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CENTRAL INTELLIGENCE AGENCY
WASHINGTON, D.C. 20505

14 June 1976

MEMORANDUM FOR: The Director of Central Intelligence

FROM : William W. Wells
Deputy Director for Operations

SUBJECT : MILITARY THOUGHT (USSR): US Supersonic Strategic Bombers and Air Defense

1. The enclosed Intelligence Information Special Report is part of a series now in preparation based on the SECRET USSR Ministry of Defense publication Collection of Articles of the Journal "Military Thought". This article examines the development of the B-58 and B-70 strategic bombers, their capabilities and shortcomings, in assessing the capabilities of existing air defense means to counter them and the cruise and ballistic missiles they employ. The features of US and Soviet air defense systems are studied and their effectiveness compared in arriving at recommended improvements such as developing new aviation and missile equipment, increasing the number of surface-to-air missile battalions and combining air defense and antimissile means. This article appeared in Issue No. 1 (62) for 1962. [redacted]

2. Because the source of this report is extremely sensitive, this document should be handled on a strict need-to-know basis within recipient agencies. For ease of reference, reports from this publication have been assigned [redacted]

[redacted]
William W. Wells

[redacted]

[redacted]

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Intelligence Information Special Report

[redacted]

COUNTRY USSR

DATE OF INFO. Early 1962

DATE 14 June 1976

SUBJECT

MILITARY THOUGHT (USSR): US Supersonic Strategic Bombers and Air Defense

SOURCE Documentary

Summary:

The following report is a translation from Russian of an article which appeared in Issue No. 1 (62) for 1962 of the SECRET USSR Ministry of Defense publication Collection of Articles of the Journal "Military Thought". The author of this article is Engineer Lieutenant Colonel R. Tumkovskiy. This article examines the development of the B-58 and B-70 strategic bombers, their capabilities and shortcomings, in assessing the capabilities of existing air defense means to counter them and the cruise and ballistic missiles they employ. The features of US and Soviet air defense systems are studied and their effectiveness compared in arriving at recommended improvements such as developing new aviation and missile equipment, increasing the number of surface-to-air missile battalions and combining air defense and antimissile means. End of Summary

[redacted] Comment:

An Engineer Lieutenant Colonel R. Tumkovskiy was identified as publishing an article in a November 1955 issue of Vestnik Vozdushnogo Flota, concerning methods of using and obtaining maximum ranges of jet aircraft. After 1962 the SECRET version of Military Thought was published three times annually and was distributed down to the level of division commander. It reportedly ceased publication at the end of 1970. [redacted]

[redacted]

Supersonic Strategic Bombers and Air Defense
by
Engineer Lieutenant Colonel R. Tumkovskiy

The introduction of missile equipment into service with the various branches of the armed forces has brought about important changes in the development of combat aviation, particularly strategic aviation. A considerable portion of the tasks of destroying operational-strategic targets in the enemy rear that were earlier carried out by strategic aviation are now assigned to intercontinental and medium-range missiles.

On the other hand, the introduction into the air defense forces of surface-to-air missiles and supersonic fighters equipped with air-to-air missiles, along with the development of radar systems for detecting the air enemy and for guiding fighters and surface-to-air guided missiles, have considerably increased capabilities for repelling strikes by strategic bombers and destroying them in the air. Consequently, some delay in the development of strategic bombers has been noted in recent years in the US. In 1959, for example, the US Department of Defense decided to discontinue development of the B-70 supersonic strategic bomber. The B-58 supersonic bomber has undergone testing for more than four years. Still, in spite of this long testing period, it does not meet the necessary indices.

The B-58 has a serious shortcoming. In spite of its maximum supersonic speed of about 2,100 kilometers per hour, its main flight mode is at subsonic speed. Only in this mode can it reach its maximum flight range, 7,000 kilometers. In the supersonic mode, there is a sharp rise in its fuel consumption (approximately 50 percent) and a corresponding reduction in its flight range. Therefore, this mode can be employed for only a short period of time without considerably reducing the flight range.

