TECHNOLOGY

The advance of laser weapons

During the last decade, the power of continuous-operation lasers has risen from about 100 watts to several hundred kilowatts—enough to be used for cutting steel in heavy industry (SN: 6/14/75, p. 384). Inevitably, speculation has increased concerning their military applications (SN: 2/2/74, p. 74 and 3/29/75, p. 211). Probably the most thorough public discussion of that effort appears in a three-part series in Aviation Week and Space Technology (Aug. 18, Sept. 1 and Sept. 8), written by senior editor Philip J. Klass.

The first big breakthrough in developing high-powered lasers was the creation of the gas-dynamic laser (GDL), in which gases exit from a combustion chamber at supersonic speeds, "frozen" in excited energy states, in which they can lase. Klass says the most advanced prototype weapons system now in use is an air-borne GDL using carbon dioxide.

Because of its higher efficiency, a newer concept, the electric-discharge laser (EDL), is now gaining favor. In its most advanced form, this device uses an electron beam to ionize gas atoms which are then excited by an electric discharge. A 250 kilowatt carbon monoxide EDL has been successfully tested. Unfortunately, electricity requirements for EDL's run nearly 10 times the entire power capacity of a large bomber, so a variety of short-duration, high-capacity power packs are being explored.

To overcome the power and space requirements of GDL's and EDL's, while providing a shorter wavelength (better propagation through the atmosphere), many companies are betting on the eventual dominance of chemical lasers. Here extremely reactive gases (like hydrogen and fluorine) are suddenly combined, creating a highly excited product (HF) that can be lased with little additional equipment or power. The most powerful of these is a pulsed HF laser that delivers a 20-nanosecond pulse with an instantaneous power equivalent to 200 billion watts.

The problem is delivering enough energy to a target to cause structural damage. A 15-kilowatt laser with a beam 0.04 inches in diameter can deliver the equivalent of 1.9 megawatts per square centimeter—enough to burn through a half-inch of aluminum in about a third of a second. As power densities increase to 10 megawatts/cm^2, absorption increases and damage occurs much more quickly. At 100 megawatts/cm^2 an explosion of material takes place—shattering a plexiglass cockpit or creating deadly X-rays from vaporizing metal.

However, with the best possible conditions, at present less than a fifth of the radiated energy reaches a target two miles away, because of dissipation in the atmosphere. Thus even more powerful lasers will be needed before practical weapons systems can be introduced. Weapons scientists are also trying to produce shorter wavelength beams, since these transmit better through the atmosphere. Gas lasers derive their infrared energy from molecular vibrations; future short wavelength (visible) lasers may be created using electron excitation in the atoms of vaporized metals.

In outer space, no atmospheric dispersion occurs, and Klass says the Defense Department's Advanced Research Projects Agency is shifting its priorities toward small chemical lasers that could be used in satellites. The U.S.S.R. is known to have successfully tested "killer satellites," and the Defense Department is anxious to develop ways of protecting its spacecraft. (It might be recalled that two of the three men who received the Nobel Prize for inventing the laser are Russian.)

Klass quotes Defense Department officials as saying that by the end of this decade enough information will have been derived from the prototype and experimental programs now underway to make firm decisions on how to deploy laser weapons in the field. The work is also expected to produce considerable non-military benefits.