

SCIENTIFIC RESEARCH IN LASERS AND THEIR MILITARY APPLICATIONS

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In this age of rapid technological achievement, most people have heard of lasers, but most keep a respectful distance, acknowledging humbly that such a topic is the inalienable domain of the scientist. Few know what lasers actually are.

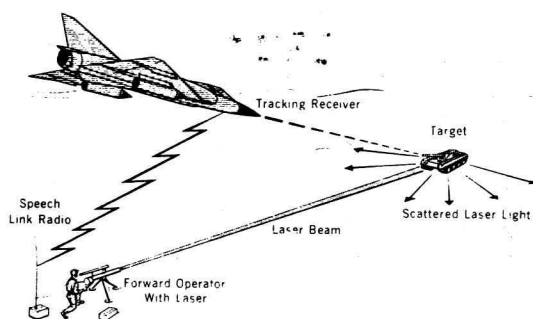
For many the laser is immediately identified with the death ray of classical science fiction. But lasers have found application in a host of humane and imaginative ways. These include the 'welding' of a detached eye retina (saving such patients from total blindness), the treatment of cancer, satellite communications, television and numerous industrial applications, as well as the exciting new photographic development known as holography by which three-dimensional photographs are produced.

The physical principle of the laser (the word is an acronym for Light Amplification by Stimulated Emission of Radiation) was discovered in 1960. Charles H. Townes and Arthur L. Schawlow, two brothers-in-law, played a major role in the discovery, but it was a certain Theodore H. Malman at the famous Hughes Aircraft Company in California who first obtained laser action.

Lasers are basically nothing more than special sources of light. Ordinary light is composed of many colours or wavelengths whereas laser light is monochromatic, that is to say it consists of a simple colour or wavelength. All light waves in a laser beam are coherent: they are exactly 'in step' while those of ordinary light are a 'random jumble'. These two properties give laser beams their unique characteristics: they can be aimed and focussed with incredible sharpness, and they can be pulsed in bursts of less than one millionth of a second in duration. Consequently laser beams can be focussed on a point without any damage to surrounding areas. Lasers are composed of glass or gas (notably carbon dioxide) or chemicals like hydrogen fluoride, enabling them to provide enormous quantities of energy.

Before discussing a few of the more interesting military applications of lasers, it would be useful to discuss briefly two of the drawbacks in their use.

Like other forms of light, laser beams are greatly and adversely affected by fog, rain, dust, vegetation and other battlefield obstacles. Consequently laser beams are of limited value as large-scale surface weapons, and are being developed rather for use from aerial platforms. The development of lasers to operate not only in the visible range of the electromagnetic spectrum but also in the highly penetrating ultraviolet — and gamma — ray wavelengths should reduce this problem. The health hazard attendant on the use of laser beams remains a major stumbling block in the way of large-scale laser progress. The Americans have major programmes under way to determine the biological effects of laser radiation, especially on the eyes and skin tissue and on tissue repair and growth rates.



Target marking using a pulsed laser.

One of the first applications of the laser technique by military forces was in the development of the laser rangefinder. This system consists of a pulsed laser device, an accurate timing mechanism, a receiver or collecting point for the reflected light and an electronic device for converting the elapsed time into a distance measurement. Rangefinders have been developed for accurate air-to-ground and air-to-air as well as for space ranging measurements. They have also been developed in various sizes and

for a variety of appliances. The Americans have developed a low-cost mine rangefinder used with their grenade launchers. Laser rangefinders are also installed in or on most tanks today in order to improve their capabilities, (as in the Chieftain tank for example). They can also be of great assistance to ground troops. The hand-held laser rangefinding system used by the latter is able to determine the range of a target in less than a second and weighs only about two kilograms.

The distances measured by the rangefinders are generally displayed in digital form. In most cases the electronic output of the range data is fed into a ballistic computer, which can take the various factors, the elevation and speed into account so that the required information can be quickly and accurately obtained, guaranteeing a 'bullseye'.

Lasers can also be used to guide bombs unleashed by aircraft on to their targets. The Americans have put this to very successful use in Vietnam both with self-propelled and free-fall bombs. These modified bombs have optical laser-seekers or sensors installed in the nose, and movable guide vanes in the rear.

