C.I.C.

COMBAT INFORMATION CENTER

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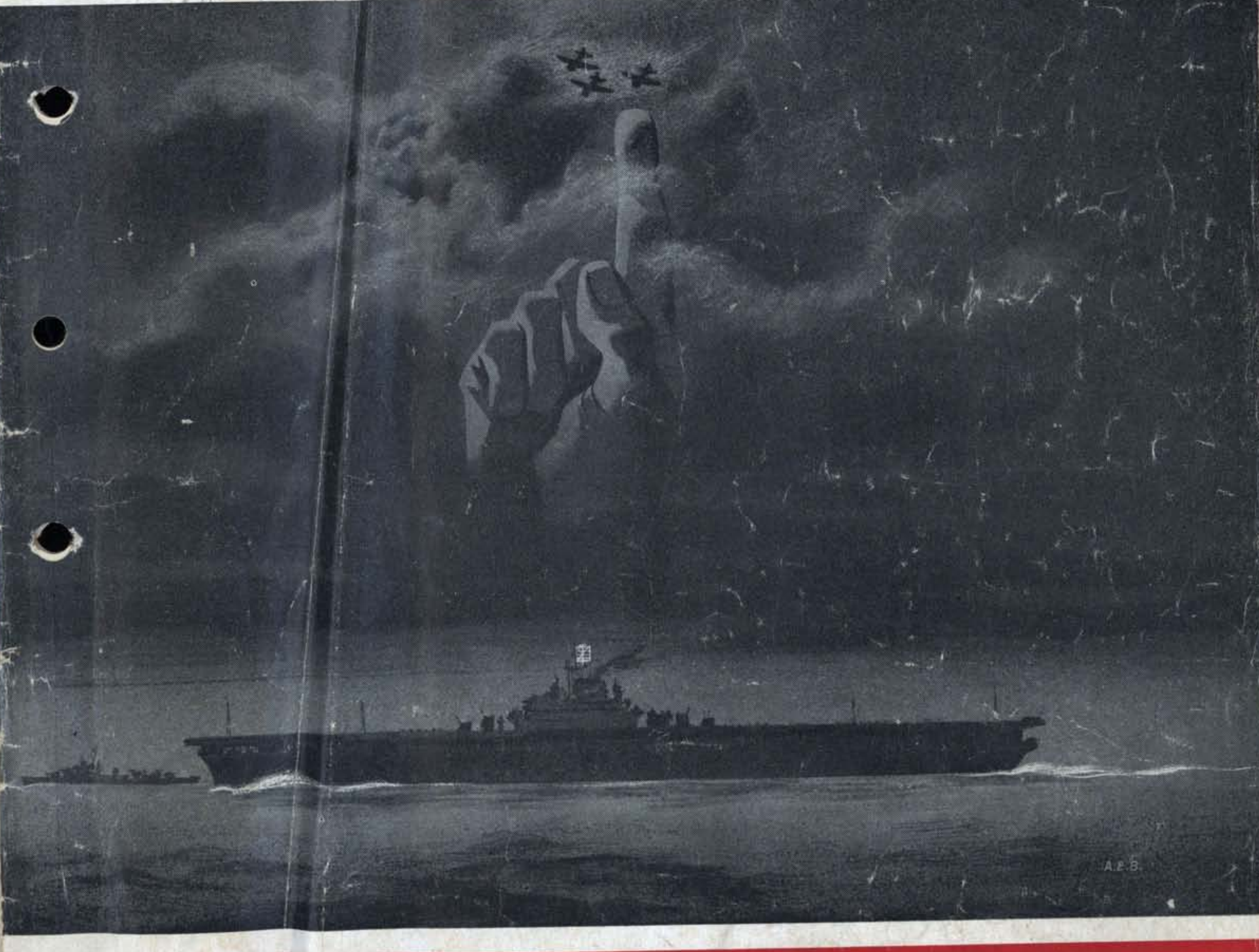

OFFICE OF THE CHIEF OF NAVAL OPERATIONS

CONFIDENTIAL

C. I. C. COMBAT INFORMATION CENTER JULY 1944

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A *Confidential* magazine published monthly by the Chief of Naval Operations for the information of commissioned, warrant, enlisted personnel, and persons authorized, whose duties are connected with the tactical use and operation of electronic equipment.

OPERATING PERSONNEL ARE INVITED TO SEND ARTICLES DIRECTLY TO THE EDITOR

This publication can be of maximum service only if operating personnel freely contribute items of interest. Accordingly, contributions are invited and may be addressed directly to The Chief of Naval Operations, Editor of "C. I. C.", Washington 25, D. C., with a copy to immediate Commanding Officer.

Contributions of all types are welcome, including critical comments on articles which have appeared in this publication, suggestions for the improvement of equipment or techniques, and personal accounts of operations.

