AD-A058 403 FOREIGN TECHNOLOGY DIV WRIGHT-PATTERSON AFB OHIO F/G 19/2
LASER SYSTEM-GUIDED BOMB,(U)
NOV 77 C P TS'AI
UNCLASSIFIED FTD-ID(RS)T-1785-77 NL

1 OF 1
AD
A058403

END
DATE
FILMED
10-78
DDC

1

FTD-ID(RS)T-1785-77

FOREIGN TECHNOLOGY DIVISION

LASER SYSTEM-GUIDED BOMB

by

Chen Pin Ts'ai

Approved for public release;
distribution unlimited.

EDITED TRANSLATION

FTD-ID(RS)T-1785-77 22 November 1977

MICROFICHE NR. FTD-77-C-001461

LASER SYSTEM-GUIDED BOMB

By: Chen Pin Ts'ai

English pages: 10

Source: Hang K'ung Chih Shih, Number 11-12, 1976, pages 52-54

Country of origin: China
Translated by: SCITRAN
F33657-76-D-0390
Requester: DRDMI-YDL
Approved for public release;
distribution unlimited.

PREPARED BY:

TRANSLATION DIVISION
FOREIGN TECHNOLOGY DIVISION
WP-AFB, OHIO.

LASER SYSTEM-GUIDED BOMB

Chen Pin Ts'ai

In 1960, the laser was first transformed from imagination into reality and soon was followed by a period of "laser heat" in foreign nations. A number of countries carried out extensive trials on the military applications of the laser; among these attempts, the progress on a laser guided bomb was relatively fast.

Coming down to it, a guided bomb is really no new gadget. Quite a few countries started the experimentation and development of guided bombs to improve the accuracy of aviation bombing as early as the mid-thirties and conducted preliminary tests in war operations. As a result of the low speed carrier planes available at the time, the guided bomb had short range and poor mobility. Furthermore, with rudimentary guiding systems, the carrier plane had to be within close range of the target. The result was a declining survival rate for the carrier planes. The U.S. Imperialists have suffered dearly in the battlefield of Korea and the guided bomb vanished from the scene after that.

In the 1960's, the United States again resorted to the guided bomb in her struggle for supremacy with the Soviet Revisionists and for gaining blackmail capital in the Vietnam invasion war. Since the technology was available for developing and producing second generation guided bombs, soon a host of guided bombs came into existence which are controlled by television, infrared, compass, laser, and so on.

Being one type of aviation weapon, guided bombs have their intrinsic characteristics in war operations. The laser guided bombs in particular had attracted attention.

Structural Characteristics and Operational Principles of Laser Guided Bombs

Laser light is coherent in both space and time, and is obtained from the amplification by stimulated radiation of incoming light. Like radio waves, the laser can be modulated, amplified and detected. The divergence angle of the laser is very small; for example, the divergence angle of a ruby laser of wavelength 0.7 micron can be as small as 10^{-4} radian. With this divergence, the laser beam can have a beam diameter of approximately one meter after a 10 kilometer propagation. Obviously, lasers can improve the accuracy of guidance substantially.

Today most laser guided bombs use semi-active guidance, that is, the target is illuminated by a beam of laser light and scatters the light energy. The scattered light is detected by the bomber plane which aims the bomb at the scattering source. The guidance head in the bomb then tracks the scattering center and guides the bomb toward the target, see Fig. 1.

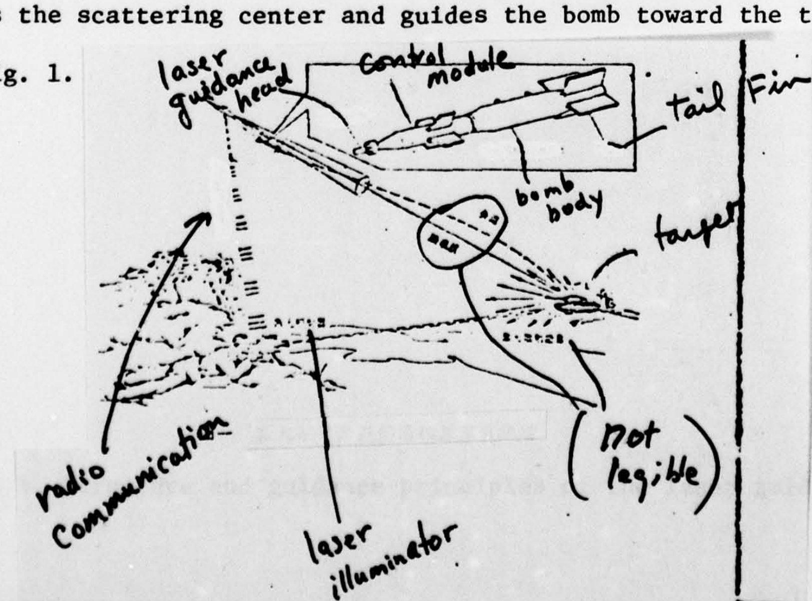
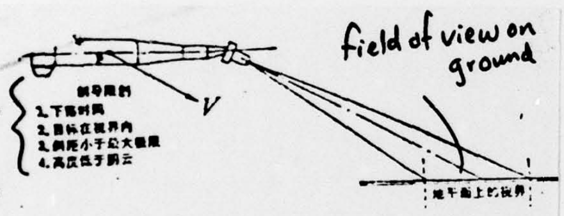


