SEMICONDUCTOR LASER APPLICATIONS TO MILITARY TRAINING DEVICES

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Systems using semiconductor gallium arsenide lasers have been developed in-house to train military personnel in M-16 rifle weapon firing against both pop-up targets and scaled model aerial targets.

The pop-up target system consists of two parts: (1) a miniature laser transmitter which clips on the barrel of an actual M-16 rifle, and (2) detectors and a receiver to score weapon hits. The system may be used to save ammunition costs, and to teach the correct sight picture, trigger squeeze, posture, and breathing techniques. The trainee also uses his own weapon so he becomes quite familiar with its feel. Because the laser system is eye-safe, no elaborate range safety precautions are necessary. Safe training can be accomplished in inhabited areas with these systems. Since the simulation unit can shoot in excess of one million shots on a small commercial battery, more training can be accomplished at a very low cost.

The gallium arsenide laser diode emits a 150 nanosecond flash of infrared energy and is eye-safe. The radiation is at a wavelength of 9050 Angstroms (near infrared) at 25°C. The laser output is four watts of peak power. The beam is collimated by a single, simple double convex lens, and the beam diameter at 300 meters is approximately 15 centimeters. However, the beam may be adjusted to a larger or smaller diameter. The laser which acts as a transmitter is powered by a small commercial 45-volt battery which is usable for in excess of one million shots. The unit can either emit a single flash, or shot, or simulate the weapon's firing rate for a 20 round magazine. When the weapon is fired the infrared laser pulses are detected by a large area silicon photodiode. In the pop-up target configuration, detectors are fastened to a standard M-31A1 Army pop-up target, which is a silhouette of a man. No changes are necessary to the pop-up mechanism to adapt it for use with this laser weapon fire simulator. The receivers have a field effect transistor, FET, front end and have a minimum of low cost components. The system has a range in excess of 500 meters in sunlight. In addition, this system can provide a record of score. The pop-up target system and laser transmitter attached to an M-16 rifle are shown in figure 1.

The aerial engagement trainer system is used to train military personnel to engage aerial targets. The trainer is used to teach squad members to detect and identify hostile aircraft, estimate the range, speed and direction of the target, proper alignment of the sight to obtain the correct lead, and to continuously track and engage the target. The scores for an entire squad firing at the target can be electronically totaled. The target is a 1/12 scaled model aircraft that is equipped with several silicon photodetectors. Lead angle is incorporated in the laser transmitter system by a mechanical swivel, which offsets the gallium arsenide laser transmitter at the lead angle which corresponds to the speed of the scaled model. The transmitter fires at the cyclic firing rate of the M-16 weapon and simulates the number of rounds in the weapons magazine. In the aerial engagement model, the

laser transmitter beam is shaped with an aperture or stop to a rectangular geometry. The rectangular beam enables the use of fewer photodiode detectors on the target. An electronic counter is used to score the number of hits on the target. A special feature to allow the student to get the proper sight picture for the various lead angles has also been incorporated. A Xenon flasher is located in the model's cockpit; when the student has the correct lead, the flasher is activated. This enables the student to see the correct sight picture for the various aircraft speeds prior to firing at the scaled moving target. The aerial engagement system is shown in figure 2.