CLEAR PHOTOGRAPHS OR DRAWINGS TO ACCOMPANY THESE ARTICLES ARE ESPECIALLY DESIRED

UNITED STATES FLEET

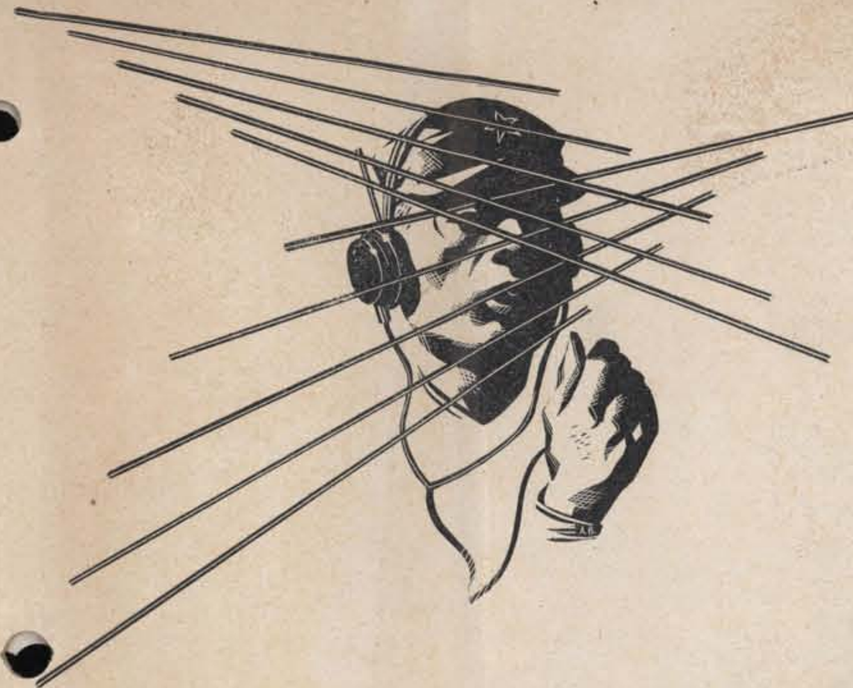
Headquarters of the Commander in Chief
Navy Department, Washington, D. C.

1 July 1944.

Properly used Radar with its associated electronic equipment is one measure of our superiority over the enemy. The Combat Information Center and the CIC team are the principal means, afloat and ashore, of utilizing radar's information. In the air, radar and radio play a vital part in this war. In striving for the most effective results in electronic warfare, the operational development of personnel must be continuously in accord with the technical development of the equipment.

This magazine CIC is established as an aid to Command, CIC, Aviation and other interested personnel to present, monthly, a digest of the latest operational methods evolved, and lessons learned in combat, so their skill and ability may, at all times, equal the capabilities of the equipment which is available to them.

R. S. EDWARDS,
Chief of Staff.



WINDOW

ALL POWERS *are now dropping Window decoys and jammers during the majority of their raids on land and sea forces. This article presents a digest of information on this type of deception and describes the purpose, appearance, and characteristics of Window jamming.*

Window is paper-backed aluminum foil of such size and shape as to cause a sizable reflection of the radar beam. It is usually dropped in great quantities by attacking aircraft in the vicinity of enemy fire-controlled radars, or further out to jam and confuse the GCI (Ground Control Interception) and long-range warning systems.

The radar beam which normally strikes an aircraft, and by reflection causes a single signal or *blip* on the radar screen, is similarly affected by Window when it is cut to the proper length. Instead of one or several *blips* from the several planes in the air, a profusion of "fictitious" targets, at various ranges and bearings, appears on the screen. The operator will become confused if not properly trained and thus lose track of the actual target.

The primary purpose of Window is to deceive and confuse the enemy during low visibility and deceive or jam his radar systems. Since the enemy can rely, during good visibility, on optical systems of fire control, the use of Window to spoil his radar ranges has not been considered too effective. However, the proper use of Window against fire-control systems becomes increasingly useful day or night as the accuracy and tracking speed of the controlling radars are improved, and as the radar fire-controlled system becomes more and more electro-mechanically automatic.

WINDOW IN THE PACIFIC

Tactical use of Window by our aircraft in the Pacific Theater could parallel the proven technique employed in the European Theater, with modifications to meet local tactical situations. When reconnaissance and intelligence indicate that enemy bases or ships are utilizing radar for ground controlled interception, gun laying, searchlight control, or air interception (AI) against our night bombing attacks, various tactical employments of Window would be indicated. The Japanese apparently have installed fire-control radars on some of their capital ships and supporting DD's and DE's. It must be assumed that the pace of development is such that air intercept and searchlight control are effective, or rapidly becoming so.

SOME TACTICAL USES OF WINDOW

Window is chiefly an offensive weapon used to upset the enemy's defensive measures. It may be used (a) for decoy or deception or (b) to jam the enemy's radars.

(*a*) *Decoy or deception:*

(1) A false raid may be simulated by dropping large quantities of Window within range of enemy radars; then when enemy fighters go out to meet the supposed raid, the true raid comes in low on the target from another bearing.

(2) Window may falsify the size and composition of strikes, a few planes simulating large groups coming in from various bearings, thus forcing the enemy to scramble and split fighter strength, and lessening the opposition which the real raid must meet.

(3) During low visibility, lead planes may confound GCI with Window which covers up all other bombers in the force and prevents enemy controllers from directing fighters to plane-to-plane interceptions.

(*b*) *Jamming Enemy Radars:*

(1) In the enemy's defended area, a lane 20 miles wide, to and from the target, may be saturated with phantom targets, rendering the enemy's fire control and intercept radars largely or completely useless. Bombers may then travel this blocked-out skyway and unload with a minimum of opposition.

(2) The area around the enemy's fire control radars may be saturated with Window so that neither guns nor lights can be radar-aimed. During low visibility, this is extremely effective.

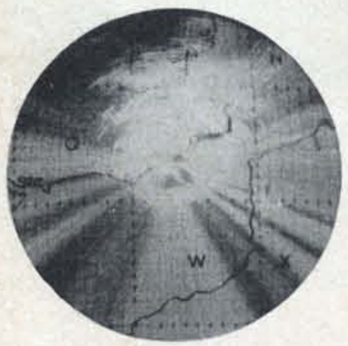
(3) Ships in a task force may fire ahead large quantities of Window, run into it, and be screened from shore-based enemy radars.

(4) A bomber being pursued by a night fighter can jam the enemy's AI by unloading Window and effectively screen a get-away.