The B-58 aircraft, in comparison with subsonic bombers, can negotiate air defense systems somewhat more successfully thanks to the brief employment of the supersonic flight mode. However, it will not have significant advantages with regard to the time required to deliver strikes and with regard to ensuring a surprise approach to the targets. Present-day air defense means, particularly surface-to-air guided missiles, can effectively counter the B-58 aircraft, and for this reason, evidently, the US Air Force command is not relying on the extensive employment of them. Altogether, 116 B-58 aircraft were ordered at the end of last year; of these, 68 have been produced. In the combat units, however, there are altogether only about 30 of these aircraft.

In spite of the shortcomings of the first supersonic bomber, work has now been resumed abroad, and particularly in the US, on the development of future strategic bombers and strategic aerial reconnaissance aircraft.

The theory of "mixed forces" forms the basis of plans drawn up by the American command for the coming decade with regard to the building of strategic strike means. According to this theory, strategic means of attack should include intercontinental ballistic missiles, medium-range missiles, and manned bombers. Although currently giving preference to the development of ballistic missiles, the Americans have also resumed development of high-Mach bomber aircraft.

The explanation for this is that an aircraft has a number of advantages over unmanned means of delivering nuclear weapons to targets: it can carry a heavier load of nuclear bombs and can hit several targets in one sortie; it can carry air-to-ground missiles and carry out tasks of reconnoitering targets and delivering strikes against them during the course of a single sortie; and a long-range manned aircraft is currently the sole means for carrying out strategic reconnaissance for the missile forces. Furthermore, the crew of an aircraft can detect previously undetected moving targets against which ballistic missiles cannot be employed; the combat task assigned to a bomber can be changed during its flight to the target; a bomber delivers more accurate strikes against the targets and can be employed repeatedly to carry out combat tasks.

Also, American military circles regard manned bombers as the most effective "cold war" means, since they can be sent for purposes of provocation to the borders of the countries in the socialist camp. In such an instance, the bombers will not cross a prearranged line without receiving a special order for the delivery of a strike. Ballistic missiles cannot be employed in this manner since, as is known, they cannot be brought back after they have been launched.

In order to carry out the above tasks and to replace the obsolete B-58 bombers, work has been resumed in the US on the development of the supersonic B-70 Valkyrie bomber. The first wing of these aircraft is expected to be in service with the US Strategic Air Command in 1966. Aircraft of this type will be the basic means of strategic aerial reconnaissance, the purpose of which is to provide missiles and strategic aviation with the data necessary for delivering strikes and to monitor the results of the strikes.

This aircraft is supposed to have a maximum flight range of approximately 13,000 kilometers, a cruising speed of 3,200 kilometers per hour, and a flight altitude of 22 to 25 kilometers. An aircraft of this class would be a "canard" monoplane, with a delta wing and horizontal stabilizers located forward of the wing. The takeoff weight of the aircraft is approximately 250 tons. The power plant consists of six turbojet engines, with a cumulative maximum static thrust of approximately 80 tons. The aircraft crew is made up of four men: the pilot (the commander of the crew); the copilot; the navigator-bombardier; and the operator of the electronic countermeasures equipment.

Various types of nuclear or conventional bombs can be suspended in the bomb bay of this aircraft. Pods with reconnaissance equipment can be suspended in the bomb bay instead of bombs so that the aircraft can be employed as a reconnaissance aircraft.

The B-70 aircraft can also carry and launch Sky Bolt type air-launched ballistic missiles. These missiles have inertial guidance systems into which, before the missile is launched, the necessary initial data about the position of the aircraft and the target are fed from the aircraft navigation-bombing system, and the flight mode and profile of the missile are also set. After launch, the missiles go over to self-contained guidance from their own onboard guidance system, become independent of the delivery aircraft, and do not need to be tracked in the initial sector of the flight. The guidance system is set up in such a way that during the missile launch it permits the delivery aircraft to deviate somewhat from the course toward the strike target.

