FTD-HT-66-164

FOREIGN TECHNOLOGY DIVISION

RADAR WARNING SYSTEM

by

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EDITED TRANSLATION

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English pages: 8

SOURCE: Hang K'ung Chih Shih. (Aeronautical Knowledge), No. 12, 1964, pp. 9-11.

Translated under: Contract AF 33(657)-16409

CH/0035-064-000-012

TP6001490

PREPARED BY:

TRANSLATION DIVISION
FOREIGN TECHNOLOGY DIVISION
WP-AFB, OHIO.

CIRC ABSTRACT WORK SHEET			0898 1950
(01)Acc Nr. TP6001490	(65)SIS Acc Nr. AP5011863	(40) Country of Info CH	(41)Translation Nr. HT6600164
(42)Author YIN, JUI (3009/3843)			Priority II Distribution STD
(43)Source HANG K'UNG CHIH SHIH			

(02)Ctry	(03)Ref	(04)Yr	(05)Vol	(06)Iss	(07)B. Pg	(45)E. Pg	(73)Date	(47)Subject Code
CH	0035	64	000	012	0009	0011	NONE	15, 17

Language			
CHINESE	N/A	N/A	N/A

(39)Topic Tags radar network, air defense system, early warning radar, fire control system, missile detection, missile guidance

(66)Foreign Title

NOT AVAILABLE

(09)English Title

RADAR WARNING SYSTEM

(97) Header Clas	(63) Clas	(64)Rel	(60) Release Expansion
0	00	0	

ABSTRACT: Since the rapid development of the electronics industry after World War II, radar has been used to perform various missions in the Air-Defense System. For low speed aircraft, radar systems can be divided into early warning radar, ground fire-control radar, etc. Today, however, the speed of aerial attacks is greatly increased in ballistic missiles and supersonic aircraft. The time allowed to compute defense data is therefore greatly reduced, and the old defense systems are no longer capable of handling a high-speed air attack. For meeting the challenge of ICBM attack, the defense system must be modified. One approach is to increase the effective radar distance, and to automate the calculation of all data and its delivery to the defensive missile site. Newly developed radar units such as ground-to-air missile-guiding radar, air-to-air missile-guiding radar, and guided missile search radar have been extensively developed. The author points out, in conclusion, that an air defense system must be constantly changing to meet the requirements of newly developed techniques of aviation. Orig. art. has: 4 figures. English Translation: 8 pages.

RADAR WARNING SYSTEM

by

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Due to the advances in radio electronics, a new field for air defense techniques has been developed — radar air defense. Radar appeared first before World War II. It was designed to detect targets and measure their positions by means of reflections of electromagnetic waves, just as man can detect large structures or mountains by echoes.

The Region of Influence of a Radar Station

A radar station can only search for targets within a certain region because of the limitation of its parameters — wavelength, dimension and shape of the antenna, transmitter efficiency, sensitivity of the receiver, etc. In other words, every radar station has a definite "region of influence," which varies in size and shape according to the radar parameters. Figure 1 shows the approximate shape of the region of influence of an early warning radar station. The shape is a hollow cone constructed by rotating the dark-colored leaf-like surface 360° in the direction of the antenna sweep pattern about

vertical axis. The radar station can only detect targets within the body of the cone (region 3); targets outside the cone or within the hollow region cannot be detected. Regions 1 and 2 are called the "blind regions."

Warning and Attack

From the above discussion, it is seen that a single radar station cannot detect invading enemy aircraft coming from all directions. Hence, several radar stations must work in conjunction: that is, radar stations with different parameters should be used so that they have different regions of influence; and the blind region or one radar station can thus be covered by the regions of influence of the others. As a result of several radar stations working together in this fashion, a search network for the entire space can be constructed.

Furthermore, due to the limited power of the transmitted signal of the radar station and the presence of noise in the receiver, the radar has a definite range of action. The maximum range of action of the radar stations in use at present varies from several hundred to several thousand kilometers. In order to increase the range of action, not only must the transmitting power be increased, but also the size and shape of the antenna and the frequency of the transmitted signal must be changed at the same time. However, increasing the range of action by varying the radar parameters (while keeping the same region of influence) will result in a decrease in the accuracy of the position measurement of enemy aircraft. The role of air defense is not just to discover enemy aircraft and send out alarms, but to take positive measures to destroy them after detection. To do this requires accurate data concerning their positions, which also must be measured accurately. However, as mentioned above, under a fixed region of influence, the increase in the range of action and improvement of position accuracy are contradictory. Since this contradiction cannot be resolved with one radar station, several must be used to supplement each other, i.e., some radar stations are used manly for detecting targets and for sending out alarms; others are used to measure

accurately positions of targets at a closer range enabling attacks to be launched on the enemy aircraft. Hence, since they first appeared, stations have always been used as a combined system in air defense.