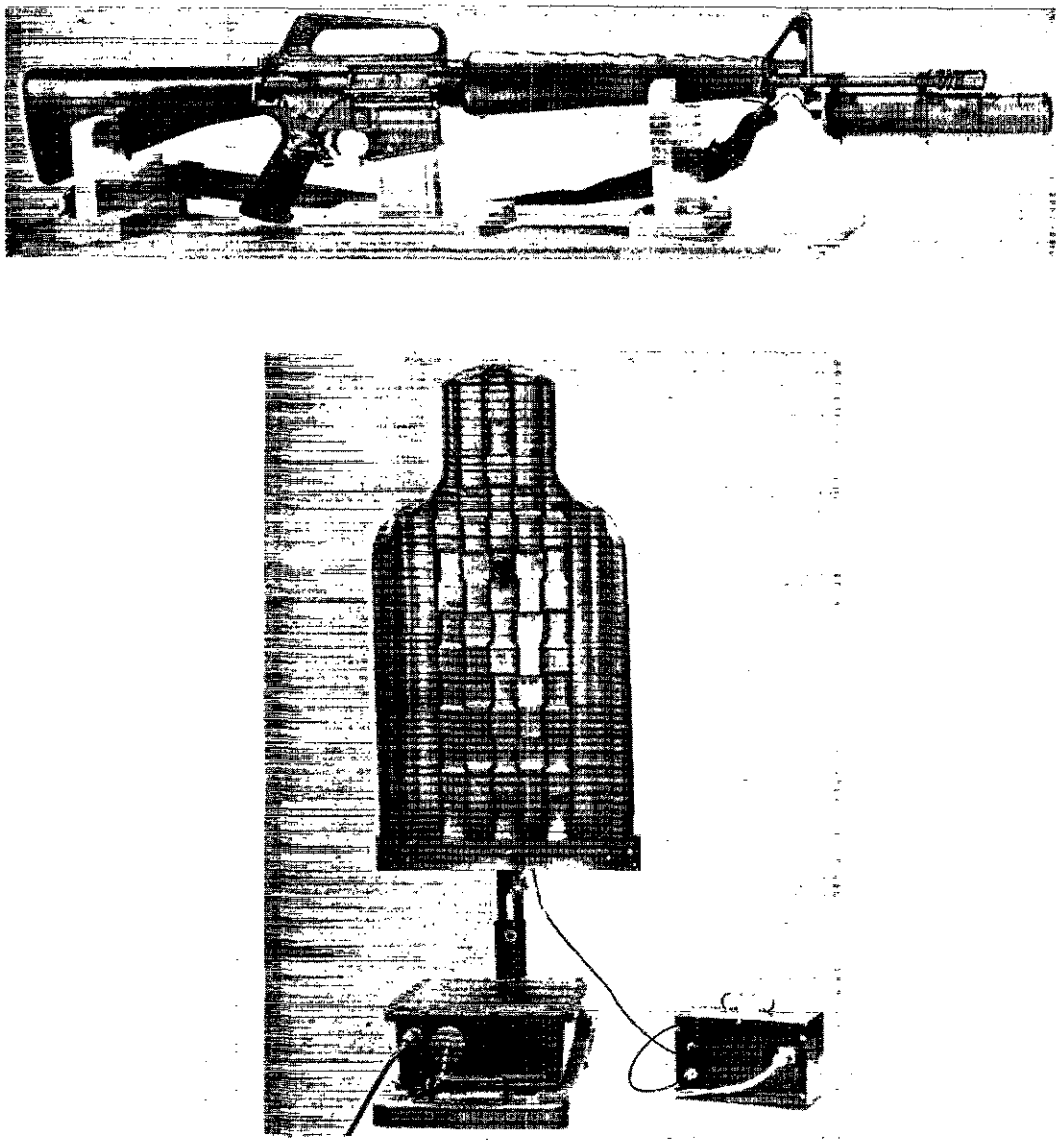

Figure 1. M-16 Rifle Laser Weapon Fire Simulator System

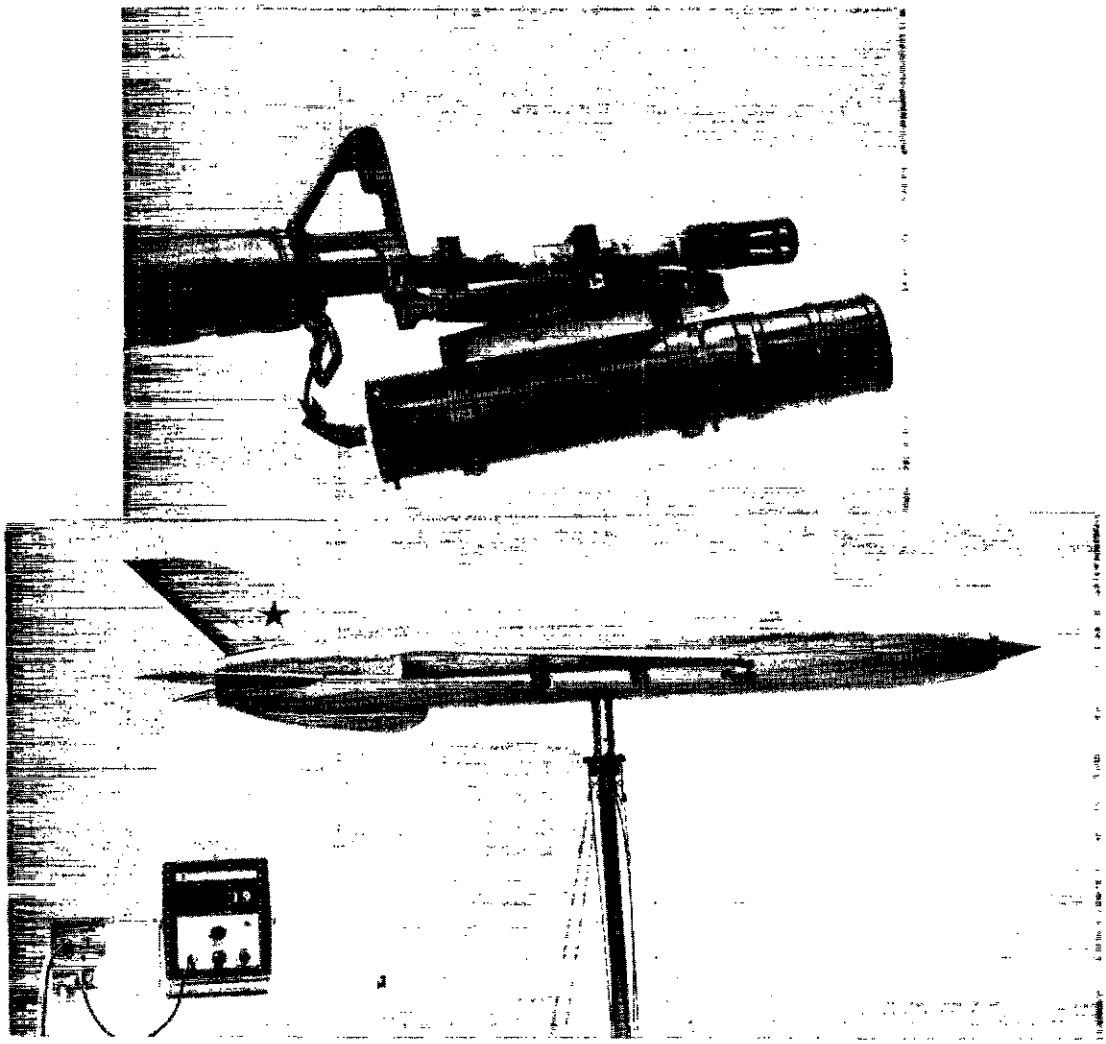

Figure 2. Aerial Engagement System

A study was performed at the U.S. Army basic training center at Fort Jackson, South Carolina, with the pop-up target system, to determine the effectiveness of a marksmanship training program of instruction using the laser weapon fire simulator as opposed to the present program of instruction utilizing live ammunition. The objective was to determine which combination of live ammunition and laser training will give the best training results. To determine the best results, scores on the live ammunition record fire range of each group were compared. Figure 3 shows the results. Notice in all cases recruits trained with the laser did as well, or better than soldiers trained exclusively with live ammunition, which costs six cents a round. It has been estimated that six million dollars in ammunition costs alone will be saved each year using this training device.

A moving target system using a semiconductor laser is now under development. In this system both the laser transmitter and a receiver are attached to an actual M-16 rifle. A corner mirror or retro-reflector is attached to the moving man target. When the rifle is fired, an eye-safe laser pulse of near infrared energy is transmitted.

If the trainee's sight is on the target, the retroreflector will return most of the energy directly back to vicinity of the transmitter and receiver, even if the retroreflector is not directly on axis to the transmitter. The received pulse is amplified and actuates a tone indicating a hit. The batteries and a small speaker are in the rifle's magazine. The retroreflector is placed in front of the man or dummy so that it will be necessary to lead the man to get a hit. If the dummy moves at varying speeds, apertures are used to shutter or unshutter the appropriate retroreflector. The trainee gets instant scoring without complicated radio links to relay back the firing results. In this system the retroreflector requires no target maintenance; it only needs to be kept reasonably clean. At closer ranges high gain materials can replace the retroreflector. This system allows programming for the dummy to move at various speeds. The system is safe and requires less range personnel to operate than a standard rifle range, and saves the cost of ammunition.