Characteristic of this class of bombers is their single flight mode. They cruise at their maximum altitude at a strictly fixed true air speed of 3,200 kilometers per hour. Any deviations, even small ones, from the set flight mode, as well as maneuvering, result in a considerable overconsumption of fuel and a corresponding reduction in range. Consequently, the set flight program must be adhered to very precisely. Another characteristic is the high degree of inertness of the aircraft resulting from its considerable speed (900 meters per second) and from flight in a rarefied medium. Therefore, it is to be expected that the maneuverability of this class of aircraft will be limited.

The B-70 supersonic bomber is equipped with various automatic systems, the most important of which is the navigation-bombing system. This system combines radar, astronavigational, and inertial methods of navigation.

Included in the system are the following elements: a gyro-stabilized platform with speed and acceleration sensors; an automatic astrosextant; a surveillance radar; a Doppler radar; and a computer. The system is supposed to provide for air navigation, bombing and the launch of guided missiles, and to provide the following data: present-position coordinates of the aircraft in the form of geographic latitude and longitude; course; ground speed; track angle; true air speed; direction and velocity of the wind; flight altitude; position of the aircraft in space; distance to the destination or target; and the bomb release or missile launch signal.

In order to ensure negotiation of enemy air defense means, they intend to install on the B-70 aircraft equipment for radio reconnaissance and electronic countermeasures, as well as equipment to detect missiles with infrared homing heads. The employment of radar and infrared decoys is supposed to protect the aircraft against the various types of missiles used by air defense means.

It is obvious that the means and forces of present-day air defense systems will not be equally effective in intercepting existing subsonic bombers and future supersonic bombers.

Therefore, it is of interest to assess, even if only approximately, the capability of present-day air defense means to counter supersonic aircraft having a cruising speed of 3,200 kilometers per hour, a cruising altitude of 22 to 24 kilometers, and armed with air-to-ground missiles.

Present air defense systems are a complex set of means made up of three basic parts: radar detection, warning, and guidance systems; groupings of air defense fighter aviation; and groupings of surface-to-air guided missiles.

The radar detection and guidance system supports the combat operations of air defense fighter aviation and surface-to-air guided missiles. The latter work in close cooperation. Fighter aviation usually operates on the distant approaches to the installations being covered in an effort to disrupt combat formations and destroy bombers and unmanned cruise missiles.

Surface-to-air missiles, as a rule, cover the immediate approaches to the targets of the strikes, having as their task the destruction of the air targets not destroyed by the fighters.

Thus, the bomber, when approaching the strike target, must first negotiate the zone of counteraction by the air defense fighters, then that of the surface-to-air guided missiles.

An air defense radar system performs two main tasks: the detection of aerial targets and the guidance of active air defense means to them. The guidance of air defense fighters is often provided for by the very same means that detect the air targets.

Surface-to-air guided missile systems, as a rule, have their own target indication and missile guidance radars. However, the target indication radars of surface-to-air guided missiles work in close cooperation with the detection radars and are guided to the air targets by their data. In any air defense system, an effort is made to move the first line where air targets can be detected by radar as far away as possible from the installations being covered, so as to ensure the greatest possible margin of time and space in order to employ the active air defense means. In carrying out this task, radars with a large detection range are employed, and the radar posts are moved as far as possible from the installations being covered in the direction of the probable approach of the enemy bombers. When there is sufficient space, the radar cover can consist of several consecutively located detection lines.

Shown in Figure 1 is a diagram of the radar detection zone of the US east coast.

The detection system consists of three consecutively located detection lines:

-- a near line made up of shore posts, with a detection depth of 400 kilometers;

-- an intermediate line consisting of island posts, with a detection depth of 580 kilometers;

-- a distant line of seaborne posts, with a detection depth of 900 kilometers.

