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ANTIBALLISTIC MISSILE WEAPONS (II)

By

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ANTIBALLISTIC MISSILE WEAPONS (II)

Beijing FANDAODAN WUQI [ANTIBALLISTIC MISSILE WEAPONS] in Chinese Aug 81 unnumbered introduction, table of contents, pp 76-100

[Introduction, table of contents and chapters 9, 10 of book "Antiballistic Missile Weapons" by Liu Shaoqui [0491 4801 3808] and Li Xianlin [2621 7341 7207] published by National Defense Industries Press, 100 pages. Chapters 2-8 of this book published in JPRS 81679, 1 September 1982, No 333 of this series]

[Text] Introduction

It is an objective law of development that every form of attack has its corresponding defense.

The appearance of every new advanced weapon inevitably results in the development of a weapon to defend against it. Antiballistic missiles, which are intended for defense against nuclear ballistic missiles, are still under development.

The antiballistic missile is an extremely large, complex, costly weapon system involving a wide range of technologies. The United States took 20 years and spent a total of more than $10 billion to produce the Safeguard system, which nonetheless had low effectiveness and was taken out of service in February 1976.

This book presents a systematic introduction to antiballistic missile systems. It is divided into 10 chapters. The first eight describe the organization, capabilities, interception process and guidance principles of the systems, penetration and antipenetration techniques, and the design and characteristics of the antiballistic missiles themselves. Chapter 9 describes other approaches to ballistic missile defense such as laser weapons, particle beam weapons and the like. Chapter 10 describes the status of certain foreign antiballistic missile systems and discusses trends in the development of such systems.

Prof Shi Chaoli [0670 6389 4409] and Comrade Shen Zhongfang [3088 1813 5364] read the manuscript carefully and made many valuable comments, Comrade Chen Mingdi [7115 2494 1717] did much work associated with the writing of the book, and Comrades Chang Bozhi [1728 0590 2535] and Lu Zheng [7120 6154] drew the diagrams and the cover illustration for the book; we take this opportunity to express our gratitude to them.

Because antiballistic missile systems involve an extremely wide range of technologies and our own abilities are limited, the book may contain errors; readers' corrections and criticisms are earnestly solicited.

Data on U.S. and Soviet antiballistic missile systems presented in the text are drawn from open foreign publications; since different publications sometimes present conflicting figures, the data presented here should be used for reference only.

[Translation of] Table of Contents

Chapter 9. Other Ways of Intercepting Missiles

The several foregoing sections fairly systematically described one of the ways of intercepting ballistic missiles by using antiballistic missiles [ABM] to intercept ballistic missiles (or use of missiles to counter missiles, for short). This interception system is an advanced weapons system. All that is needed is prompt discovery (see Warning System), accurate identification (see Target Recognition Systems), precise tracking [see Ground-Based Guidance Systems], rapid decisions (see Command and Control Systems), and effective interception (see Antiballistic Missiles) and incoming opponents--ballistic missiles--can be destroyed.

However, if any single link malfunctions or fails, interception may collapse or become passive and vulnerable, or the entire system may be destroyed. In fact, since target recognition problems have yet to be resolved and since speed and maneuverability of ABM's are fairly poor, ABM's are as yet unable to deal effectively with incoming ballistic missiles. This has consequently given rise to the exploration of other means and a seeking after other methods.

Brief Description of Various Means of Interception

As people came to doubt the effectiveness of ABM weapons, questions arose about what weapons could better handle attacks by ballistic missiles. These apprehensions led to the exploration of other means of intercepting ballistic missiles. For many years both the United States and the USSR have explored various different means of intercepting incoming missiles, and in addition to the use of antiballistic missiles to destroy incoming missiles described in the foregoing, they used other technical means such as the following:

Use of lasers to intercept and destroy incoming targets (medium-range, long-range, and intercontinental ballistic missiles, and space weapons), termed laser antiballistic missiles.

Use of particle beams to intercept and destroy incoming targets, termed beam weapons.

Use of super guns [chaopao 6389 3517] to intercept missiles.

In addition there was satellite interception of missiles, vehicle-mounted interception devices to intercept missiles, and other means of destruction such as use of large numbers of metallic confetti clouds to create a large protective screen to intercept missiles, and use of high powered electromagnetic generators or quantum generators to render missiles inoperative.

However, some of the aforestated methods are in the process of development while others are merely ideas.

Laser Weapons

What are lasers? How do lasers become weapons?

Laser [an acronym for light amplification by stimulated emission of radiation], as the name suggests, is light emitted when a substance is stimulated. It is a new type of light source. Since a laser has unique properties, it has wide uses, and prospects for its development as a weapon are particularly good. What unique properties does a laser possess?

1. Dispersal of its light beam is extremely small and its directionality is extremely high. A popular tale relates how a single grain fills an entire granary. What kind of grain is this? How can there be such a large piece of grain? It is a lamp. A very small oil lamp shines in every direction. When ordinary light shines, it shines in all directions. But lasers shine parallel beams of light in a single direction (See figure 9-1). For example, the helium and neon laser devices widely used in industry have a dispersion angle for red laser beams only 1/1000th that of a searchlight, its diameter being only 1/2 millimeter. Were a laser beam to be shone on the moon over a distance of more than 380,000 kilometers on an area of less than 2 kilometers in diameter, the light waves bounced back from the moon could be received on Earth.

2. A laser is extremely bright. Since dispersal of a laser beam is small, and its energy can be concentrated at a very small angle, it is extremely bright in the direction in which it shines. Except for a nuclear explosion, no other device can concentrate light as intensely as a laser.

3. A laser is extremely monochromatic. Monochromatic light means light waves that are very small in length. The wave length is called spectral line width. The narrower the width of the spectral line, the more singular the wave length, and the better its monochromatic character.

Each color of light has a specific wave length. The light emitted by an ordinary light source is of all kinds, and its color distribution is very broad, meaning its wave length is very broad. The light put out by the sun, for example includes, red, orange, yellow, green, blue, indigo, and violet as well as other radiation wave lengths.

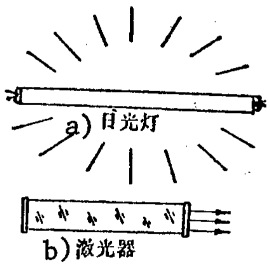


图9-1 激光与普通光的区别

Figure 9-1 Distinction Between Laser Light and Ordinary Light

a. Fluorescent Light
b. Laser Device

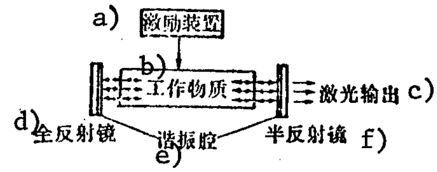


图9-2 激光器的基本结构

Figure 9-2 Basic Structure of a Laser Device

a. Exciter
b. Working Material
c. Laser Light Output
d. Fully Transparent Plate
e. Resonator
f. Semitransparent Plate

People have used these properties of laser light for the good of mankind, but they may also be used to make weapons for use in warfare.