(5) A very effective use of Window is for the screening of a torpedo-bomber or dive-bomber attack on an enemy task force. Parachute-suspended Window can be used to blanket the entire area of the task force, and the planes can then attack safe from detection by the enemy's blinded fire-control radar.

ENEMY USE OF WINDOW

"Window" on H/R tube. Horizontal polarisation.



"Window on PPI." Heavy concentration of "Window" to north, and jamming also from the east.

The Germans retaliated to the United Nations use of Window by also employing this countermeasure. The Japanese have been employing Window in all areas of the Pacific.

Recent German use of Window has reached the point where almost complete infiltration of an area has been attained. The pictures are actual photographs of radar screens taken during a recent German bombing raid in the United Kingdom area. The Japanese have also shown an appreciation of the potentialities of Window by continued increase of the quantity used. The Axis Powers have mainly concentrated their efforts against radars operating in the meter bands, though recently the Germans have made specific attempts against Allied centimeter radars. To date, there is no evidence that the Japanese have employed Window directed against our centimeter bands. It is practically impossible to jam centimeter equipment because of the narrowness of the beam and the short resolution (distance in feet the signal travels between pulses). To jam centimeter, Window would have to be dropped every 3 seconds.

APPEARANCE OF WINDOW

At the start of jamming, Window will appear as a series of blips which resemble the blips from aircraft. If large quantities are dropped in one area, a "blackout" of part of the radar screen will occur and the equipment may be rendered temporarily ineffective.

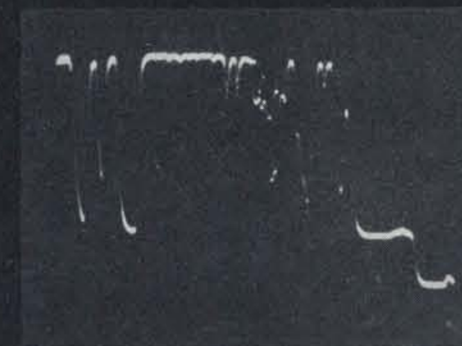
1 SG PPI: The two targets at about half range are: Window at the smaller range and a destroyer at the greater range. The plane dropped Window in nonconcentric circles to screen the destroyer, see pictures 2 and 3.

2 SG PPI: Circular spot is Window dropped to screen a DD.

3 SG PPI: Same Window 15 minutes later, showing drift with the wind. The destroyer is Southwest of the Window at about 100° at half range.

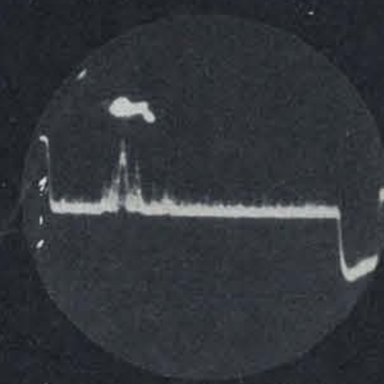
4 SG PPI: A trail of Window has been dropped as plane approached from 080°.

5 SG A Scope: The third pip from the right is Window. Just to the left of the Window is the plane that has just dropped it.



6 SC A Scope: The plane that dropped the Window in picture 5 has continued and left a trail of Window. Both of the single pips near the pulse on the left are planes. Note that the Window far out has begun to disperse and lose effectiveness.

7 FD C and I: Window appearance on FD scope. There are no targets here besides Window.



8 SG A Scope: The Window that was dropped for the FD shot 7 was tuned for 700 Mc/s. The SG shot 8 shows the effect of 700 Mc/s. The target pip moving through the mild Window interference is an aircraft.

As time goes on and Window disperses, each blip will become wider and of less amplitude, and while occupying more of the timebase will become less like an aircraft blip.

The difficulties in operating are similar to those which would occur if clutter (ground return) extended over wide limits of range, and was of an amplitude greater than normal.

As with normal clutter, once the Window jamming has been recognized and the best method of operating is understood, much of the reduction in efficiency can be eliminated.

POINTERS FOR OPERATORS

Following are some facts about Window which will help operators to recognize its presence and to determine how to read through it.

(1) The strips of foil are "tuned" by the length to which they are cut. Approximately half the wave length of the radars to be jammed gives maximum interference. Such Window is somewhat effective against other frequencies, moderately so against higher frequencies but much less so against lower frequencies.

(2) Window cut to half wave length is more effective against long pulse length than against short. *Range discrimination* (the range difference necessary for two or more targets to be identified separately) aids in distinguishing phantoms from true targets. If batches of Window are not separated in space by more than this range difference, the Window will produce a continuous echo on the scope, making it very difficult to pick out the real target.

(3) Window is less effective against radars with narrow antenna-beam width and weak side lobes than against radars with wider antenna-beam width and stronger side lobes. (Strong side lobes give the same trouble with Window as with permanent echoes.) When batches of Window are not separated in space by more than a beam width, a continuous echo appears on the scope as the antenna rotates, but when separation exceeds a beam width, there will be breaks in the contaminated area as the antenna rotates, and planes may be spotted in these open spaces.

(4) When large batches of Window are dropped in a given area, many echoes resembling aircraft will appear on the scope. Here are pointers on how they look and act:

a. A Window echo beats very heavily, but otherwise is similar to a fixed echo, with practically no change in range or bearing.

b. Window falls relatively slowly, so its effect remains long after departure of the plane which dropped it. Wind sometimes spreads Window so as to contaminate large areas rather uniformly.

c. As in Figure 1, Window may show as many separate, closely spaced echoes which stay at a fixed range. In this illustration the echo of the plane dropping Window is at the right. On a PPI scope Window appears as a solid block of brightness along the trail of the plane dropping it, as shown in Figure 2.

