd., Farmingdale, NY, 17735 or via e-mail to lartronics@aol.com. We hope to hear from you soon! **EN**