Is laser light produced naturally? No. Laser light is emitted from laser devices. There are very many kinds of laser light, but they are fundamentally composed of three parts: an exciter power supply, laser light material (working substance), and an optical resonator as shown in Figure 9-2.

The power supply provides a source of energy for the laser device, and may be of various kinds such as a shining light, gaseous discharge, and direct hook up to an electric power source.

The laser light material is the working substance that can produce laser light. Several hundred materials have been so far discovered that may be used to manufacture laser devices including crystals, glass, gases, semiconductors, and organic dyes. Laser devices made from crystals or glass are termed solid laser devices, such as laser devices using rubies into which chromium ions have been mixed. Laser devices in which gaseous materials constitute the working substance are called gaseous laser devices and include helium and neon gas laser devices, and carbon dioxide gas laser devices. Laser devices that use semiconductor materials as the working substance are called semiconductor laser devices and include gallium arsenide laser devices.

Because particles within these materials (such as electrons, protons, molecules, and ions) are excited to produce light spontaneously, and in an of themselves, they independently luminesce. This is a spontaneous and uncontrolled luminescence process. The light produced by a slow radiation reaction of this kind will shine in all directions; its movement will be chaotic and uncontrolled. This is the dominant process when an ordinary light source luminesces. But luminescence of materials can be of another kind as well, namely that when particles are excited by a light shining from outside, they may luminesce as light that is completely identical with the outside light in its direction, wave length and movement. This process is known as light amplification by stimulated emission of radiation [or laser, for short]. By controlling the beamed light, it is possible to control the nature of the laser light. If one were to liken the slow radiation of ordinary light to a crowd of people milling around, then the light waves of laser light would be like a column of soldiers all marching in step.

If an exciter power source is used to intensify excitation of a particular substance (laser material), it can be a special state of "population inversion." (In any given substance, low energy level atoms are always more numerous than high energy level atoms. When an abnormal state is produced in which the number of high energy atoms is greater than the number of low energy atoms, this is termed population inversion as illustrated in figures 9-3 and 9-4). At this time, the process of light stimulation is greatly enhanced and laser light becomes the absolutely dominant form of light. Thus control over the properties of the light may be exercised. Such control entails use of optical resonators. Two optical resonators made of reflecting mirrors function in an extremely powerful way to select the wave length and direction of the light. They permit only light traveling in a specific direction and of a certain wave length (called a definite "model") to exist within the cavity. If a laser light material is placed in the optical resonator and an exciter power source used to put it in a state of population inversion, the radiation from the laser light material will be stimulated light of the model selected by the optical resonator and will be emitted from the end of the optical resonator to become the laser light wanted.

Experiments have shown that when a lens is used to focus the laser beams, any material at the point of focus will be turned into ashes in the twinkling of an eye. If laser beams are shone upon an enemy, that would mean annihilation of the enemy without firing a shot, would it not? What an uncommon weapon this is!

What is a laser weapon? Simply stated, a laser weapon is one that uses laser energy to damage a target such as the direct killing or wounding of enemies, and the destruction of cities or military installations. Use of a high power laser device equipped with a turret to direct laser beams to a target and a tracking and aiming system produces a weapon that can be used in actual warfare. Laser light has other military uses as well, such as laser-guided bombs or shells, laser radar, laser range finding, laser gyroscopes, and laser communications.

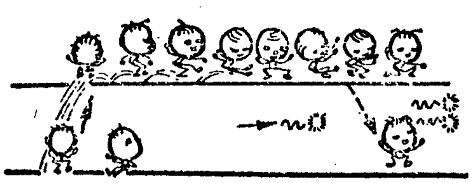


图9-3 "粒子数反转"状态

Figure 9-3. State of "Population Inversion"

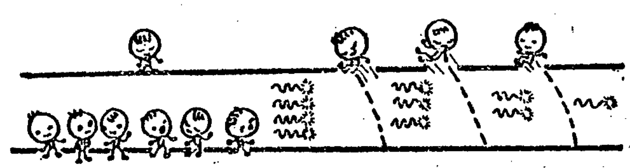


图9-4 通常绝大部分的粒子处于能级最低的基态

Figure 9-4. Ordinary State in Which an Overwhelming Majority of Particles Are at the Lowest Energy Level

Laser weapons are usually made up of a high power laser device, a target tracking and guidance system, a command and control system, and a source of electricity (as shown in Figure 9-5 and Figure 9-6).

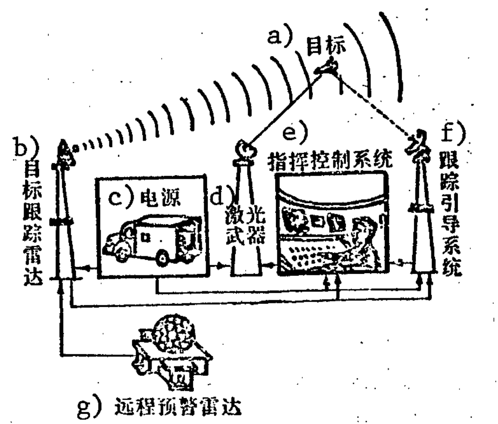


图9-5 激光武器的主要组成示意图

Figure 9-5. Schematic Diagram of Laser Weapon Major Components

a. Target
b. Target Tracking Radar
c. Electric Power Source
d. Laser Weapon
e. Guidance and Control System
f. Tracking and Guidance System
g. Long Range Warning Radar

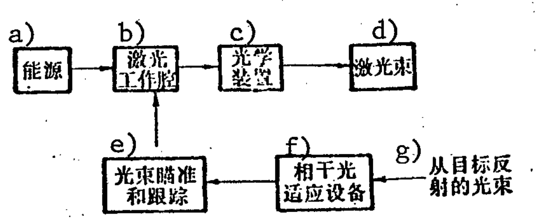


图9-6 激光武器方块图

a. Power Source
b. Laser Light Work Cavity
c. Optical Device
d. Laser Beams
e. Laser Beam Aiming and Tracking
f. Coherent Light Adapter
g. Light Beams Reflected From Target

Figure 9-6. Schematic Diagram of Laser Weapons

The high power laser device is the basic part of laser weapons. There are several hundred kinds of laser devices in use today, but mostly gaseous laser devices, electrically exicted laser devices, and chemical laser devices are used in weapons, and chemical laser devices hold a commanding position among these.