(5) Alert operators can often read through Window by familiarizing themselves with distinguishing characteristics of Window echoes and manipulating the controls of their sets to combat Window effects and bring out every possible difference between Window and true target echoes. Attention to range separation, beam separation, flutter, fixity or mobility of echo, manual control and scanning the infected area, manipulating gain controls—these methods have produced successful reading through Window many times.

CinCPAC AND CinCPOA SAY OF WINDOW

"Use of Window against fire control radar can be considered as Doctrine. The use of Window against surface warning systems should be limited to those circumstances when it is desired to confuse the enemy as to the direction from which the attack is taking place and as to the number of planes taking part in the attack. The use of Window against early warning systems may add to the confusion of enemy operators but will not prevent the enemy from obtaining early warning of attack.

"An energetic and aggressive enemy attack with the aid of Window can make well-trained range-finder operators extremely valuable. (*Continued on p.*

RADAR AND WEATHER

THE PHANTOM ENEMY

One year ago this month a Pacific force consisting of battleships, cruisers, and destroyers fired intermittently for more than an hour against targets discovered by radar, under circumstances that created doubt as to the presence of enemy forces.

Radar reception was exceptional and after the "battle" started spots were obtained which indicated that the enemy was covered with projectiles—yet at no time was enemy fire observed nor were enemy ships sighted.

But contact with enemy forces was expected; the crew was keyed up and the SG, FC, and FD radars said that the "enemy" was there. Result—a battle with a phantom enemy.

The upshot of the battle was the conclusion that the force had been firing at an island some 75 miles outside of the range of the big guns on the battle wagons! Atmospheric conditions had stepped in to modify the usual range characteristics of the radar sets and, because of reception on second, third, or fourth sweeps on the scope, the ranges looked authentic as first sweep ranges.

Weather and atmospheric conditions may greatly modify the normal range characteristics of radar and VHF radio. Serious errors and false evaluation of radar presentation may result if we do not take into consideration the effects produced by these conditions. Such effects on radar and VHF may leave doubt in our minds as to the effectiveness of the equipment. We can, however, by understanding and allowing for these phenomena make useful instruments more effective: the weather will work *for instead of against* radar and microwave equipment.