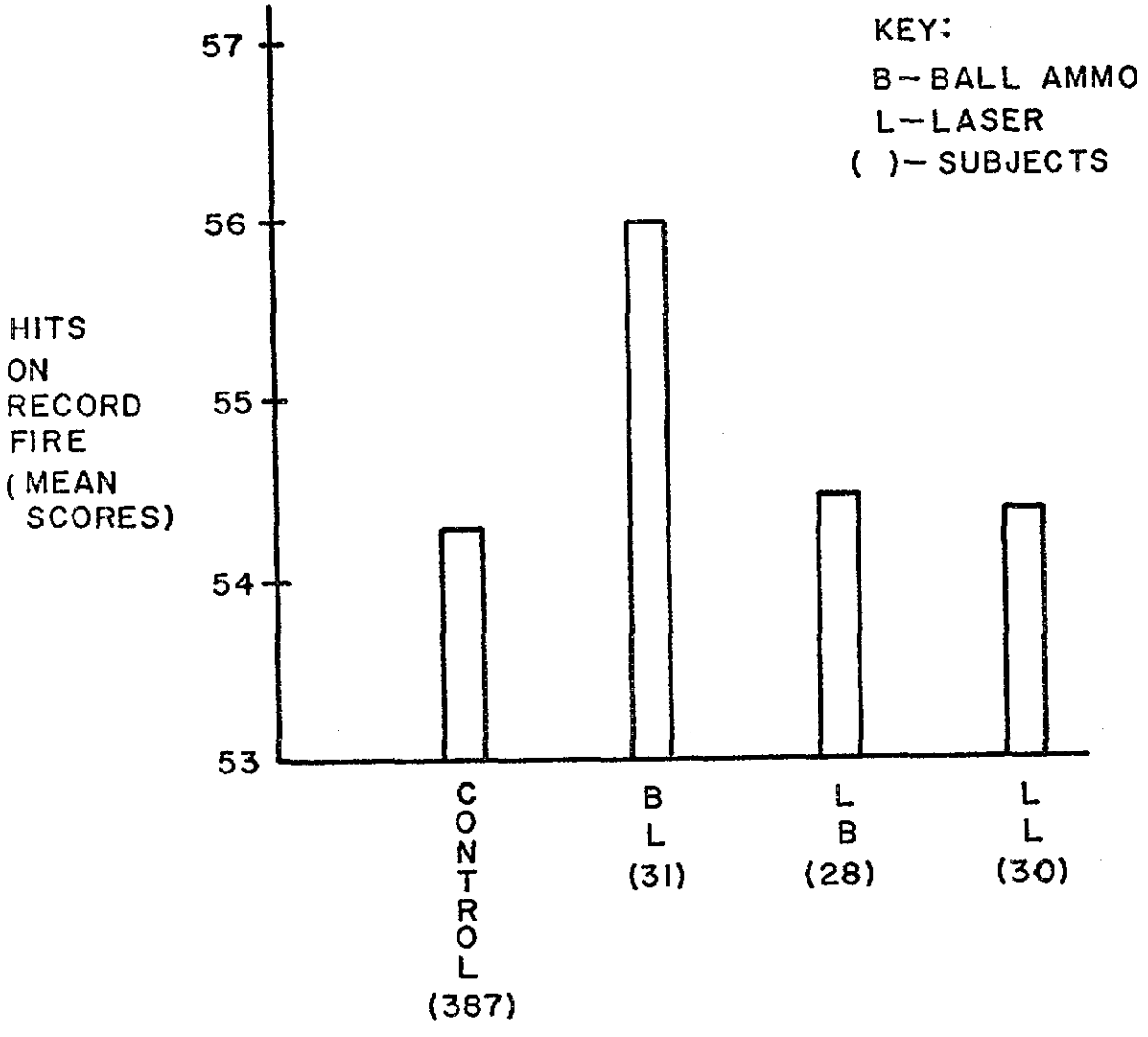

Figure 3. Results of Laser Rifle Transfer of Training Tests at Ft. Jackson, S.C.