Tracking and guidance systems. When laser weapons illuminate a target, only when the target is at the exact focal point of the laser beams can the light energy be concentrated most quickly and most accurately for release to destroy the target, such as causing the surface of the target to melt, to destroy structural members, to ignite inflammable materials, and to incinerate organisms and people. Therefore, the tracking and aiming of laser beams and accurate guidance of beams is extraordinarily important.

Target tracking system. This system accurately fixes the location and speed of the target to make sure the beams do not go off target, and the guidance system guides the laser beams accurately to the target to strike the target surely and accurately. If the laser beam energy traveling at the speed of light is transmitted along the aiming axis of the tracking device, the direction of the aiming axis will be the guidance direction of the laser beams.

In order to deal with a rapidly flying target (such as a missile warhead or a space weapon), it is necessary to calculate the point of impact in order to destroy the target, and inaccurate calculation of the point of impact is the main reason why accuracy of defensive weapons in hitting targets is not high. When the target is a maneuvering flying body, this problem becomes even greater. If the transmission is done rapidly and accurately by a reflective mirror, the problem of guidance accuracy of the aiming system itself can be solved. In this case, the degree of accuracy of guidance will depend on the degree of accuracy with which the point of impact was calculated. Currently vehicle-mounted laser weapons have a tracking accuracy of several times per 10,000.

Laser weapons hold many advantages for the interception of missiles as follows:

1. Laser beams are transmitted at the speed of light; therefore, laser weapons can destroy incoming missiles or other flying objects in the twinkling of an eye. This means that when laser weapons are used, there is no need to take into consideration the time of launch and lead.

Figuring the average speed of ABM's to be 4 kilometers per second, the speed of a laser is 75,000 times that of an ABM. It would taken an ABM about 21 hours (or almost a day) to "travel" the distance a laser can "travel" in 1 second. What an astounding numerical value this is!

2. Laser radiation is powerful and it can be strongly focused; thus its ability to inflict casualties is great. Since there is little dispersion of laser beams, their energy can be concentrated within a very small angle. If a lens if used to focus the laser light, temperature can reach several thousand degrees at the point of focus. You can perform a small experiment by placing a concave lens between the rays of the sun and a piece of paper. You will discover that a hole is burned in the paper very quickly. If a concave lens is used to focus a high energy laser beam, within the twinkling of an eye a solid substance can be turned to ashes!

3. Inertia is slight and lasers may be used flexibly. The direction of launch may be changed at any time and any target can be attacked at will. As a result, the casualty rate is high.

4. Nonnuclear killing and wounding means no radiation contamination and no pollution of the surface of the land and the air. Following the explosion of a nuclear weapon, heat and radiation cause serious destruction. In addition radiation contamination injures people and animals. For example, at Hiroshima, Japan in 1945, numerous innocent people were slaughtered by the first atomic bomb.

Simply stated, laser weapons have strong firepower; they can select rapidly various kinds of targets; they can hit high speed targets; and they are unaffected by electronic jamming.

But there are advantages and disadvantages to everything, and some technical problems are also inherent in laser weapons. One is the power problem. At the present time, the power of laser devices is fairly low. Thus their power output has to be increased; laser weapons have to be perfected; and their accuracy has to be improved. When laser weapons shine on a target, only when the target falls exactly at the point where the beams are focused can the maximum light energy be concentrated to destroy the target. Consequently, this places very high demands for beam accuracy. Currently only highly accurate television tracking systems can satisfy requirements for measurement accuracy, but such systems cannot be used in all weather conditions. Thus, it is still necessary to solve the problem of laser tracking and aiming. The atmosphere seriously degenerates laser transmission, so it is also necessary to solve problems in their transmission through the atmosphere.

If laser weapons are mounted on artificial earth satellites or on spaceships, they are called satellite-mounted laser weapons. They can both intercept ballistic missiles and attack space weapons. This is an ideal weapon because the natural air-free environment of space lends itself to the transmission over very long distances of laser beams, and there is no degeneration by the atmosphere so the effectiveness of laser weapons is not impaired.

For a diagramatic sketch of laser weapons destroying a target, see Figure 9-7.

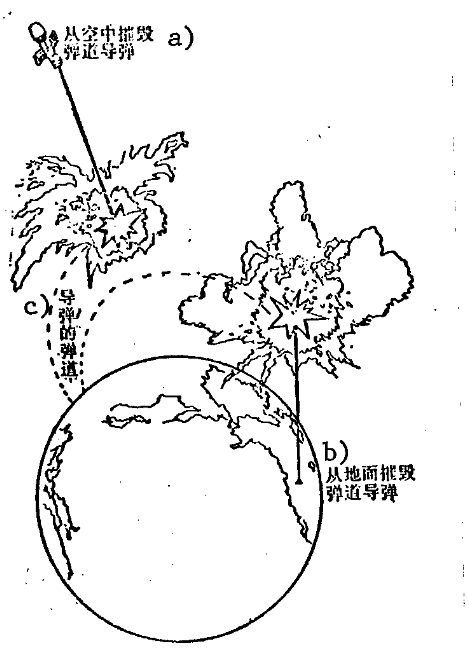


图9-7 激光武器摧毁目标示意图

Figure 9-7. Figure Showing Laser Weapon Destruction of Target

a. Destruction of Ballistic Missile in the Air
b. Destruction of Ballistic Missile From the Ground
c. Trajectory of Ballistic Missile

As laser technology rapidly develops, the power of lasers will also increase; consequently, prospects for laser weapons development will become greater. With each day's development of, in particular, ballistic missile penetration techniques, it will become difficult for antiballistic missile systems (use of missiles against missiles) to hold their own. Under these circumstances, laser weapons may emerge as a new way of intercepting ballistic missiles. In other words, use of laser weapons (either in the air or from the ground) to intercept ballistic missiles is one ideal way of countering missiles and it is one of the focuses of laser weapon development. Reportedly the United States Department of Defense has successfully tested laser weapons to shoot down an antitank missile. A look at the future shows bright prospects for laser weapons.

Particle Beam Weapons

Particle beam weapons are also termed ray weapons. High energy accelerators are used to collect and accelerate particles to form powerful particle beams of high energy, which are shot at targets at nearly the speed of light to destroy them.

The particle beams that issue from high energy accelerators consist of electron beams, proton beams, and neutral atom beams. The first two are electrically charged particle beams; the latter is an atom beam that carries no electrical charge. (It is a charged atom beam that has become neutral after having been accelerated in an accelerator).

Let us now use charged particle beams as an example to explain how particle beam weapons are formed. Particle beam weapons generally consist of three major parts, namely an energy source, an electron nozzle, and a collector accelerator.