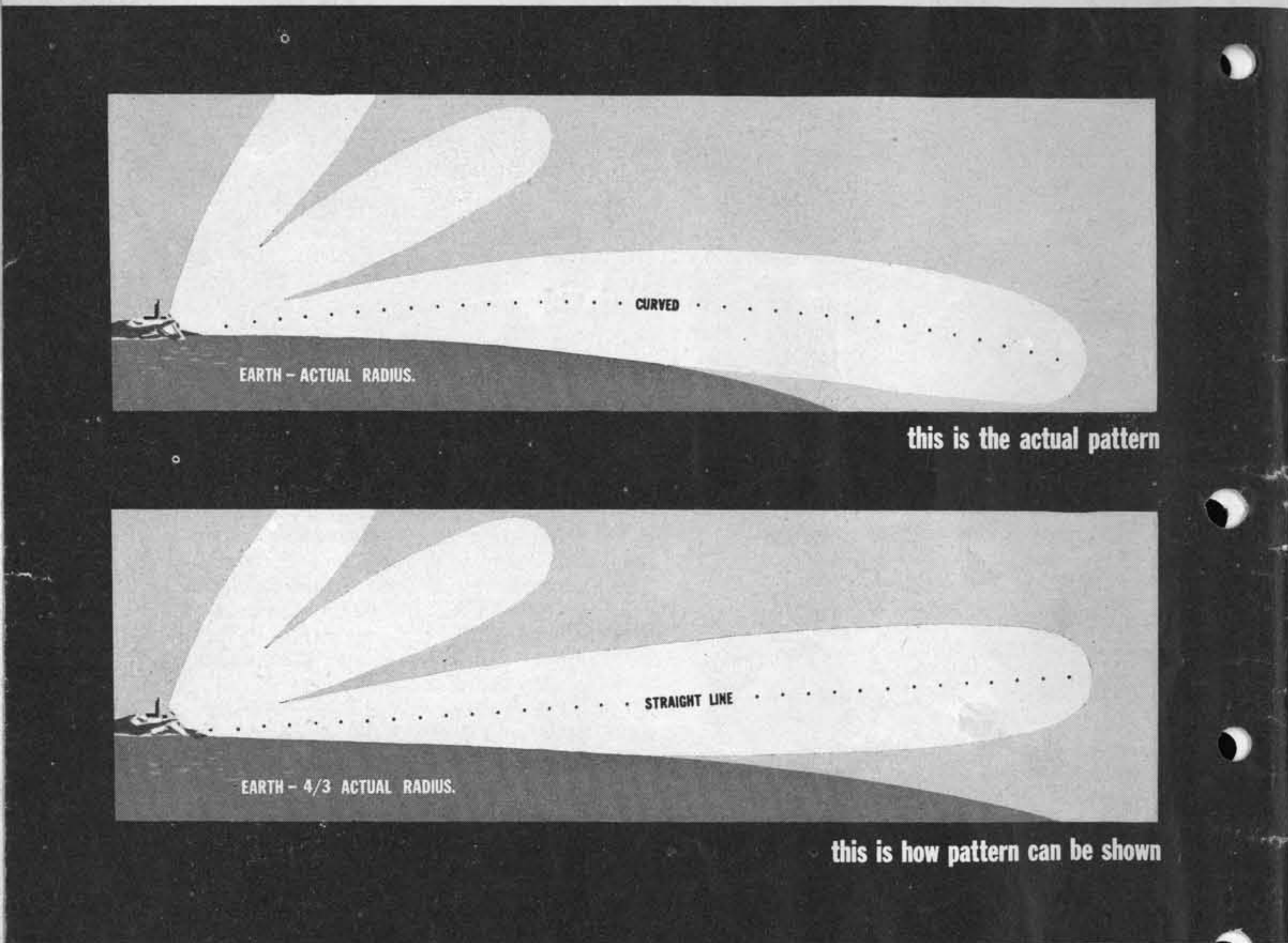
BENDING OF WAVES

Unusual ranges are caused by *bending* or refraction of the radio waves by the atmosphere. A most important special case of refraction is the concentration of the wave energy in ducts within the atmosphere. This *bending* and *duct formation* is a direct result of the meteorological factors involved—factors of weather and atmosphere—and peculiar, in many cases, to the locality and the season.

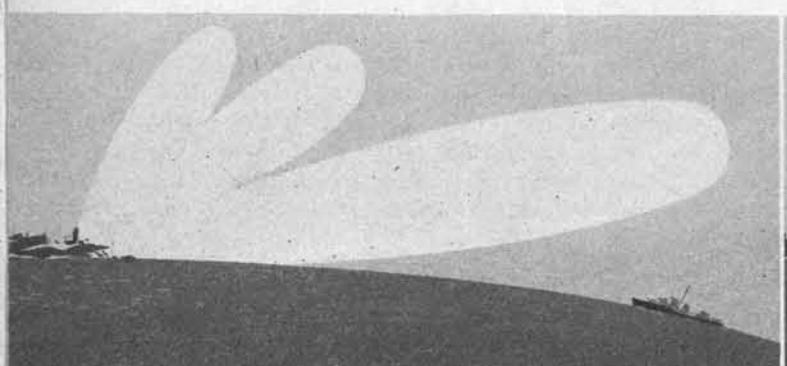
The VHF or radar operator usually assumes that short waves and microwaves, at frequencies above about 30 megacycles, travel along the line of sight from the transmitter to the receiver, and, in the case of radar, to and from the target. Experience has shown that this assumption, nearly true in many instances, may lead to serious errors or false evaluation if applied to radar operation and microwave communication.

Radio waves are bent from a straight line path as a result of refraction by the lower atmosphere. This bending, or *refraction*, is generally recognized as a property of light. It is equally a property of radio waves. The underlying principles are exactly the same in both cases.

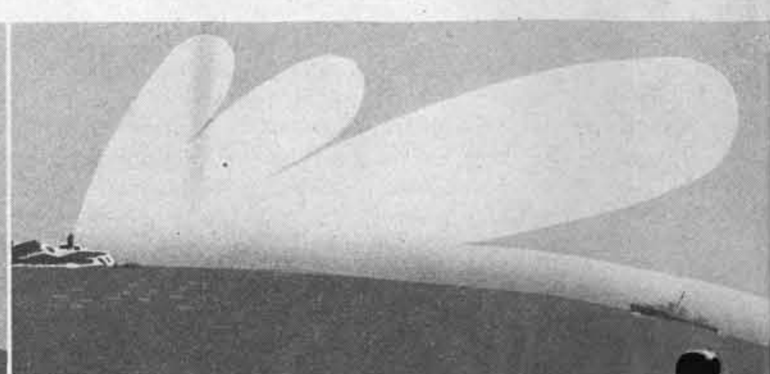
As can be seen from the illustration of the actual pattern, the bending of the waves, or rays, by the atmosphere permits one to see farther than he would otherwise. In the figure the vertical dimensions have been strongly exaggerated so that the earth's curvature becomes clearly visible. Under average weather conditions the horizon distance is increased by about 15 percent, but at an elevation near the first lobe the increase in range is much less than this amount. This is the case of standard refraction, or *standard propagation.*



It is rather inconvenient to draw curved rays in radar coverage and calibration diagrams. This can be avoided by assuming that the earth's radius is $\frac{4}{3}$ the actual radius. Then in the diagrams the rays appear as straight lines when the propagation is of the standard type. This method often is adopted in radar calibration practice, with coverage diagrams drawn or printed to the $\frac{4}{3}$ value of the earth's radius. This corrects for the effect of normal bending in the atmosphere. The radar operator merely plots the position of his target on such a diagram and assumes that the radiation travels along a straight line between the radar and the target. He can then ignore the effects of standard refraction while doing his work.



Radar lobe pattern in standard atmosphere . . . Steady variation of temperature and humidity aloft.



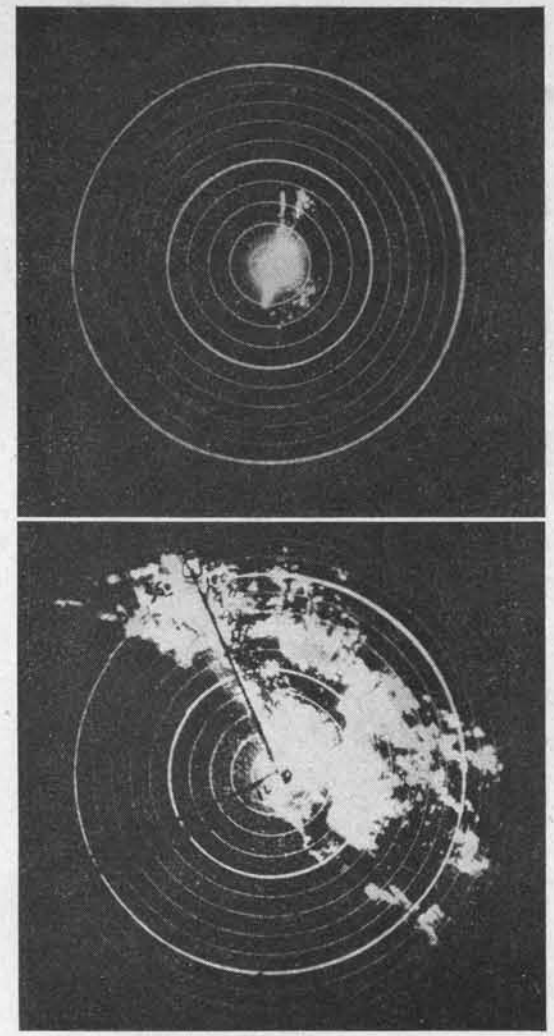
Radar lobe pattern in nonstandard atmosphere . . . A duct has been formed on the surface and ship is detected.