Installed at the posts are radars of the types AN/FPS-3 and AN/FPS-19, which ensure the certain detection of air targets at a range of 400 kilometers and an altitude of up to 12 kilometers. It is also possible to detect air targets beyond the limits of this zone, but the probability of detecting them decreases sharply. In addition to the above-mentioned radars, the posts also have radars of the type AN/FPS-6B which determine the altitude of air targets.

Calculations show that when bombers fly at their present altitudes and at speeds of 800 to 1,000 kilometers per hour, this system of radar cover permits the detection of these air targets one hour to one hour and ten minutes before they approach the installations being covered. The system provides for the tracking of targets into the entire depth and by altitude, as well as for the guidance of fighters to them.

With bombers that have a flight speed of 3,200 kilometers per hour, this radar system, given its range, could ensure their detection only within 17 minutes of their approach to the strike targets. However, when the bombers fly at an altitude of 22 to 24 kilometers, the probability of detecting them will decrease greatly.

It should be noted that in the European and Far Eastern Theaters of Military Operations, the existing detection depths are less than what is shown on the diagram.

Thus, the radar cover system under discussion cannot effectively counter supersonic bombers in either depth or altitude of detection.

US radar posts have lately been re-equipped with radars of the AN/FPS-7 type, which are capable of detecting air targets at a range of up to 600 kilometers and an altitude of up to 30 kilometers. It can be expected that the installation of radars of this type will improve somewhat the capabilities of the radar cover system; however, it is unlikely that this will greatly increase its operational effectiveness against supersonic aircraft.

If we assume that the minimum margin of time required to activate air defense means is 30 minutes, then the depth at which supersonic bombers must be detected will be 1,600 kilometers.

For reasons of geography, it is not always possible to establish such a detection depth for air targets in the European and Far Eastern theaters of military operations (because of the short distances between the countries). This kind of detection depth can be established only on an intercontinental scale.

The employment by supersonic bombers of cruise missiles of the Hound Dog type, which have a launch range of 800 kilometers, and of air-launched ballistic missiles of the Sky Bolt type, with a range of 1,600 kilometers, will complicate even further the tasks assigned to the air defense system.

When given the task of intercepting bombers before they launch cruise missiles, the radar system must not only detect the aircraft in time, but must also guide to them means of destruction launched from sites located 1,000 kilometers and more from the probable line of interception.

If we assume the flight speed of the means of destruction to be Mach 4, it will take them approximately 15 minutes to meet a bomber that is to be intercepted 1,000 kilometers away. During this time, the bomber will have travelled 800 kilometers. It is evident that under these conditions, the depth of the detection system must be more than 1,800 kilometers, that is, 2,500 to 3,000 kilometers, so as to ensure that the air defense can take timely measures to carry out the interception.

When employing radars with a detection range of 600 kilometers and a 30 percent mutual overlapping of radar fields, three or four consecutively located lines of radar posts will have to be prepared. There will be a corresponding increase in the number of radar posts needed to prepare lines along the front. All the radar posts must be linked with one another by a dependable communications system, and the tracking of air targets and the guidance of the means of destruction to them must be fully automated.

It can be assumed that the establishment and operation of such a radar system will present very great difficulties. It will likely be impossible with the technical means known today to establish radar systems that can detect and intercept bombers armed with ballistic missiles having a launch range of 1,600 kilometers and more. And it will hardly be advisable to assign the task of intercepting bombers delivering ballistic missiles. At present, fighter aviation has in service mainly all-weather fighter-interceptors, which are designed for day and night operations under difficult weather conditions. The majority of the fighters have a maximum flight speed in the range of Mach 1.7 to 2.2, and a static service ceiling of 20 to 21 kilometers.

The main weapons of the fighters have become air-to-air missiles with radar or infrared guidance systems. In attacks made from the rear hemisphere, these missiles ensure considerable probability of destruction.