The power source is usually derived from the pulse power produced by nuclear fission or fusion. Since no electric power station could provide the large amounts of electrical energy consumed by such a device, usually a nuclear explosion type electric power generator is specially designed for use. Such a generator can produce 100 - 1,000 pulses per second. Nuclear fission or fusion releases large amounts of energy and emits high voltage pulse currents. By using control switches and special transmission circuits, this current is transmitted in the twinkling of an eye to huge energy storers where the pulse electrical charges are accumulated. Ultra-high voltage switches are used to release the electricity in nanoseconds.

Flow compressors and electronic injectors convert the pulse high voltages to electron beams, and powerful electromagnets accelerate them in very long electron guns. They are then fired through an electron nozzle to the collector accelerator, which acts as a vehicle for producing and accelerating protons.

Collector accelerators are central to particle beams. Between the electron nozzle and the collector accelerator, an injection valve is installed to introduce the working material (such as hydrogen). Because of the high speed collision of electron beams, electrons are peeled off to form protons, which are collected and accelerated and finally emitted at nearly the speed of light to destroy targets. The basic structure of particle beams is as shown in Figure 9-8.

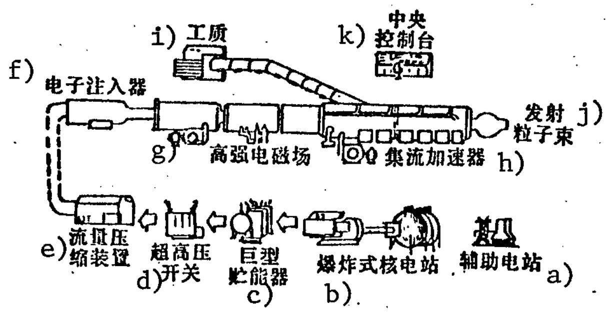


图9-8 粒子束基本结构示意图

Figure 9-8. Diagram Showing Basic Structure of Particle Beams

a. Auxillary Electric Power Station
b. Explosion Type Nuclear Power Station
c. Huge Energy Storer
d. Ultra-high Voltage Switch
e. Flow Compressor
f. Electron Injector
g. Powerful Electromagnetic Field
h. Collector Accelerator
i. Working Material
j. Emitted Particle Beams
k. Central Control Panel

Before the particle beams are ejected, they go through a stripping magnet, and negatively charged electron beams are discharged on opening. The entire process from particle beam production to ejection is carried out in a magnetic field within a closely sealed vacuum so as to insure that the particle beams will play a directional and accelerated role.

A simple combat process for particle beam weapons is as follows.

Use of fission or fusion explosions or pulses to generate electricity to produce high powered pulse charged particle beams, which are fired from ground or air installations at nearly the speed of light toward incoming targets to burn through the housing of targets and set off the triggering system in a nuclear warhead or destroy the electron equipment on an incoming missile so that incoming missiles will self-destruct or be rendered ineffective before reaching their attack area. Some people have compared the destructive role of particle beam weapons to lighting splitting a large tree. The basic working principles of particle beams are as shown in the block diagram in Figure 9-9.

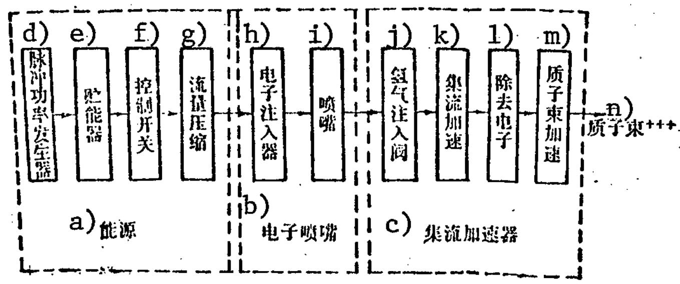


图9-9 粒子束流程方框图

Figure 9-9. Flow Diagram For Particle Beams

a. Energy
b. Electron Nozzle
c. Collector Accelerator
d. Pulse Power Generator
e. Storage Device
f. Congrol Switch
g. Flow Compressor
h. Electron Injector
i. Nozzle
j. Hydrogen Injector Valve
k. Collector Accelerator
l. Elimination of Electrons
m. Proton Beam Acceleration
n. Proton Beams+++

Particle beam weapons hold numerous advantages such as the following: 1. Rapid destruction of targets. Particle beams are fired at almost the speed of light (300,000 kilometers per second), while an antiballistic missile averages a speed of only 3-4 kilometers per second, a more than 100,000 fold difference between the 2. To intercept a target 1,000 kilometers distant, by using a particle beam weapon, the target can be hit in the twinkling of an eye while use of an antiballistic missile to intercept the target would require anywhere from several seconds to several minutes (The "Sprint" requires 6.5 seconds; the "Spartan" requires 6 minutes.) 2. High hit rate and strong destructive power. Particle beam weapons hit targets directly and they may be used repeatedly on targets until they hit. They are unlike conventional weapons, which require that a warhead or a shell reach an area close to the target with the warhead or shell exploding in order to destroy the target. 3. They are flexible in their use. The direction in which they are fired may be changed at will so as to deal with targets coming from any direction. 4. There are no nuclear pollution problems.

Particle beams and lasers have numerous similarities such as fixed straight line transmission, rapid speed, high accuracy, large amount of energy (generally requiring between 10^9 - 10^{10} joules per pulse), and reusability. As a result particle beam weapons and laser weapons have been termed directional energy weapons. Of course, the energy of laser beams is easily obstructed and degraded by cloud layers that are impervious to light. As a result, stormy weather greatly reduces the effectiveness of lasers while particle beams, like thunder and lightning, remain unaffected by weather. For this reason, people term particle beam weapons all-weather weapons.

Particle beam weapons, like weapons in general, have to accurately track and be aimed at a target before they can destroy it. Consequently, they need a highly accurate orientation and tracking system to accurately fix target position so that the particle beams can directly hit the target. The affect of magnetic fields is one of the main reasons for changes in the trajectory of electric particle beams. They cause inaccuracies in particle beam tracking and aiming against targets. If fired particles go off target, a device for correcting the direction of fired particles has to guide the fired particles to the target position in response to a guidance signal, and a "magnetic mirror" is one such device. A magnetic mirror readjusts the strength of an electromagnet to force charged particles to change their discharge direction. It is designed on the same principles as the reflection of light rays by a mirror. Use of magnetic mirrors permits changes in the direction of discharge of particle beams for accurate aiming at targets. Second, a system for assaying hits is required. If a hit is not scored with the first firing, it is necessary to figure how far off target the beam was so that aiming direction can be corrected for the next firing.