GUIDED PROPAGATION

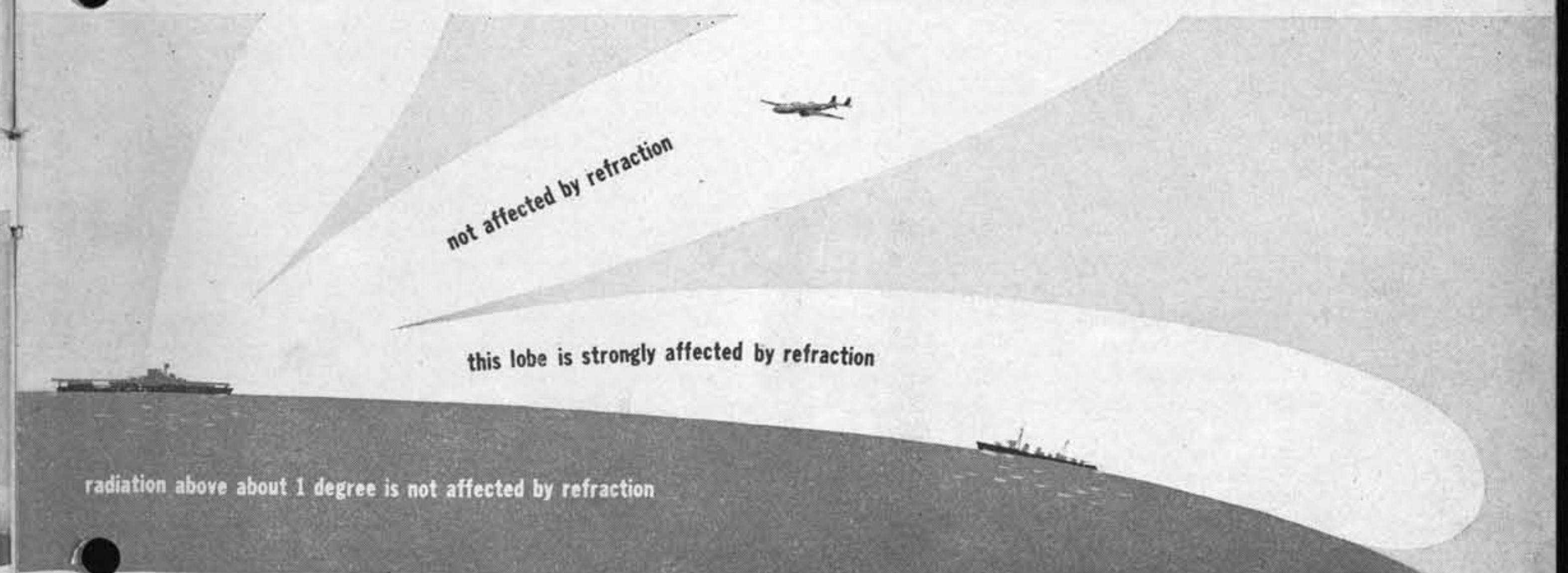
Wave propagation deviating from standard occurs under special weather conditions. The most important type is called "guided propagation", "trapping", or "super refraction"—formerly referred to as anomalous propagation. The main feature of this type of propagation is an excessive bending of the rays due to refraction. This bending occurs principally in the lower layers of the atmosphere and mainly in the lowest few hundred feet. In certain regions, notably in warmer climates, excessive bending is observed as high as 5000 feet. The amount of bending in regions above this height is almost always that of the standard atmosphere.

Two factors are operative in producing a rapid change of refractive index with height: namely, variation of moisture with height and variation of temperature with height. Excessive refraction occurs when there is a rapid decrease of moisture with height ("moisture lapse") and, to a lesser degree, when there is a rapid increase of temperature with height ("temperature inversion"). The most pronounced cases of excessive refraction occur when both these conditions prevail at the same time.