The aggregate of the considerable superiority of fighters over subsonic bombers in flight performance data, of the powerful guided weapons, and of the radar guidance systems currently ensures that it is highly probable that the fighters will destroy the air targets.

In Figure 2 there is a diagram of the most frequently employed method of interception. The fighter takes off to encounter the bomber. It is guided by ground-based radars into the encounter area before it has locked onto the enemy aircraft with the onboard interception and aiming radar installed in it. The ground guidance is then switched off, and the fighter pursues the target on a pursuit curve, exploiting its superiority in speed. When it reaches the effective fire distance on the line of interception, it launches its missiles.

The distance from the takeoff airfield to the line of interception depends considerably on the depth of the radar detection and guidance system, the flight performance data of the air defense fighters, the accuracy of their guidance from the ground, and the flight performance data of the enemy bombers. For the majority of the air defense systems of the capitalist countries, the line at which fighters intercept air targets is from 100 to 350 kilometers away when takeoff is made from ground alert status. It is obvious that present-day fighters will be considerably less effective in intercepting bombers that fly at a speed of 3,200 kilometers per hour and an altitude of 22 to 24 kilometers: pursuit-course attacks will become impossible, since the bombers will be superior in flight speed and altitude.

Theoretically, fighters that are slower than bombers can carry out attacks on collision courses provided that they are flying at an altitude lower than that of the bomber.

The launch of missiles with aircraft guidance to the selected point is done from the pitch-up position. This attack requires a very precise approach by the fighter to the launch point, which will be very difficult because of the great relative speeds of the aircraft and their poor maneuverability at high altitudes.

Completely new aircraft are necessary in order to successfully intercept supersonic bombers (with a speed of 3,200 kilometers per hour and an altitude of 22 to 24 kilometers) at great distances. One of the ways of carrying out this task could be to develop aircraft capable of prolonged flight and armed with long-range air-to-air missiles. By cooperating with the early warning radar system, these aircraft could be on airborne alert on the axes of the probable flight of the bombers and could intercept them with guided missiles. These aircraft could be built with nuclear power plants.

In present-day air defense systems, surface-to-air guided missiles are employed to cover the immediate approaches to the probable targets of bomber strikes.

Surface-to-air guided missile systems can be divided into two main groups:

-- short-range surface-to-air guided missiles, which have a range of fire of up to 60 kilometers and an altitude range of 20 to 22 kilometers;

-- long-range surface-to-air guided missiles, which have a range of fire of more than 150 kilometers and an altitude range of up to 30 kilometers. An example of these surface-to-air guided missiles is the American Nike-Hercules missile, which has a range of fire against subsonic aircraft of up to 160 kilometers and a maximum altitude range of 30 kilometers, and the Bomarc, which has an operating range of 400 kilometers and a maximum altitude range of 20 to 22 kilometers.

All the surface-to-air guided missile systems are designed to intercept air targets flying at speeds of Mach 2.3 to 3.2. It is evident that the surface-to-air guided missiles of the first group, because of their insufficient range and altitude range, will not be very effective in intercepting bombers flying at high-Mach speeds. Only long-range surface-to-air guided missiles will be able to counter supersonic aircraft; however, even their fire capabilities will be limited. Let us examine this, using the example of the Nike-Hercules type of surface-to-air guided missiles. This surface-to-air guided missile is designed to destroy air targets flying at speeds of up to 3,700 kilometers per hour. Each battery has a target indication radar with a maximum operating range of 225 to 250 kilometers.

When intercepting air targets flying at speeds of 800 to 1,000 kilometers per hour, the maximum kill range is 160 kilometers. When the speed of the air target increases to 3,200 kilometers per hour, the kill range decreases to 90 kilometers. At the same time, the number of missiles that can be launched against the aircraft as it passes through the kill zone decreases from five or six down to one or two. Because of the high speed of the aircraft (900 meters per second), which is close to the maximum speed of the missile at the moment the sustainer engine cuts off (1,000 meters per second), pursuit-course firing is completely ruled out, since the missile simply will not be able to overtake the aircraft.