Fig. 1 Structure and guidance principles of the laser guided bomb

A laser guided bomb can be modified from the ordinary aviation bomb by installing a laser guidance head and control mechanism. Generally the "duck configuration" layout is used. Its main components are: the laser guidance head, control module, ordinary aviation bomb body and tail fin. (See Fig. 1)

The guidance head is a small cylinder, followed by a stabilization ring. A directional coupler type mechanism, located between the guidance head and control module, joins the head and the body. When not being used, the guidance head is in its locked position. After the bomb is dropped, the guidance head unlocks and the relative air current, acting on the stabilization ring, causes the guidance head to turn (see Fig. 2).



Limitations on guidance
1. Time of fall
2. target within field of view
3. Slope less than maximum value
4. altitude below clouds

Fig. 2 The guidance head turns in the guiding process

After it has rotated, the angle between the axes of the guidance head and the bomb body is approximately equal to the angle between the velocity vector and the body axis. There are two reasons for doing so: (1) to keep the guidance head aimed at the general direction of the target all the time and (2) to maintain an angle of attack for the body during the flight in order to increase its range.

The laser guidance head is actually a laser receiver (see Fig. 3). Its front end has a glass protection shield, which is transparent to the laser light, followed by a filter. The frequency bandwidth of the filter is made fairly narrow to filter out some noise signal and let through the laser light with wavelength between 0.6 micron and 1.06 micron. The bandwidth should not be so wide as to jeopardize the anti-interference ability, and it should not be too narrow as to cause loss of signal either. The focusing lens located behind the filter focuses the laser light onto the detector. The detector is a photosensitive element made from germanium or silicon . It is most sensitive to the laser wavelength emitted by solid lasers such as the neodymium doped glass laser or the neodymium doped yttrium aluminum garnet laser.

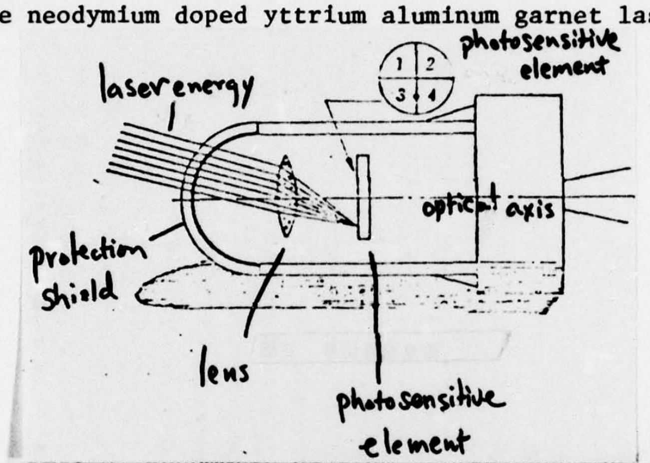


Fig. 3 Schematic diagram for guidance head

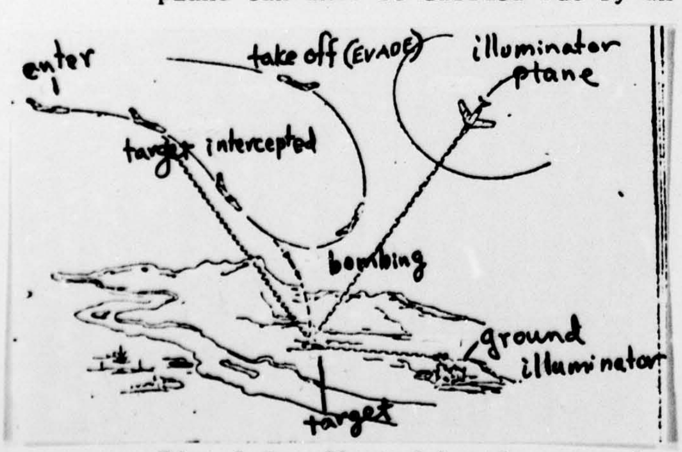
The control module contains a small computer and the helm. The helm planes rotate as follows: the two vertical ones turn to the left or to the right together. The horizontal ones turn similarly. The four large tail fins are for improvements of lift, range and mobility.