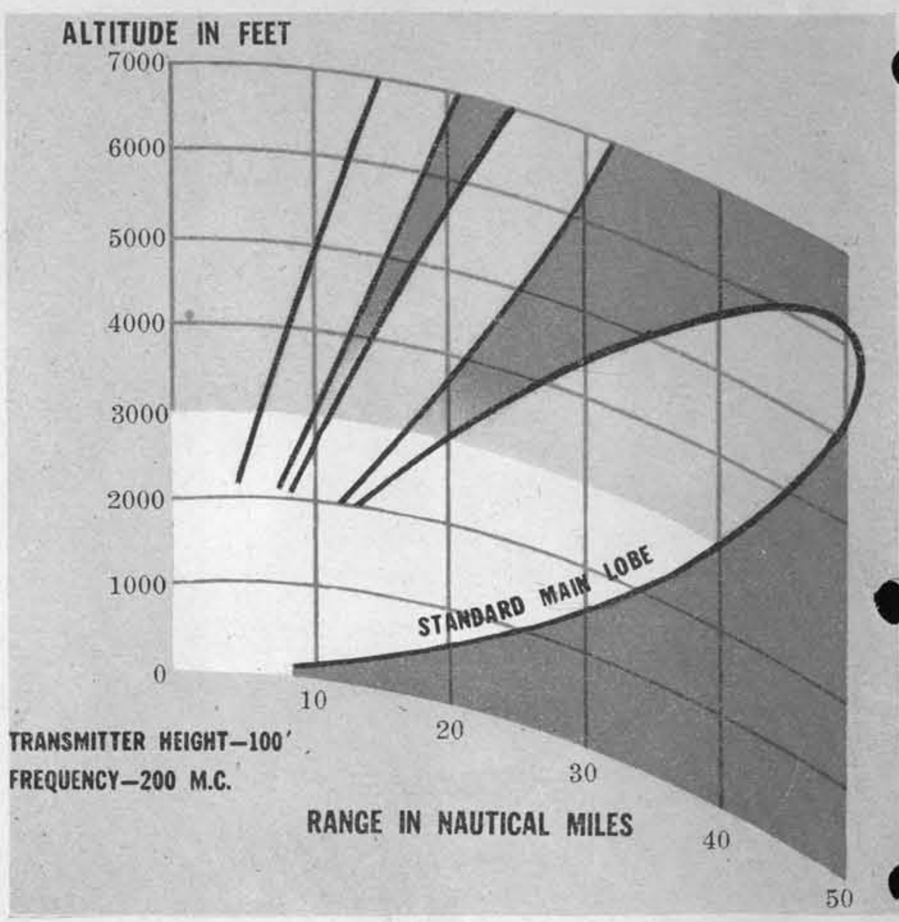
The amount of refraction, that is the amount of angular deflection of the rays, is very small and in no case exceeds a fraction of a degree. How then can these small effects influence radar operations? The answer is that they do not influence operations unless the angle between the ray itself and the horizontal is very small. If radar is used for fire control, searchlight control, or fighter intercept control, the targets are usually at medium or short ranges, and the angle between the line of sight and the horizontal is usually



P. P. I. Scope showing.
Upper—Standard Propagation Conditions.
Lower—Ground Clutter with a Ground-Based Duct.



LOBE DIAGRAM UNDER STANDARD CONDITIONS



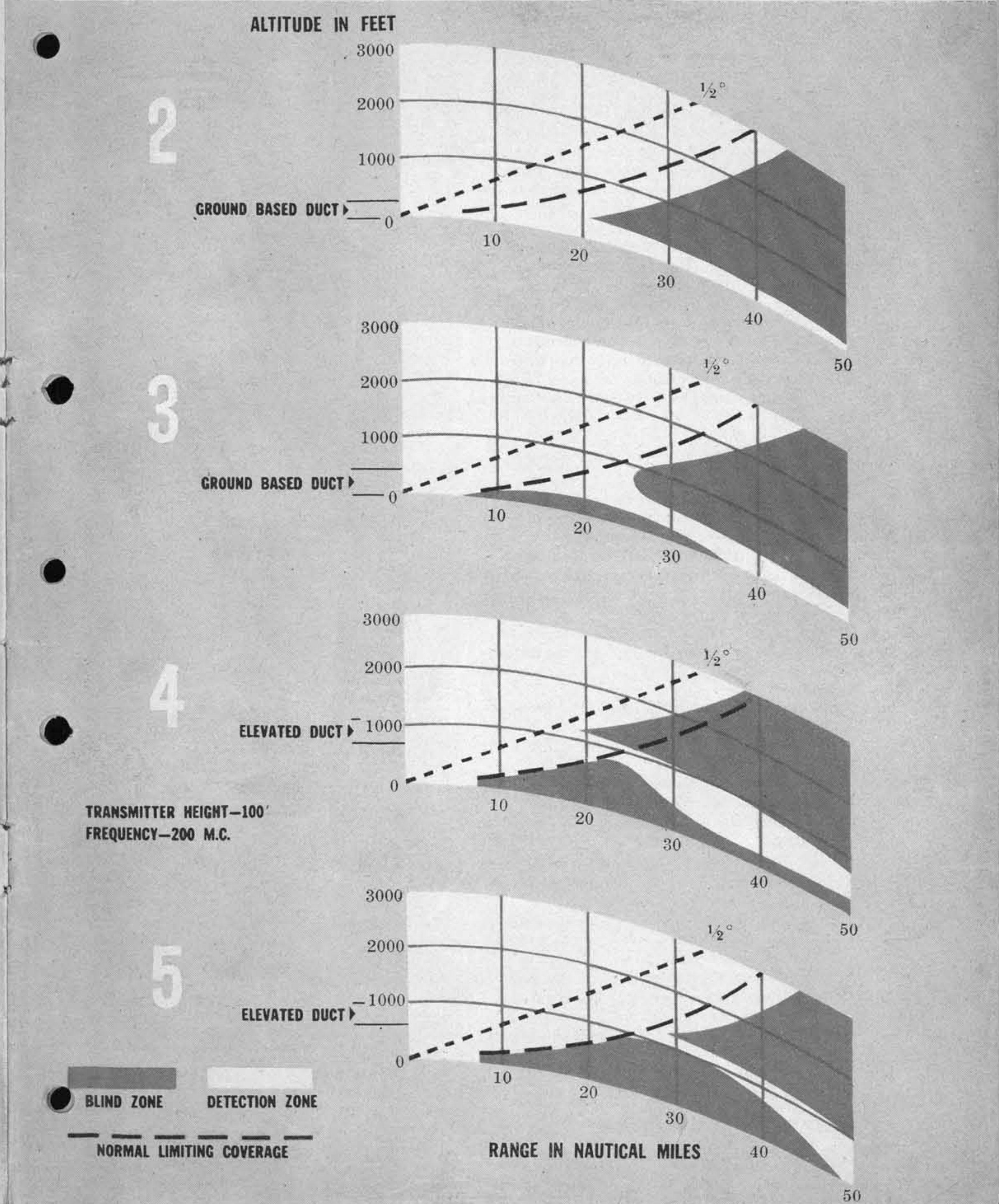
larger than one to two degrees. Refraction has practically no effect on such an application of radar.