As a consequence of the decrease in their fire capabilities, the number of surface-to-air guided missile battalions will have to be increased considerably (twofold) in order to cover a given area. In addition, new surface-to-air guided missile systems whose missiles have considerably higher speeds and ranges will have to be developed.

Let us examine the Bomarc type of surface-to-air guided missile system. In this system, an unmanned cruise missile is employed as the missile. It is equipped with an aircraft-type detection and guidance radar (with a detection range of 55 kilometers and automatic tracking range of 28 kilometers).

The missile warhead has a nuclear charge equivalent to 30,000 tons of TNT. The cruise missile can be guided from the ground with data from ground-based radars and from its own onboard interception and aiming radar when the latter has locked onto the aerial target.

The process of intercepting an air target with a Bomarc type cruise missile takes place in the following way: with the aid of a booster engine and a sustainer engine, the cruise missile accelerates to a cruising speed of Mach 3 at an altitude of 20 kilometers. After acceleration, the booster engine is jettisoned and further flight toward the air target is carried out with the aid of a turbojet sustainer engine.

During the flight of the missile, the ground-based radars simultaneously track it and the target, and with commands from the ground guide it into the area where the target can be detected by the radar on board the missile. After the onboard radar locks onto the air target, ground guidance is switched off and the cruise missile goes over to the homing guidance mode so as to intercept the air target. The considerable superiority of the cruise missile over present subsonic bombers in altitude and speed ensures that the latter will be quickly overtaken.

The powerful nuclear warhead makes it possible to destroy air targets even when the burst occurs at a distance of several hundred meters away.

Since the flight speed of present Bomarc type surface-to-air guided missiles is equal to the speed of Mach 3, their combat capabilities to intercept bombers flying at the same speed will be considerably decreased.

Supersonic bombers armed with Hound Dog type cruise missiles or with air-launched ballistic missiles will not have to enter the zone being covered by surface-to-air guided missiles in order to deliver a strike against the targets. When cruise missiles are employed, the task of intercepting them will fall to surface-to-air guided missiles. The flight speed of present-day cruise missiles is about 2,016 kilometers per hour, and their maximum altitude is 23 kilometers. The small dimensions of the cruise missiles reduce by 30 to 35 percent the range at which they can be detected by the target indication radars of surface-to-air guided missile batteries. Because of this, and also because of the high speed of cruise missiles, the fire capabilities of surface-to-air guided missiles will be substantially reduced. Under these conditions, a Nike-Hercules type battery will be able to fire one or two missiles against a cruise missile. The consecutive launch of cruise missiles at intervals of several seconds and the echeloning of them according to flight altitude to the target will ensure the certain destruction of the target by the last cruise missile, since the battery will not even have the time to fire at it.

To ensure a successful strike under these conditions, the enemy may employ the first cruise missile as a dummy target in order to distract the attention of the air defense.

The employment of air-launched ballistic missiles by bombers makes it impossible for the present surface-to-air missile systems to destroy these missiles. This task will require the combination of air defense and antimissile defense means.

The arming of subsonic bombers with air-to-ground missiles will ensure their successful combat employment for a number of years more, since, in order to deliver a strike against a target, they too will not have to enter the air defense zone.