Early Warning Radar Air Defense Systems

Radar air defense systems appeared first during World War II. During the post-war period, considerable improvement was made in this field. The operation of air defense systems can be seen in Fig. 2.

District A is an early warning network convered by several search radar stations. The purpose of the stations is to detect targets as early as possible, measure the approximate target positions, and then report to the control center by telephone. On the basis of the data received, the control center carries out an analysis and study of the hostile environment, determines whether aircraft are flying toward strategic positions, the extent of the threat, and, finally, which aircraft should be destroyed immediately.

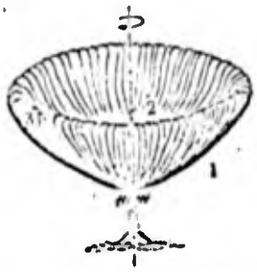


Fig. 1. Effective range of an early warning radar station.

After determining the enemy aircraft to be destroyed, an order is given to District B where a number of medium-range combat control radar stations are installed. These stations have the responsibility of obtaining more accurate measurements of the positions of the enemy aircraft (height, range, angular position,) the directions and flight speed, and trajectories. Then, these data are relayed back to the control center by telephone where the situation for air combat is reevaluated, and the combat is determined strategy — i.e., whether to destroy the enemy crafts by antiaircraft guns or fighter planes.

If it is decided to attack by fighter planes, orders are given to the fighter base District C, and the positions of the enemy are transmitted to the fighter guidance radar stations. After take-off, the fighter planes are directed toward the enemy planes by guidance

radars and assume critical strategic positions to prepare for an attack. As the fighter planes approach the enemy, the intercept radars aboard the planes are activated; remaining under the control of the guidance radars, the pilots then employ the intercept radars to search for targets. After the targets are located, the mission of the guidance radars is completed. According to the data from the intercept radars, the pilots track aim and destroy the enemy planes.

If it is decided to attack by means of antiaircraft guns, the orders and data on the enemies position are transmitted simultaneously to the site of the antiaircraft guns District D. The tracking radars on the site are activated, and begin searching and tracking the enemy planes according to the information received from the control center. In the meantime, the antiaircraft guns operated by the radars will be directed so that firing will commence when the enemy planes enter within range.

This type of air-defense system was effective during World War II and in the immediate post-war years. At that time, because the aircraft speed was rather low, an appreciable amount of time was available for combat preparation after the enemy planes had been discovered. Furthermore, since the number of airplanes was small and the air environment was rather simple, the commanding officer could make his analysis, judgement and command quite effectively. For example, if early warning radars had discovered a group of bombers three hundred kilometers away, it would take the bombers fifty minutes to reach our base(i.e., assuming the flying speeds of the enemy places to be one hundred meters per second). Within the fifty minutes, it would be possible to complete sufficient preparation for combat.

Aerospace Engineering and Air Defense Systems

After the 1950's, rapid development was made in aerospace engineering. Moreover, the speed of aircraft was increased considerably. In addition the intercontinental missile has appeared and there has been a great increase in the number of flying mechanisms. These factors have all made air defense much more difficult. The main difficulties are presented as follows:

First, the increase in flying speed has reduced considerably the amount of time available for combat preparation. In order to ensure a certain amount of preparation time, the range of action of the radar station must be increased. For instance, the speed of the modern intercontinental missiles is over three kilometers per second; in order to gain five minutes for combat preparation, they must be discovered by early warning systems 900 kilometers away. If in an attack, airplanes flying at nearly sonic speed are employed instead of missiles, they must be discovered at a distance of approximately 600 kilometers in order to allow fighters to intercept and destroy them. If ground-to-air missiles are used to intercept enemy aircraft, the range of detection can be relaxed somewhat, but still must be over 500 kilometers.