The bomb will follow a free-fall trajectory after it is dropped until the laser light intensity received by the guidance head is strong enough to serve as the control signal. At this point, the guidance system starts working and the bomb is in guided flight.

The illuminator (i.e. laser) is an essential part of the bomb guiding system. The illuminator can be airborn or on the ground. It can be either modular or portable, with a weight variation from the more than 600 kg for a heavy unit to less than 4 kg for a portable unit. Some are used only in the illumination of the target, others have distance measuring ability also. The features common to all types are high peak power, narrow pulse-width and small divergence angle.

Application Methods of Laser Guided Bombs

Among many application methods, the following two are more important: In the first method, one plane is used as the illuminator carrier responsible for searching and illuminating the target. After the search plane spots the target, it will direct the bomb carrying plane to the target area (Fig. 4) and keep circling while providing laser signal to the guidance head by continued illumination on the target. The illuminator plane will leave the action zone after the bomb has touched the ground and exploded and air photos have been taken. As soon as the bomber enters the action zone, it will search for the laser signal using the instruments on board. Once the signal is intercepted, aiming and bombing are carried out the usual way and the bomber can leave the action zone after the bomb is dropped. The mission of the illuminator plane can also be carried out by an unmanned plane or by ground personnel.



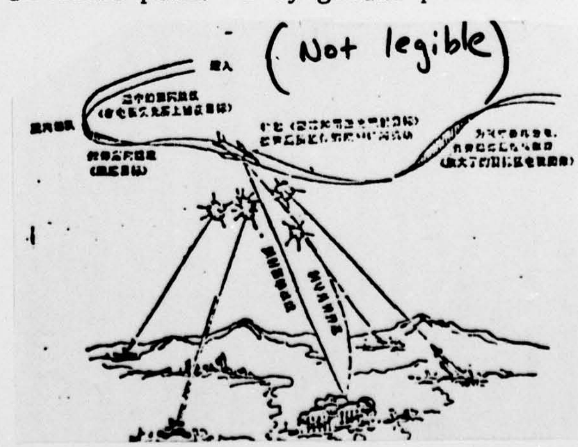


Fig. 4 Coordinated battle operation Fig. 5 Single-plane battle operation

The other method is to have the same plane conduct the illumination and bombing. The same plane will search and find the target, illuminate it with the laser and carry out the guided bombing. (See Fig. 5)

A Comparison of Laser Guided Bombs and Other Air-to-Surface Weapons

As of now, the laser guided bomb is in its application-development stage. Preliminary operations have indicated that it indeed has many merits, but some shortcomings as well.

Generally speaking, laser guided bombs are highly accurate and powerful, two merits not to be ignored. However, laser guidance can not operate under adverse weather conditions -- cloud, fog, rain and snow can all impede the laser propagation seriously. The ubiquitous smoke on the battle field, including the interfering smoke screen by the enemy, and suspension dust can also attenuate the laser intensity and thereby reduce the time of guided flight and accuracy of bombing. These shortcomings are intrinsic to laser. In addition, the illuminator carrier plane has to stay above the action zone for a relatively long period of time. The risk of attack by enemy fighter and anti-aircraft missile further jeopardizes the bombing accuracy. This problem will not be completely solved even if the single-plane-operation scheme is adopted. Consequently, it is best to secure the command of air at the action zone which usually is not easy. These are the limitations of the laser guided bomb.

Comparison of laser guided bomb and air-to-ground guided missile:

With an engine, the guided missile has greater range and mobility, but also reduced load of explosive and a higher cost. On the contrary, a guided bomb has more explosive, higher damaging power, lowest cost and, since it has no power device, a shorter range and low mobility.

Comparison of laser guided bomb and television guided bomb:

Laser guided bombs can operate day or night as long as the weather is clear. Television guided bombs are inoperative at night and require clear weather even during the day. The illuminator carrier plane in the laser guiding system has a low survival rate and, once destroyed, the guidance head will lose its target and cause the bomb to follow a free-fall trajectory. Remote control television guidance has similar disadvantages but in the automatic television guidance scheme, the plane can evade as soon as the bomb is dropped. Television guidance can be used in attacking places too obscure for laser illumination such as a railroad tunnel. As to the costs, laser guidance instruments cost a lot less than television guidance equipment.

Comparison of a laser guided bomb and an unguided bomb:

A laser guided bomb is an effective close-range point-target air assistance weapon; in this respect, the unguided bomb cannot compete. But laser guidance is certainly not a cure-all; for instance, large area bombing still needs unguided bombs. Although the cost of a laser guided bomb is three to four times that of a conventional bomb, with the accuracy taken into account, the overall point-target operation cost of the former turns out to be much less.