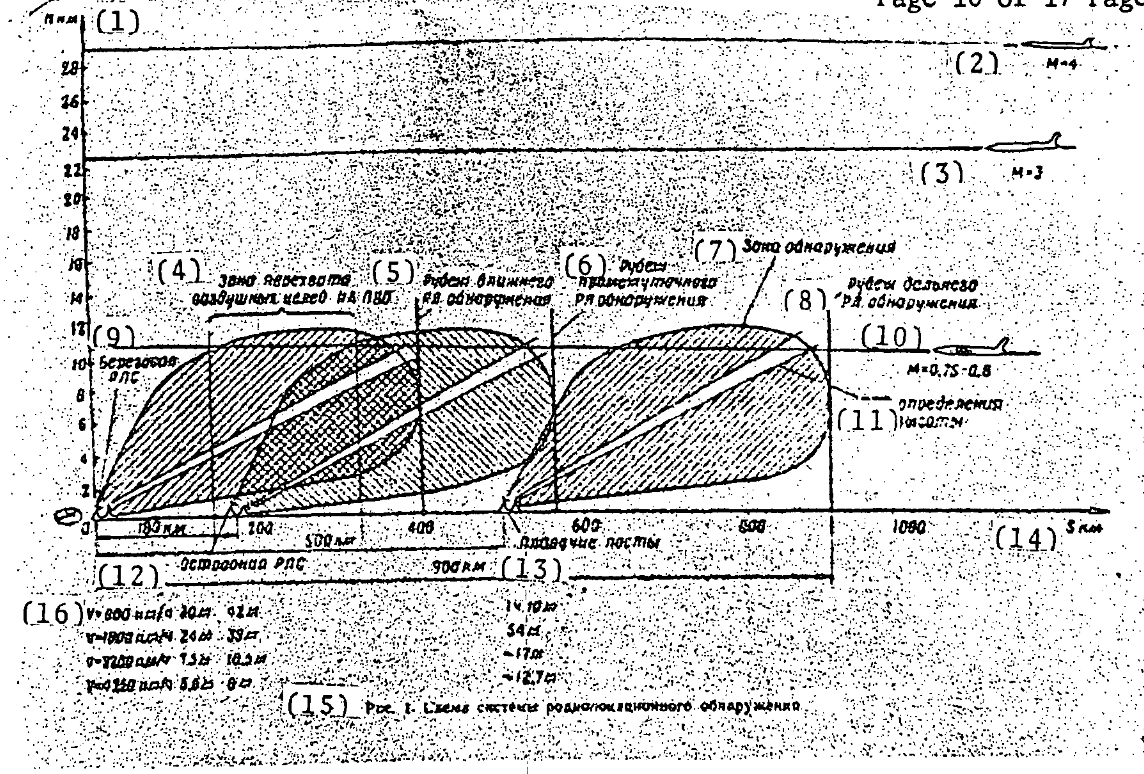
In order to negotiate an air defense, a supersonic bomber can employ its capabilities of maneuvering vertically and horizontally. Thus, for example, a supersonic bomber flying at an altitude of 22 kilometers and a speed of 3,200 kilometers per hour can, upon approaching a strong air defense area, execute a "zoom" by climbing to the dynamic ceiling that its stability and controllability permit and correspondingly losing speed. If the aircraft can decrease its speed to Mach 2, the dynamic ceiling will be about 40 kilometers. Thus, in the process of climbing to its dynamic ceiling, an aircraft can "jump over" the air defense zone beyond the range of the air defense means. This maneuver can be employed by reconnaissance aircraft when carrying out the aerial photography of strongly defended targets.

High flight speed gives the bomber the broad capability of rapidly shifting its direction. In the event that it is detected one hour before it approaches enemy territory (3,200 kilometers away), it can with small changes in course move to targets along a front of thousands of kilometers.

This will force the enemy to bring air defense forces and means up to combat readiness on a continental scale, which will make it impossible to concentrate them in the sectors actually threatened and will at the same time exhaust air defense personnel.