For example, one particle beam weapon currently envisioned would use negative hydrogen particle beams. The negatively charged hydrogen would be accelerated by going through a charge changing chamber, thereby being fired at a target. The simple process generated by the hydrogen particle beams would be as follows: First hydrogen gas would be put into one end of the electron beam generator. When the electron beams started up, they would generate an ionogenic process, i.e., the hydrogen atoms would lose electrons to become protons. Next these large numbers of protons traveling at high speed (close to the speed of light) would be collected and accelerated to form charged particle beams, which would be rays. Figure 9-10 provides a diagram of a ray weapon fired against a target from a ground site, and Figure 9-11 provides a diagram of one fired against a target from a base in space.

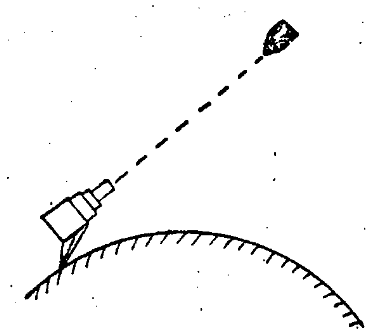


Figure 9-10. Particle Beam Weapon Fired From the Ground

图9-10 从地面发射的粒子束武器

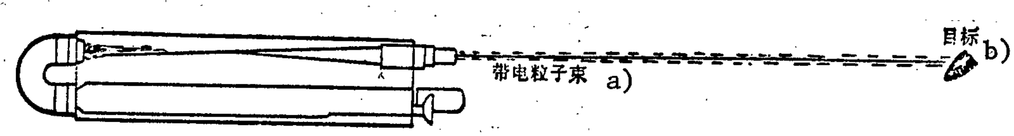


图9-11 从空中射向目标

Figure 9-11. Particle Beam Weapon Fired From Space

a. Charged Particle Beam

b. Target

Static analysis and experiments have shown that in the transmission of particle beams, neutral particle beams are suitable for use in the atmosphere because they can avoid the degradation of particle beam transmission caused by the atmosphere, and the effect of the earth's magnetic field on particle beams can be reduced.

It has been estimated that particle beam energy requirements are 10^{12} joules per pulse, and that the pulse width is about 1 microsecond. Since particle beam weapons are fired directly at targets, they function as antiballistic missile warheads; Since they travel at almost the speed of light, there is no need at all to figure firing time. They can turn rapidly from one target to another and nimbly handle multiple incoming warheads, so particle beam weapons are one of the ideal weapons being envisioned. A comparison of them with antiballistic missiles shows particle beam weapons to be faster, more accurate, and able to handle multiple warheads or maneuvering warheads.

Though particle beam weapons and laser weapons are both termed directional energy weapons, the two differ. The former fires particles toward a target; th latter fires light toward a target. Lasers are a highly concentrated, organized light particle beams, and these light particles are called photons. Particle beams are electrically charged particles or neutral atoms fired from high energy accelerators. Concentration of the flow of these particles forms a beam. Particles may be generated in various ways. The explosion of a hydrogen bomb is one way of producing particles.

Research over a period of more than 10 years shows that particle beam weapons are also a potential way of countering ballistic missiles. Even though they are still a long way from meeting requirements for use, they are being given extremely serious attention in foreign countries, which are constantly experimenting with them.

Figure 9-12 is a diagram showing interception of missiles using various means.

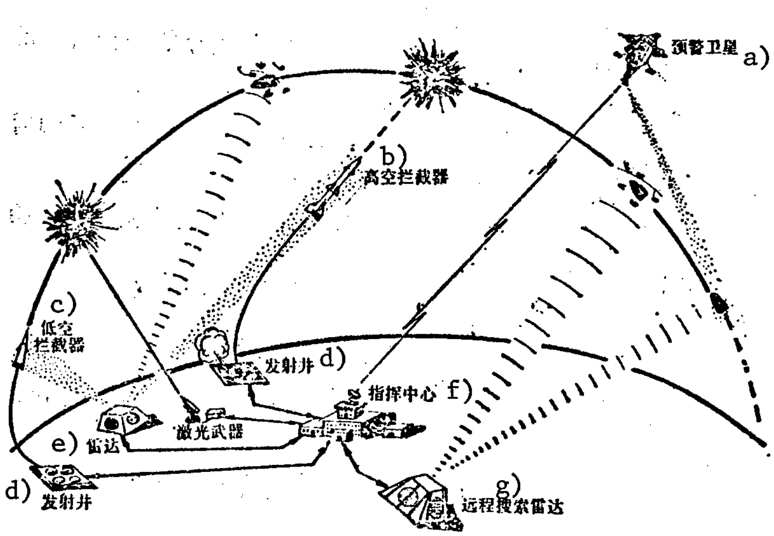


图9-12 多途径拦截导弹的一种设想

a. Warning Satellite
b. High Altitude Interceptor
c. Low Altitude Interceptor
d. Launch Silo
e. Laser Weapon
f. Command Center
g. Long Range Search Radar

Figure 9-12. A Conception of Multiple Ways of Intercepting Ballistic Missiles

Chapter 10. Current Status and Development Prospects of Foreign Antiballistic Missile Systems

"A seller of spears and shields said the following in praise of the sturdiness of his shields: 'Nothing can penetrate them.' Later on he praised his spears saying, 'This spear of mine is extraordinarily sharp; there is nothing it cannot penetrate.'"

"A person asked him, 'How can your spears pierce your shields?' The seller of spears and shields could not answer."

Though this is a fable told in "Han Feizi," it concisely describes the relationship between spears and shields. Today's most advanced weapons are also nothing more than developments of spears and shields. Ballistic missiles are only one kind of modern spear, and antiballistic missiles are a modern form of shield.

One might ask the following: How can one use modern spears (ballistic missiles) to "pierce" today's shields (antiballistic missiles)?

Nowadays no one could answer such a question accurately. That is because since ancient times and right up until the present spears and shields have complemented each other, and spears and shields have come about and developed through a process of reciprocal advancement.

Electronic jamming and counterjamming, and weapons penetration and counterpenetration have come about and developed through mutual restraints.

The Status of U.S. Antiballistic Missile Research

Simultaneously, with their vigorous development of various kinds of offensive ballistic missiles, both the United States and the USSR have actively developed defensive weapons.

The United States began to develop antiballistic missile weapons systems in 1955 in a process that may be simplified as follows:

Nike-Zeus System -- Nike X System -- Sentinel System -- Guardian System

The Nike-Zeus ABM System developed by the United States Army was developed from a ground to air ballistic missile. This system used two interceptors.

One was a three stage solid ballistic missile, which was used to defend against attacks from intercontinental ballistic missiles. It totaled 14.63 meters in length and was 0.91 meters in diameter at its largest point. It weighed 10.3 tons and had a working time of less than 2 minutes. The other interceptor was a two stage solid missile used to intercept aircraft. This was developed out of the second and third stages of the previous one, and totaled 8.23 meters in length.