Interference and Anti-interference of Laser Guidance

When a new weapon imerges, its "mystery" is usually short-lived. People will soon figure it out and find methods to counter it. There are many ways to interfere the laser guidance system. We will briefly describe a few:

1. Incoherent interference

Incoherent interference methods are many. For example, smoke screen, camouflage, and flare interference belong to this category. Zirconium and fluorine arc lamps are common light sources for interference. Both sources can produce intense luminosity and brightness in the 0.4~1.5 micron region of visible and near infrared spectrum, which happens to be the working region of most optical systems. These sources can be used to provide a bright background to overshadow the target, or to form several bright spots as false targets. Such methods are sophisticated versions of smoke screen and camouflage.

2. Coherent interference.

This category includes direct interference, reflection interference and scattering interference.

a. Direct interference -- Continuous wave laser interferometer is usually used in this method. The interference beam is aimed at the laser guidance head to induce saturation so that it cannot recognize the target.

b. Reflection interference -- A laser with a wavelength and pulse repetition rate similar to the enemy's illumination laser is used. A false target is illuminated with this laser to divert an enemy guided bomb. In this interference scheme, a receiver is used to detect the wavelength and pulse rep rate of the enemy's laser.

c. Scattering interference -- Here the interference laser is aimed at the general direction of the guidance head. The atmosphere-scattered energy enters the guidance head to achieve the purpose of interference.

Current laser guided bombs have no anti-interference ability. The topic of anti-interference, however, has been placed on the agenda of research and development. Judging from today's technology, anti-interference by coded signal is a viable option. In this scheme, the illuminator laser emits a coded signal and the guidance head is programmed to receive this pre-coordinated code and filter out other laser signals. This method not only counters interference but also prevents redundance and skip in bombing.

To name a few topics for future investigation: interference and counter-interference problems in laser guidance need to be solved; the survival rate of illuminator carrier planes needs to be increased perhaps through improvements in illumination distance and sensitivity of guidance heads; the possibility of unmanned carrier planes should be investigated and continued research on atmosphere interation and target reflection characteristics. There is also the possibility of combining the guidance techniques of laser, radar, television, infrared and compass to remedy the intrinsic shortcomings of laser guidance and make it an all-weather system. This seems to be a route worthy of consideration.

Like other new technologies, the laser guided bomb which emerged in the late nineteen sixties, has shown some unique merits and some deficiencies as well. It will no doubt approach perfection with the progressing scientific technology and remedies will be found for its shortcomings.

RED AND WHITE, OR YELLOW AND GREEN?

Most airports use the two colors red and white for area and installation indication; for example, white is usually used to indicate the center line of the runway and fire engines are generally painted bright red.

But recently some research institutes in foreign nations proposed that the results may be better if yellow and green are used instead of red and white. They claim, for instance, that lime green seems to be a better candidate than white for marking runways. In the poor visibility of fog or rain, lime green is more eye-catching than white. Also, with traces of snow on the runway, this color stands out better than white.

As for the red of fire trucks, one can substitute it with lime or chalky yellow. Red is not very distinguishable at night or in bad weather while yellow is more eye-catching. When the human sensory preceptions are strongly stimulated, such as exposure to strong light or high noise, the visual perception toward red is weakened, but not for green or yellow. With the intense noise of landing and takeoff and the glaring lights at night, people's attention can easily be diffused at the airport. If the vehicles are painted lime yellow, they might be more attention-getting.

Whether these opinions are practical awaits the tests of experimentation. Some foreign airports are experimenting with color change of the runway centerline. It would be some time before we will know the effects.

DISTRIBUTION LIST

DISTRIBUTION DIRECT TO RECIPIENT

ORGANIZATION	MICROFICHE
A205 DMATC	1
A210 DMAAC	2
B344 DIA/RDS-3C	8
C043 USAMIIA	1
C509 BALLISTIC RES LABS	1
C510 AIR MOBILITY R&D LAB/FIO	1
C513 PICATINNY ARSENAL	1
C535 AVIATION SYS COMD	1
[redacted]	[redacted]
C591 FSTC	5
C619 MIA REDSTONE	1
D008 NISC	1
H300 USAICE (USAREUR)	1
P005 ERDA	1
P055 CIA/CRS/ADD/SD	1
NAVORDSTA (50L)	1
NASA/KSI	1
AFIT/LD	1

ORGANIZATION	MICROFICHE
E053 AF/INAKA	1
E017 AF/ RDXTR-W	1
E404 AEDC	1
E408 AFWL	1
E410 ADTC	1
E413 ESD	2
FTD	
CCN	1
ETID	3
NIA/PHS	1
NICD	5