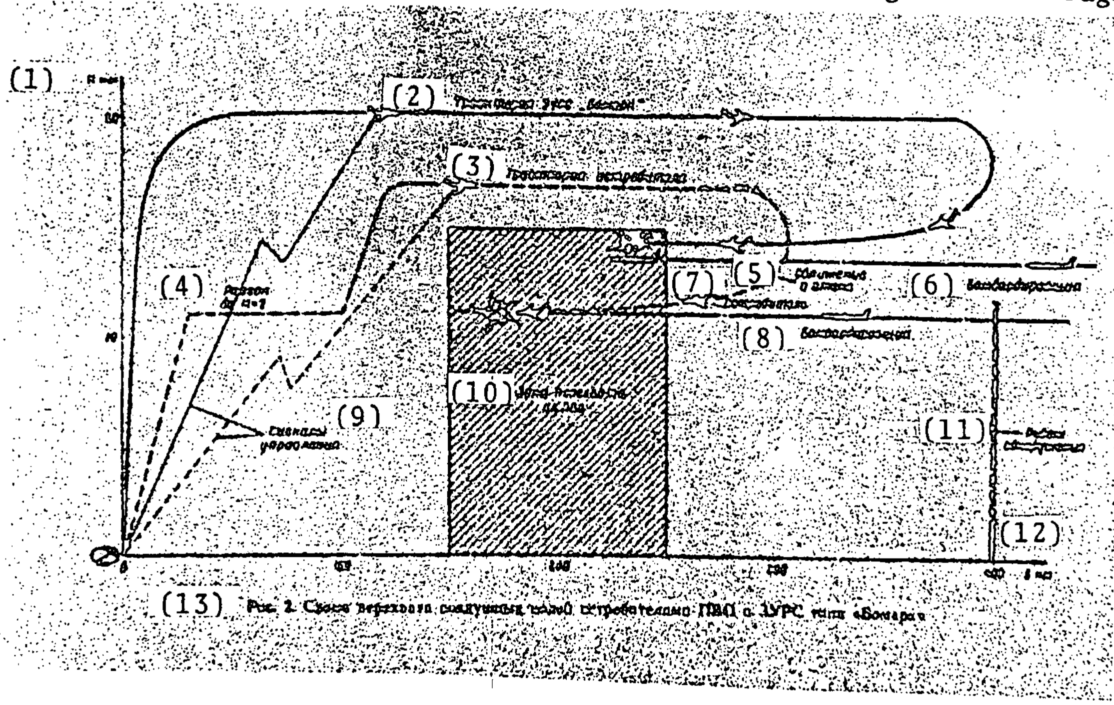
It can be said in conclusion that present-day air defense means are not effective enough to combat supersonic bombers travelling at a speed of Mach 3.

The introduction of such bombers into service and the employment by them of guided air-to-ground cruise missiles and air-launched ballistic missiles will place completely new tasks before air defense. In connection with this, existing combat means will have to be improved and new ones will have to be developed. Air defense means and antimissile defense means will have to be combined so as to ensure the defense of individual installations and the conduct of air defense operations in large theaters thousands of kilometers wide and deep.



Legend to Figure 1

(1) Altitude in kilometers
(2) Mach-4
(3) Mach-3
(4) Air defense fighter aviation zone of interception of air targets
(5) Near radar detection line
(6) Intermediate radar detection line
(7) Detection zone
(8) Distant radar detection line
(9) Shore radar
(10) Mach-0.75 - 0.8
(11) Height-finding radar
(12) Island radar
(13) Seaborne radar posts
(14) Range in kilometers
(15) Figure 1. Diagram of Radar Detection System
(16) Speed = 800 Kilometers/Hour 30 Minutes to 42 Minutes
1 Hour 10 Minutes



Legend to Figure 2

(1) Altitude in kilometers
(2) Trajectory of Bomarc surface-to-air guided missile
(3) Trajectory of fighter
(4) Acceleration to Mach 2
(5) Approach and attack
(6) Bomber
(7) Fighter.
(8) Bomber
(9) Guidance signals
(10) Air defense fighter aviation interception zone
(11) Detection line
(12) Range in kilometers
(13) Figure 2. Diagram of Interception of Air Targets by Air Defense Fighters and by Bomarc Type Surface-to-Air Guided Missiles