The third stage of the "Nike-Zeus" ABM mostly controlled the movement of the "Nike-Zeus." It was equipped with two control apparatuses. One of these relied on air movement for control and was used in the atmosphere. The second one was controlled by jet counteraction, and was used outside the atmosphere.

The "Nike-Zeus" intercepted incoming missiles in their final trajectory. It had an interception altitude of from 110 - 160 kilometers, and the entire system was composed of the following several main parts:

1. "Nike-Zeus" ABM;
2. Target search radar with a functional range of about 1,600 kilometers;
3. Target recognition radar, with a functional range of about 960 kilometers;
4. Target tracking radar with a functional range of about 320 kilometers;
5. Data processing computer;
6. ABM guidance radar with a functional range of about 320 kilometers;
7. ABM guidance computer, capable of simultaneously guiding one to three ABM's to intercept targets;

The appearance of the "Nike-Zeus" brought about the use of large amounts of chaff (false targets) by ballistic missiles, with the result that the "Nike-Zeus" system lost its combat capabilities.

Why did the first generation of American ABM's lose their combat capabilities? And what of the second generation of ABM's?

With the appearance of large amounts of chaff accompanying warheads, the mortal weakness of the "Nike-Zeus" system--inability to distinguish between true and false targets--was completely exposed. In addition, other technical deficiencies such as limited system capacity, inability of its radar to deal with multiple targets, the slowness of its mechanical scanning radar, and such weaknesses were revealed one by one. As a result, in 1964 the "Nike-Zeus" had to be cancelled. With this, a halt was called to the first generation of American ABM weapons systems.

The second stage ABM weapons system, the "Nike X" sought to remedy the weaknesses of the "Nike-Zeus" system.

The "Nike X" contained the following several basic parts:

1. Sprint;
2. Spartan;
3. Target search radar;
4. ABM site radar;
5. Rapid computer;

The "Sprint" low altitude interceptor was developed to solve the problem of identifying real and false targets because recognition through the filtering of the atmosphere is effective only below an altitude of 60 - 80 kilometers.

"Sprint" was a high acceleration interceptor whose acceleration reached 100 g (acceleration of a free falling body being 1 g, i.e. 9.80 meters per second^2).

The "Spartan," which was developed as a high altitude interceptor with an increased range, carried a heavier, greater equivalent weight nuclear warhead that could be used to intercept high altitude incoming targets.

The "Nike X" was made up of the "Sprint" and the "Spartan" for interception tailored to different altitudes. First the "Spartan" would intercept incoming targets at high altitudes, and then targets that had gotten through would be intercepted at low altitude by the "Sprint."

Yet another major component of the "Nike X" system was its multifunctional reciprocal control site radar, which solve the problem of tracking multiple targets. Consequently, both the target search radar and the antiballistic missile site radar used reciprocally controlled site radar.

In order to improve defense capabilities, further improvements were made to the "Nike X" weapons system. For example, the range of the "Spartan" was increased, and long-range infrared final guidance techniques were used so that it could take care of multiple warheads, multiply and independently-targeted [MIRV] warheads, maneuverable [MARV] warheads, low trajectory missiles and some orbital weapons. Improvements to the "Spartan," made it accelerate faster, increased its speed, increased its maneuverability, and increased its guidance precision. To solve the recognition problem, multifunctioning reciprocal control site radar was developed.

The "Nike X" system's use of differential interception (at high and low altitudes) was an improvement over the "Nike-Zeus," but it was never deployed. In 1976 following successful detonation of China's hydrogen bomb, the United States Government became alarmed. It thereupon added a simple system of fairly low defensive capability to the "Nike X," called the "Sentinel" system.

In order to be able to contend with the USSR, the United States did not stop at the "Sentinel" system with its fairly low defensive capability. In March 1969, the United States halted production and deployment of the "Sentinel" system, and announced the beginning of development of the "Guardian" system ABM weapons system. The "Guardian's" evolutionary process is shown in Figure 10-1.

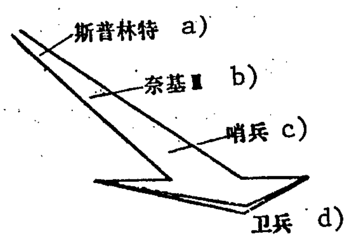


图10-1 “卫兵”的演变

Figure 10-1 Evolution of the "Guardian"

a. Sprint
b. Nike III
c. Sentinel
d. Guardian

The basic components of the "Guardian" system were identical with those of the "Sentinel" system, i.e., it was composed of long-range search radar and ABM site radar taken from the high altitude interceptor, "Spartan," and the data processing system taken from the low altitude interceptor, "Sprint." (See Figure 10-2)

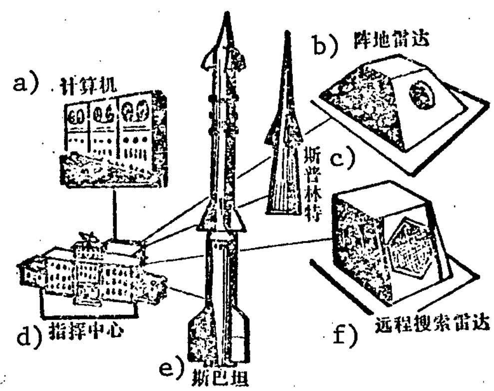


图10-2 “卫兵”系统的主要组成部分

Figure 10-2 Major Component Parts of the "Guardian" System

a. Computer
b. Site Radar
c. Sprint
d. Control Center
e. Spartan
f. Long-Range Search Radar

The long-range search radar (PAR) was used for long-range search and warning, and for recognition and tracking of targets. It was deployed in the northern part of the United States in reinforced concrete structures 61 square meters wide and 33.5 meters high. The complete radar array took up a 1.2 million square meter land area. It had only 1 round array about 40 meters in diameter, and was composed of more than 6,200 electronic scanning antenna units. The radar's maximum functional range was greater than 3,200 kilometers.

The antiballistic missile site radar (MSR) was used to guide interceptors "Spartan" and "Sprint" in the interception of targets. It could also determine precise trajectory data of targets at a short distance. The functional range of this site radar was about 1,300 kilometers. It had a definite capability for recognizing targets, and it could also track several targets.

In order to meet combat needs, the "Guardian" system upgraded its communications service system, making it one of its components. It was linked to the other five parts for high speed transmission among them of data and information.