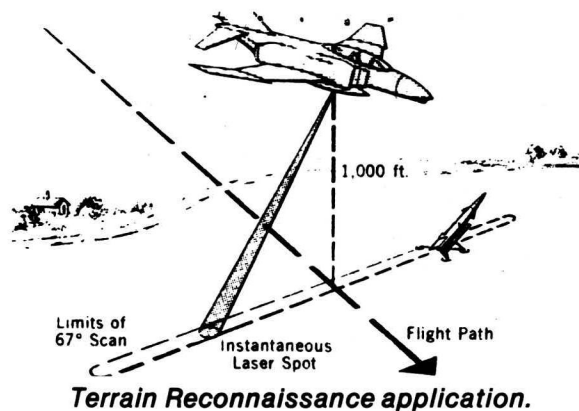
The method used to project and guide these air-launched laser-guided weapons is quite ingenious. In a battle operation the so-called designator 'shines' a laser beam on the target (eg a tank). This designator can be either installed in an aircraft or used on the ground. An aircraft drops the seeker-guided bomb or launches the laser-guided missile. The seeker of the bomb senses the unique laser beam directed from the designator and reflected off the target so that it can guide the missile or bomb to a sure hit. A problem encountered is that the laser designator, whether in a plane or on the ground, must continuously keep the target illuminated while at the same time evading hostile fire.

An improvement has been made by the USAF with the development of a pod-mounted laser designator, known as the Pave Spike system. This pod was designed for their Phantom aircraft, but has also been used in experimental trials by the British on

a Land Rover and armoured car.

One example of the application of lasers for missiles is seen in the air-to-ground Bulldog missile of the US Navy. Here a missile has been installed with a laser seeker head to hit moving ground objects designated by illumination with a laser beam. Operational evaluation has shown the weapon to be extremely accurate and very useful as a close support item for ground troops.

A technological breakthrough in laser weapons has been achieved in the US with the development of the Cannon-Launched Guided projectile. This weapon is basically a 155 mm projectile which can be launched from a standard artillery howitzer. This ingenious weapon could herald a revolution in the concept of field artillery employment.



Technically these 'smart' projectiles and the 'smart' bombs can be viewed as members of the same family. Both have on-board guidance, and both are assisted by external aids (laser beams) to guide them onto the target.

The method of operation of these projectiles is very simple and is basically the same as for the bombs. The laser designator, either on the ground or airborne, is trained on the target. The projectile, which has been fired from the howitzer, picks up the laser spot which guides it onto the target.

Lasers have immense potential for the gathering of intelligence for tactical operations. Laser beams could be used in very much the same way as present electronic equipment is used, though with greater accuracy and reliability. One can envisage high flying aircraft, such as remotely piloted vehicles,

scanning the area of enemy activity with laser beams, and transmitting vivid pictures to the ground control for immediate use by the battlefield command, without any valuable time wasted between the collection and dissemination of intelligence.

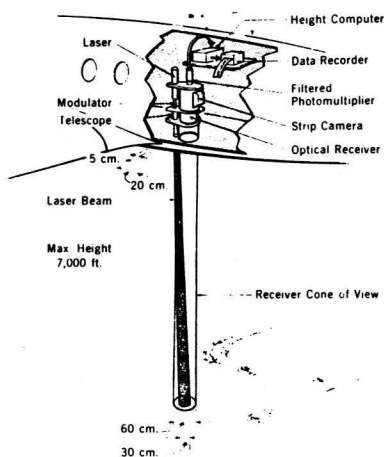
Lasers show promise as a means of simulating the effects of nuclear weapons on a laboratory scale. Such simulators can be used to test the vulnerability of military equipment to nuclear weapons and to provide researchers with an opportunity to investigate more fully the complex physics of a nuclear explosion. The laser could also be developed to help dispose of radio active waste from nuclear reactions thereby solving one of the great problems facing scientists, ecologists and the world population generally.

As a conclusion to these notes it would be apt to present a brief discussion on the so-called death-ray mentioned in the first paragraph. Recent press reports have quoted the well-known reference book, *Jane's Weapons Systems*, as indicating that there is competition between the USSR and the USA to develop and produce the first death-ray thereby achieving weapons superiority in the arms race. One of South Africa's leading scientists, however, considers it improbable that such competition does exist, and maintains that even if it did the parties involved would enforce such strict security measures that no definite information developments would be

available. Nevertheless, on quite a number of occasions already, the science fiction of the past has become the scientific fact of the present.

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Terrain profiling.