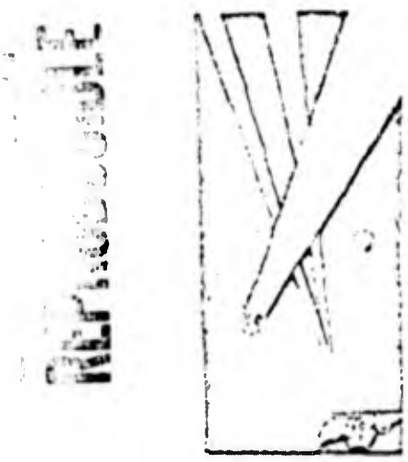
Second, modern air defense systems are confronted with many more complicated environments. Under normal conditions, there are always many flying objects in the atmosphere. In order for the control center to determine enemy aircraft from information furnished by the radar stations, it must be able to distinguish its own, those belonging to the enemy, and military and the civil airplanes. Also, it must determine whether the enemy aircraft are directed toward its territory, or just patrolling outside of it; whether the approaching aircraft intends to invade or surrender; whether the aircraft are reconnaissance planes, bombers or missiles. These questions must all be answered by the commanding officer within a very short time.

Third, once the threatening enemy aircraft are determined, a strategic plan should be established immediately. The strategy, however, is no longer a simple choice between the use of fighter planes or antiaircraft guns. In addition to these choices, the possible use of ground-to-air missiles must also be considered. During a fighter attack, the use of air-to-air missiles in addition to the possibility of using machine guns should also be taken into account.

Not only has the combat preparation time been greatly reduced, but in such a short time, the commanding officer must make a sound judgement, as well as establish a logical

strategy. Consequently, the responsibility imposed on the commanding officers is immense.

Moreover, with the development of radar sets, many methods have been developed to reduce its effectiveness. The detection of targets by radar depends on the reflection of electromagnetic waves from the targets. However, the targets themselves can transmit electromagnetic waves, hence disturbing the reflected waves and thus go undetected. Also, the targets may release highly reflective metal strips whose reflected waves will dominate the waves from the targets and also prevent their detection. The surfaces of some airplanes are covered with a layer of chemicals which can absorb electromagnetic waves without reflecting them; as a result, the planes will not be detected. All these factors increase the difficulty of the radar systems.



Modern Radar Warning Systems

The development of aerospace engineering methods to reduce the radar effectiveness, has caused great difficulties in warning systems; on the other hand, these difficulties have motivated great improvements.

First, in order to extend the period of combat preparation, many countries are making great efforts to increase the search distance of their early warning systems. They are also setting up warning networks along their territorial borders so that targets may be discovered as early as possible. Furthermore, the transmission of data is no longer dependent on telephones, but is accomplished automatically by radio.

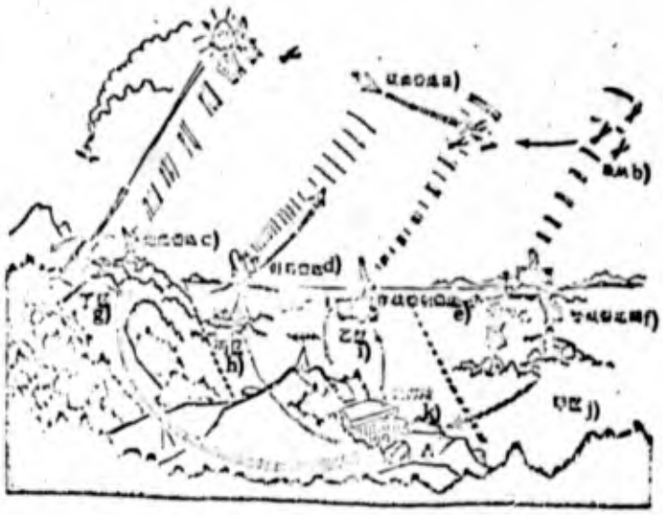


Fig. 2. An air defense system.

CODE: a) Interceptor with radar; b) enemy aircraft; c) fire control radar; d) guidance radar; e) tactical ground control radar; f) warning radar; g) D district; h) C district; i) B district; j) A district; k) command post.

Second, in order to remove some of the responsibility from the commanding officer, the analysis and judgement of data and the establishment of strategic plans are accomplished by computers. The entire procedure, from the receipt of data to the issuing of commands, is completed automatically within the control center.

Finally, in order to destroy the far more effectiveness and accuracy in combatting enemy aircraft, the performance of all types of radar sets—warning radar, combat control radar, guidance radar, intercept radar, tracking radar has been improved considerably. Several new radar sets have also been introduced, for example: discrimination radar; guidance radar for ground-to-air and air-to-air missiles; automatic search radar for guided missiles; and the recently invented laser radars, etc.

Aerospace engineering and radar warning systems are very similar in that their development supplements each other. Whenever new types of aircraft appear, the air defense researchers spare no effort to find countermeasures; on the other hand, whenever a new warning system appears, aerospace engineering will then be motivated to advance toward a more sophisticated stage.