Since the "Guardian" system's effectiveness was fairly low, low altitude interception required three "Sprints" to handle one target. It's recognition capabilities were low, and at high altitudes the "Guardian" system had virtually no recognition capabilities. When incoming targets released large amounts of metal confetti or light chaff, scattering it over an area a few score or up to 100 times larger than that of the actual warhead, the actual warhead being concealed in a jamming cloud, the radar was unable to distinguish among actual and false targets, and this was also a great weakness of the "Guardian." The system's survival capabilities were fairly low since the radar's bulk was huge and since it occupied a large area. It was prone to knock out by nuclear attack and loss of the "eyes." Reliability was poor. During wartime, this huge and complex system would require countless thousands of commands requiring high speed transmission and a high degree of automation. Should a breakdown of any command take place, the entire system would be put out of operation and be open to attack by an adversary. It also had other technical problems. As a result, in February 1961, except for the long-range search radar, the "Guardian" system had to be scrapped in entirety.

The United States' sole antiballistic missile system, the "Militiaman" missile (an intercontinental ballistic missile) deployed at a firing site near Great Forks, North Dakota, has since been forced out of service.

America's developmental work on ABM weapons during a 21 year period (from 1955 to 1976) may be simply summarized in the following several points:

In the course of about 11 years, $1.3 billion was invested in research, development, and testing of the "Nike-Zeus" ABM weapons system. Experience was gathered about research and development of ABM weapons.

Building on the foundation of the "Nike-Zeus" ABM weapons system, research, development, and testing was carried out on ABM weapons systems extending from the "Nike X," system to the "Sentinel" system, and finally to the "Guardian" system. Though deployed, the "Guardian" ABM weapons system was finally scrapped because of problems with effectiveness.

In order to solve technological difficulties with ABM weapons systems, the United States launched a series of pre-research tasks in the technology of recognition, radar, infrared, and lasers.

During these 21 years, the United States invested more than $11,674,000,000, an investment averaging about somewhat more than $500 million annually.

In addition, in the exploration of new technological methods, the United States continues research on laser weapons and particle beam weapons.

Soviet Antiballistic Weapons Situation

While vigorously developing offensive weapons, the USSR has also been extremely busy developing defensive weapons. According to foreign reports, the USSR began research and development of ABM weapons at about the same time as the United States. In 1964, the so-called "Galosh" ABM appeared in Moscow's Red Square.

Around 1969, an ABM system having the following principal components was deployed around Moscow:

1. ABM (Galosh)
2. Target Tracking Radar
3. ABM Tracking Radar
4. Long-Range Search and Tracking Radar (Dubbed "Doghouse" in the Western world)
5. Early Warning Radar (Dubbed "Henhouse" in the Western world).

All of these major components, with the exception of the early warning radar (Henhouse) located throughout the country, were deployed around Moscow.

The "Galosh" is a 2 or 3 stage solid ballistic missile with an interception altitude of about 320 kilometers that uses a nuclear warhead.

The long-range search and tracking radar (Doghouse) can track missiles at a range of more than 2,800 kilometers and has preliminary recognition capabilities.

The early warning radar (Henhouse) is a reciprocally controlled site radar responsible for providing early warning. At a distance of about 5,900 kilometers, it can detect incoming missiles and relay preliminarily obtained target information to the "Doghouse" radar near Moscow.

The site radar (i.e., the target tracking and ABM tracking radar), acting on the target information sent by the "Doghouse" radar carries out final tracking and identification of the incoming target and guides the ABM in carrying out interception.

See Figure 10-3 for a description of the Soviet Union's ABM weapons system radar network.

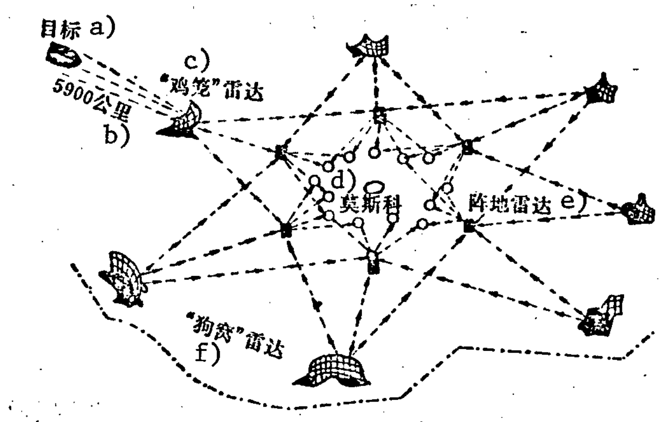


图10-3 苏反导弹武器系统中的雷达部署示意图

Figure 10-3. Radar Deployments in the Soviet ABM Weapons System

a. Target
b. 5,900 Kilometers
c. Henhouse Radar
d. Moscow
e. Site Radar
f. Doghouse Radar

The USSR took several years to ring Moscow with 64 ABM "Galosh" launchers divided among four combat companies. Each company had 16 launchers divided among four combat companies. Each company had 16 launchers equipped with 2 radar sites. At each radar site there was one large target tracking radar and two fairly small tracking and guidance radars. The large tracking radar could track about eight targets for the interception of targets outside the atmosphere. Foreign analysis showed the "Galosh" system to have been similar to the American "Nike-Zeus" system.

In order to counter the United States, the USSR itensified research and development of ABM weapons systems. According to foreign reports, the USSR also developed intercept devices for different altitudes similar to the "Spartan" and "Sprint." In addition, the USSR intensified testing of laser and particle beam weapons, and development of its particle beam weapons is currently faster than in the United States.

Future Prospects of Antimissile Systems

During the past more than 20 years both the United States and the USSR have expended huge amounts of manpower and resources on research and development of their huge, complex, and expensive ABM weapons systems for use in defending against penetrations by ballistic missiles (such as ground or submarine launched missiles). They are both self-secure, and seem to have built up a "Great Wall" psychology, believing that they can ward off attack. Actually, they cannot.

In order to penetrate ABM weapons systems, ballistic missiles employ multiple penetration techniques. These techniques, simply put, include the release of chaff, release of jamming materials, and use of MIRV's and MARV's.

Are ABM weapons systems powerless against well camouflaged missile attacks? Are they in the situation of "a mantis trying to stop a chariot?" No.

In their role as "shields" to defend against missile attacks, they use multiple interception methods such as missile interception, interception with laser weapons, use of particle beam weapons, etc.

Because of unresolved technical problems with ABM systems such as poor recognition capabilities, it is difficult to differentiate real and false targets. It is still not possible effectively to intercept numerous targets or warheads that can maneuver. Radar capability to withstand nuclear attack is fairly low, and radar is prone to attack and being put out of commission. Maneuverability of interceptors is fairly poor, making it difficult to deal with moving targets. For this reason, foreign countries are currently devoting extremely serious attention to preresearch, hoping to solve technical difficulties through preresearch and maintain a technical lead so as to produce advanced weapons systems.

