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C601 AIR-TO-SHIP GUIDED MISSILE

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A MADE-IN-CHINA WEAPON SYSTEM: C601 AIR-TO-SHIP GUIDED MISSILE

Yang Jingqing and Xu Zimou

The article mainly presents the configuration and features of the made-in-China C601 air-to-ship missile weapon system. Relatively detailed descriptions are given of the functions of missile-borne equipment and launch procedure of the missile. Moreover, the article briefly presents the technical site and airfield facilities related to the missile system.

Key Phrases: tactical missile, air-to-ship missile, C601 missile, China.

I. General Description

The C601 missile weapon system is an air-to-ship tactical missile system made in China. These missiles are hung beneath both wings of a Hong 6D aircraft, an intermediate long-range made-in-China bomber. These missiles are used to attack large and intermediate-size surface warships and their squadrons that invade the intermediate-distance and coastal sea regions. The C601 missile weapon system includes C601 missiles, airborne aiming launch equipment, and ground support equipment, and so on. The weapon system is a relatively complex system engineering

product with advanced technology and equipment; the entire system has good operational coordination and high precision. As proven in practice, the C601 missile weapon system is a practical, reliable, flexible, mobile and effective antiship weapon system that is defensive in nature.

II. Features of C601 Missile Weapon System

1. Good mobility

The C601 missile launch is effective in a wide airspace, from 1000 to 9000 meters of altitude above sea level. The combat radius of the Hong 6D aircraft is 1800 to 2000 kilometers; therefore, bombers operating from a base can blockade a sea territory of 5 to 6 million square kilometers; thus, the combat mobility of this bomber is good.

2. Long range

The longest effective range of the C601 missile is 100-110 kilometers; the longest powered-flight range is 150 kilometers. The launch sectorial angle of the missile is plus or minus 12 degrees.

3. Post-launch self-controlled approach

After a C601 missile has been launched, it does not require any guidance from the ground or aircraft. The missile automatically flies toward the target according to the pre-installed program; thus, the aircraft can immediately leave the combat zone or execute other missions; thus, the safety of the aircraft and its crew can be ensured, and the combat capability of the weapon system is enhanced.

4. High penetration capability at low altitude

When a C601 missile is in level flight, its altitude above sea level can be 50, 70, or 100 meters at cruise speed of 0.9 Mach. The active flight period of the missile is long, together with good concealment and high capability of low-altitude penetration. The strike precision of the missile is high; the object capture probability is 98 percent within the longest effective range; the automatic guidance target strike probability is higher than 90 percent.

5. High power

The payload compartment in a C601 missile contains a large quantity of dynamite; thus, it has high explosive force and has energy concentrating, armor-piercing dynamiting and casualty-inflicting functions. Even when hit by a single missile, a destroyer larger than the 3000-ton class or a transport vessel of the 10,000-ton class can be severely damaged or even sunk. Based on practical combat situations, this missile can be operated as single shots and when fired in volleys of two missiles, for much higher combat effectiveness.

6. High antijamming capability

A single-pulse active radar system is used at the terminal guidance head of the C601 missile with antiwave and antimultiple-jamming capability.

7. Simplicity of weapon system equipment

All the aiming launch equipment of the missile weapon system is accommodated in a compartment of the Hong 6D aircraft for operational convenience. Most of the ground support equipment is loaded onto a truck for convenience in deployment, withdrawal, and transfer. The airfield facilities of the missile include

only three trucks. When executing an emergency mission, only half an hour is needed for readying the missile to be suspended under the aircraft wings, then the aircraft can take off with these missiles.

III. C601 Missile

The C601 is a cruise-type missile composed of body, control and guidance system, power system, electrical system, payload compartment fuze system, and so on. The overall length is 7.36 meters, with the largest diameter of 0.76 meters, a 2.4 meter wingspan, and a weight of 2440 kilograms at launch.

1. Aerodynamic exterior and missile body

The C601 missile is a plane-symmetric normal aerodynamic configuration as a high subsonic flight vehicle with semimonocoque structure with a delta-shaped midsection single-wing of a large sweepback angle. The nose cone of the missile is an elliptic body of revolution; the midsection is cylindrical; and the three-member empennage with a 120 degree spacing is placed in the contraction sector at the tail end of the missile body. The missile has relatively high dynamic and static stability as well as maneuverability, adaptable to the flight missile profile.

2. Control and guidance equipment

The C601 missile uses the guidance system of post-launch automatic control and automatic guidance in the final flight stage; the automatic pilot can achieve stability and control of three mutually independent angular returns; moreover, with the missile-borne doppler guidance radar, radio altimeter, and command mechanism for coordination with the missile to accomplish mass-center control and range control; guidance signals from the

active type terminal guidance radar are accepted in accomplishing the automatic guidance mission.