In the realm of interception, they are researching and developing ultrafast burning propellants, very strong housings, and electronic apparatus capable of withstanding high speeds to improve interception capabilities, and improve interception capabilities. They have also envisioned lengthening and shortening low and high altitude interception, forming a three stage interception system. This means extending high altitude interception farther and mounting a final guidance system on board them in order to increase their high altitude recognition capabilities. For low altitudes, development is in the direction of even lower altitudes (below 9 kilometers), the emphasis going to the solution to problems of maneuverability and speed of interceptors. This level would be the third level of interception. The 2nd level would be the so-called missile final stage defense, interception being at an altitude of between 9 and 45 kilometers.

In the realm of systems performance, new techniques are being widely used. These include small, maneuverable radar systems and computer systems with numerous components to improve recognition techniques and improve system recognition capabilities. This includes development of laser and electronic search techniques to solve the as yet unsolved problem of real and false target recognition.

Future warfare may develop from land, sea, and air to space. The fourth battlefield is space warfare (also termed four dimensional warfare, meaning land, sea, air, and space, with satellite searching, tracking, recognition, and interception of incoming targets being one method of defense. One possibility is for satellites to carry "satellite ABM systems" for interception of ballistic missiles.

In the field of laser weapons, foreign countries have already successfully tested use of lasers to intercept antitank missiles traveling at high speed. The hit rate for laser weapons is high, and they can destroy targets in the twinkling of an eye. It may be predicted that laser weapons will certainly become one effective way of intercepting incoming ballistic missiles.

The United States and the USSR are currently in the process of exploring and experimenting with particle beam weapons to make them into usable weapons.

In summary, some as yet unsolved technical problems exist for ABM weapons sytems such as the problem of identification of real and false targets, problems of systems reliability, problems of handling multiple targets or maneuvering targets, and problems in withstanding nuclear explosions. Consequently, all systems are still undergoing technical research and development, and are in an exploratory stage. They have yet to become effective defensive weapons. What will the most effective future ABM weapons system be? Will it be laser weapons, particle beam weapons, or some other system? This is a question that individual countries are exploring, but it may be predicted that laser weapons are one of the hopeful means of interception.

Tables

Table 1. Ballistic Characteristics of Ballistic Missiles

表一 弹道导弹的弹道特性

a) 弹道导弹种类	b) 射程 (公里)	c) 高度 (公里)	d) 最大速度 (米/秒)	e) 飞行时间 (分钟)
f) 中程	1600	375	3690	10.7
	3200	690	5000	15.9
	4800	945	5800	20.9
g) 洲际	8000	1120	6350	25.3
	9600	12700	6810	29.0
	10200	1320	7400	35.2
	12800	1440	7500	37.4

a. Type Ballistic Missile
b. Range (Kilometers)
c. Altitude (Kilometers)
d. Maximum Speed (Meters/Second)
e. Flight Time (Minutes)
f. Intermediate Range
g. Intercontinental

Table 2. Subdivisions of the Radio Frequency Spectrum

表二 无线电波段的划分

a) 波段		b) 波长范围	c) 频率范围
d) 长波		20000～3000米 e)	15～100千赫 f)
g) 中波	h 中长波	3000～2000米 e)	100～150千赫 f)
	i 中短波	2000～200米 e)	150～1500千赫 f)
j) 短波		200～10米 e)	1.5～30兆赫 l)
k) 超短波		10～1米 e)	30～300兆赫 l)
m) 微波	n 分米波	1米～10厘米 r)	300～3000兆赫 l)
	o 厘米波	10～1厘米 r)	3000～30000兆赫 l)
	p 毫米波	10～1毫米 s)	30000～300000兆赫 l)
	q 超毫米波	短于1毫米 s)	300000兆赫以上 t)

a. Wave Band
b. Wave Length Range
c. Frequency Range
d. Long Wave
e. Meters
f. Kilohertz
g. Medium Wave
h. Medium Long Wave
i. Medium Short Wave
j. Short Wave
k. Ultra-short Wave
l. Megahertz
m. Microwave
n. Decimeter Wave
o. Centimeter Wave
p. Millimeter Wave
q. Ultra-millimeter Wave
r. Centimeter
s. Millimeter
t. Shorter Than 1 Millimeter. t. Greater Than 300,000 Megahertz

Table 3. Characteristics of U.S. Antiballistic Missile Weapons

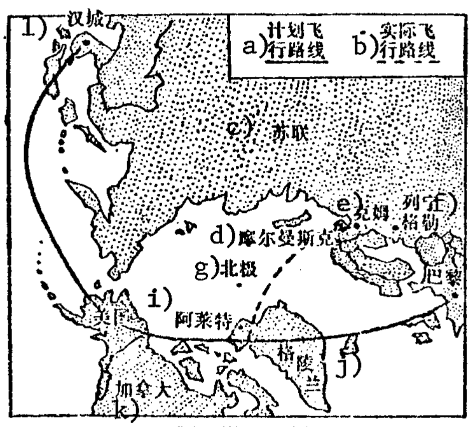
表三 美国反导弹武器性能参数表

a) 名称	射程(斜距,公里) b)	速度(公里/秒) c)	d) 高度(公里)	起飞重量(吨) e)	长度 f) (米)	直径 g) (米)	h 发动机	i 级数	制导 j) 系统	战斗部(TNT当量) k)	备注 l)
m) 奈基-宙斯	320	2.8	160	10.4	14.6	0.9	n三台固体	3	无线电指令o)	核装药p)	
q) 斯普林特	60	3.0	50以下	3.4	8.2	1.37	r二台固体	2	无线电指令s)	核装药t 1千吨	低空拦截器u)
v) 斯巴坦	640	3.5	300	15	16.6	1.1	w三台固体	3	无线电指令 x	核装药y 几百万吨	高空拦截器z)

a. Name
b. Range (Oblique Range, Kilometers)
c. Speed (Kilometers/Second)
d. Altitude (Kilometers)
e. Launch Weight (Tons)
f. Length (Meters)
g. Diameter (Meters)
h. Launcher
i. Number of Stages
j. Guidance System
k. Warhead (TNT Equivalent Weight)
l. Remarks
m. Nike-Zeus
n. Three Stage Solid
o. Radio Command
p. Nuclear Explosive
q. Spring
r. Two Stage Solid
s. Radio Command
t. Nuclear Explosive, 1,000 Tons
u. Low Altitude Interceptor
v. Spartan
w. Three Stage Solid
x. Radio Command
y. Nuclear Explosive, Several Million Tons
z. High Altitude Interceptor

Map

附 图



902次客机路线图

Passenger Flight 902 Route Map

a. Planned Flight Route
b. Actual Flight Route
c. USSR
d. Murmansk
e. Kemu [phonetic]
f. Leningrad
g. North Pole
h. Paris
i. Alaite [phonetic]
j. Greenland
k. Canada
l. Seoul

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END