Fig. 1. C601 missile hung under a wing of a Hong 6D aircraft



Fig. 2. External appearance of C601 missile

The terminal guidance radar is a special-purpose radar composed of antenna, receiver, transmitter, signal processor, automatic selector, control, electronic countermeasures, and power supply; the target message is provided in two planes of navigation direction as well as dip and elevation. Guided by the preselected guidance law, the target can be hit.

To ensure that the operating ambient temperature of the terminal guidance is not lower than 25°C in high-altitude flight of a C601 missile, high-temperature gas from the aircraft engine compressor casing can fill the radar compartment in the missile to raise the temperature, thus ensuring high-altitude normal operation of the missile-borne terminal guidance radar.

3. Power supply system

The power supply system of the C601 missile includes a liquid-fuel rocket engine, a propellant supply system, an oxidizer release system, an oxidizer casing, a combustible mixture-containing casing, and high-pressure gas bottle, and so on. The missile-borne oxidizer discharge system mainly serves to release oxidizer within the missile upon return of aircraft to the base in order to ensure landing safety of the aircraft, the missiles, and crews; the missile can be still operable.

4. Fuze in payload compartment

The payload compartment of a C601 missile is an energy concentrating, armor-piercing explosive payload compartment, containing high-energy blended dynamite. In its front section, there is a hemispherical metal energy concentrating cover; thus a high-temperature metal stream is formed after detonation to penetrate armor steel plating up to 1 meter thick.

Coordinated with the payload compartment are two sections of electrical fuzes and one section of a mechanical fuze; these are contact ignition-type fuzes with three-stage safety devices to ensure coordination between ignition and detonation in order to exploit the maximum armor-piercing effect of the payload compartment.

5. Missile flight trajectory and post-launch operational procedures

The flight trajectory of a C601 missile is shown in Fig. 4, divided into two sectors of active control and automatic guidance.

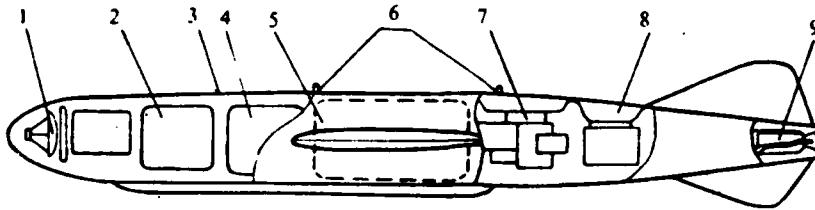


Fig. 3. Component layout of C601 missile
Legend: 1 - terminal guidance radar 2 - fuel tank
3 - missile body 4 - payload compartment
5 - oxidizer casing 6 - front and rear hanging rings
7 - automatic pilot 8 - doppler radar
9 - liquid-fuelled rocket engine

Before launch of a C601 missile and only after the airborne aiming launch equipment provides the multiple-firing element parameters, the missile is launched from the aircraft. At that time, the missile executes a nonpowered downward glide according to the predesigned equal-procedure dip and elevation angle of the same order of magnitude locus, with no static difference. When the missile is at an altitude of 850 meters above sea level, the pressure in the propellant tank increases; then the rocket engine is ignited, accelerating the missile. When the missile velocity reaches the rated value, the engine changes into the second-stage thrust status, maintaining constant flight speed of the missile. When the missile glides to an altitude of 500 meters above sea level, the missile flight locus smoothly levels out according to the index law to enter the very-low-altitude level flight. When

the missile flies to within the predetermined range, the missile-borne doppler guidance radar shuts itself off. Then the active type terminal guidance radar switches on to search, capture, and track the target. At that time, the missile guidance system turns itself into the automatic guidance status, guiding the missile to dive toward the target. Since at that time the third-stage safeties of both the mechanical and electrical fuzes are inactivated, the fuzes operate and detonate the payload compartment when the missile hits the target, thus destroying it.

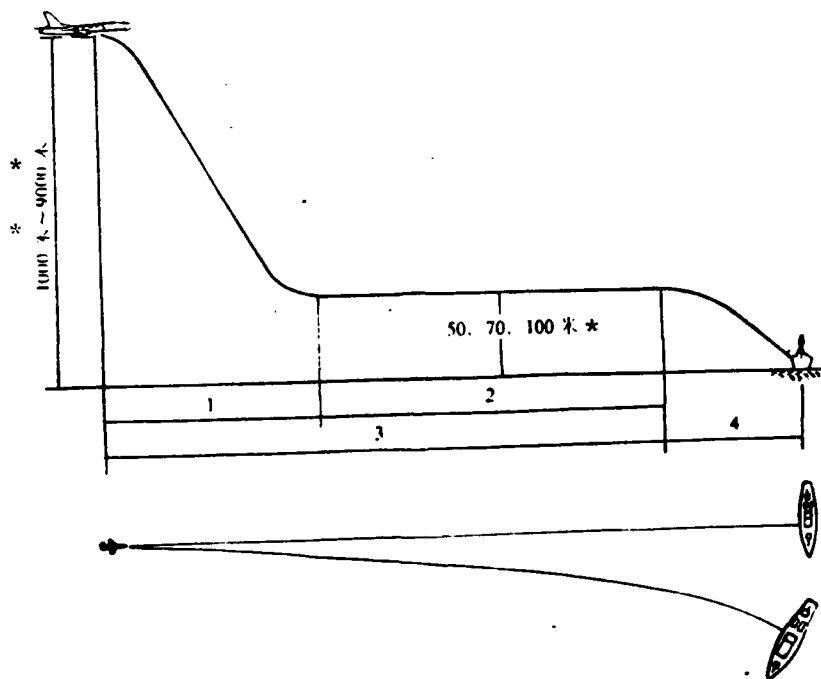


Fig. 4. Schematic diagram of flight trajectory of C601 missile
 Legend: 1 - downward glide sector 2 - level flight sector 3 - active control sector 4 - automatic guidance sector
 Key: * - meters

6. Improvement and development

For better missile performance and longer range, major improvements were made in the power supply, electrical system,

and terminal guidance radar of the C601 missile, besides using new high-energy fuel to extend the missile range to 200 kilometers. The improved missile is designated the C611 air-to-ship missile. In addition, corresponding improvements were also made in the airborne aiming and firing equipment of the C601 missile; thus, a single Hong 6D aircraft can be used to launch the C601 and the C611 missile.

IV. Airborne Aiming and Launch Equipment

1. Configuration and functions of airborne aiming and launch equipment

All the airborne aiming and launch equipment of the C601 missile is installed in Hong 6D aircraft, including target search radar, firing command instrument for calculation of multiple-firing elements, launch control platform for inspecting and launching the missile, missile suspension frame for hanging missiles, and sensing components for measuring multiple parameters. These sensing components are as follows: navigation direction datum gyroscope, gas pressure type altitude sensor, navigation direction attitude system, doppler navigation radar, inertial guidance unit, missile body gyroscope platform, and aircraft wing gyroscope platform, and so on.



Fig. 5. Missile-loading vehicle is suspending a C601 missile beneath a wing of a Hong 6D aircraft

2. Operational procedure in missile aiming and launching

When the airborne search radar discovers a target on the sea to be attacked, the aircraft navigator adjusts the threshold of the target tracking wave at the radar monitor. After the target has been securely captured, it goes on automatic tracking status. Based on parameters of various sensitive elements, the firing command instrument calculates the multiple-firing elements according to the designed hit equations. After the filtered wave has been smoothly stabilized, the parameters (automatic control flight distance, firing overall lead angle, and other parameters) are continuously fed into the C601 missile which is ready to fire. When various conditions related to firing satisfy the firing requirements, the firing permission indicating lamp on the firing control platform lights up; then the missile can be fired.

V. Ground Safety Equipment

The ground safety equipment of the C601 missile weapon system serves to ensure that the missile weapon system is always in proper technical status. The ground safety equipment is divided into two parts: missile technical site equipment and airfield facilities.

The technical site equipment primarily includes ten vehicles as follows: inspection and measurement equipment for upkeep of missile, missile maintenance equipment, mobile power supply station, gas source vehicle, gas loading vehicle, gas washing vehicle, rinse washing vehicle, missile suspension vehicle, as well as a vehicle for loading two kinds of propellants into the missile, and a transporter.

When conducting measurements and tests on the C601 missile at the technical site, the mobile power station provides electric power at 27 volts. The gas source vehicle and gas filling

vehicle are used to conduct gas-tightness inspection of the missile power system, and filling of high-pressure air into high-pressure gas bottles in the missile. Prior to the missile qualification inspection for preparation of missile operation, two kinds of propellants should be loaded, respectively. Finally, a payload compartment is installed. At that time, all the preparatory work at the missile technical site is completed, and ready for hanging the missile under the aircraft wings.

Of the airfield facilities of the C601 missile weapon system, there are primarily two missile suspension vehicles, and one ground inspection vehicle for the command instrument. The missile suspension vehicle is used to suspend C601 missiles under both aircraft wings; this vehicle is a self-propelled type vehicle capable of the following missile loading actions: elevating, lowering, motions in the longitudinal and transverse directions, rotation, tipping, as well as rolling with convenient, mobile, and flexible operations. The ground inspection vehicle for the command instrument is used to inspect the airborne command instrument and to take part in ground prelaunch inspection and simulation of pre-air-launch inspection prior to missile flight.

After numerous developmental flight tests and actual missile detonation evaluations of the C601 missile weapon system, its performance is higher than the technical requirements previously stipulated. The missile system was awarded First-Class Prize, State Level, for Progress in Science and Technology. With the successful development of the C601 missile weapon system, China's marine defenses have been fortified; the missile system has been enthusiastically welcomed by China's mass air wing personnel of the navy.

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