With early warning radar the target may be an airplane 50 or 100 miles away, and it may fly at an elevation of only a few thousand feet. In this case the angle of elevation of the target above the horizontal, as seen from the radar, is only a fraction of a degree. This applies still more to seaborne targets. The atmospheric effects then become operationally important. It should always be kept in mind that only low-angle search is affected by meteorological conditions.

A coverage diagram for standard conditions is shown above with height strongly exaggerated. Only the lowest three lobes are shown, and the higher lobes appear compressed as compared to the lowest lobe. To the right (diagrams 2, 3, 4, 5) the lower part of the same diagram is drawn as it appears under various conditions of guided propagation. The bottom part of the "standard" main lobe is shown by a broken line. The lines which separate the "blind zones" from the "detection zones" represent the range at which a medium bomber would just become visible to this particular radar set.

The diagrams clearly indicate the great extension of ranges in the duct, and also the moderate change in ranges—sometimes an extension, sometimes a reduction—above the duct. Another feature of some of these diagrams is the appearance of "skip-ranges." A plane flying at an altitude of 500 feet, for instance, would be detected early under the conditions shown in diagrams 4 and 5. As the plane approaches, the echo will disappear from the scope and reappear only at a range less than 20 miles. Similar conditions will prevail for ground clutter. In diagram 3 there would be ground clutter close in and also from beyond 33 miles, but not from the space between. For conditions shown in diagram 5, there would be echoes from very remote ground targets but not from targets at intermediate ranges.

COVERAGE DIAGRAM SHOWING DEFORMATION OF LOWEST LOBE



Sometimes the Equipment Is At Fault . . .

A change in echo strength from day to day is not necessarily caused by the weather, but might simply be caused by a variation in performance of the set. Cases have occurred where there was extensive trapping, but due to lowered set performance there was no corresponding increase in fixed echo strength. The set then will appear to be in good operating condition, and the operator will be deceived about ranges of detection for craft flying about the duct. Equipment for checking set performance is not usually available in the field. The change in intensity of nearby fixed echoes may be, in some cases, a measure of set performance but, in the absence of more elaborate checks, this method can be misleading and should not be relied upon entirely.

Failure of detection of targets is not necessarily due to weather influences. Electrical failure of the set or inadequate adjustment may be the difficulty and may be far more troublesome to identify than meteorological effects which should not be used as a "scapegoat" to be indiscriminately blamed for poor coverage.

SUMMARY—*Basic facts concerning propagation at radar frequencies*

1. Standard propagation results in a slight downward bending of the rays throughout the atmosphere, leading to an increase of the horizon distance compared to the geometrical value. It is taken into account operationally by using coverage diagrams with a 4/3 earth's radius; on a diagram modified in this way the rays appear as straight lines.

2. Guided propagation occurs almost exclusively in the lowest 2,000 feet above the ground, and usually is confined to the lowest few hundred feet (except in warm climates).

3. Super-refraction resulting in guided propagation or trapping is produced:

(a) By a pronounced decrease of moisture with height (moisture lapse), or

(b) By a pronounced increase in temperature with height (temperature inversion), and

(c) Particularly, by a combination of both of the above conditions.

4. Of the meteorological conditions conducive to guided propagation or trapping, the most outstanding are:

(a) Over sea: Flow of warm, dry air over colder water producing temperature inversions and evaporation into the lowest layers.

(b) Over land: Nocturnal cooling of the ground with clear skies and calm air or light winds (if moisture distribution in favorable).

(c) Over both sea and land: Low-level subsidence.

5. Conditions in a barometric high, including calm and clear skies and especially low level subsidence, favor trapping especially during the night (but do not necessarily produce it). Conditions in a barometric low, including strong winds, intense turbulence in the lowest layers, and overcast skies are conducive to standard propagation.

6. When the transmitter is within the duct, radar range is increased for surface targets (ships) and aircraft flying in the duct. At the same time there is an increase in fixed echo strength and consequently in ground clutter on the scopes. This may be accompanied by a change in the range of detection for craft flying above the duct.

7. When the transmitter is outside the duct, the range may either be increased or decreased from its standard value.

8. Effects of nonstandard propagation are negligible when the angle of elevation of the target is over 1°. Failure of detection at such angles must be attributed to other causes.

▼ ▼

This article, in part, is a digest of the information in *JANP 101*, June 1944 published by the Joint Communication Board, Washington 25, D. C.

Some of the original illustrations appearing in *JANP 101* are reproduced on these pages.

Copies of *JANP 101* have been distributed to Army and Navy activities.

(*Continued from page 4*)

Short of complete destruction of the enemy and his equipment, the next best countermeasure is a well-trained operator."

OPERATING THROUGH WINDOW

A partial antidote for the use of Window is the use of the lower centimeter bands which lend themselves most readily to narrow beams, hence better target definition. Shortening the pulse length also enhances definition but brings a reduction in range. Pending the replacement of present radars with improved models, the best countermeasure to Window, when used by the enemy, is training of personnel.

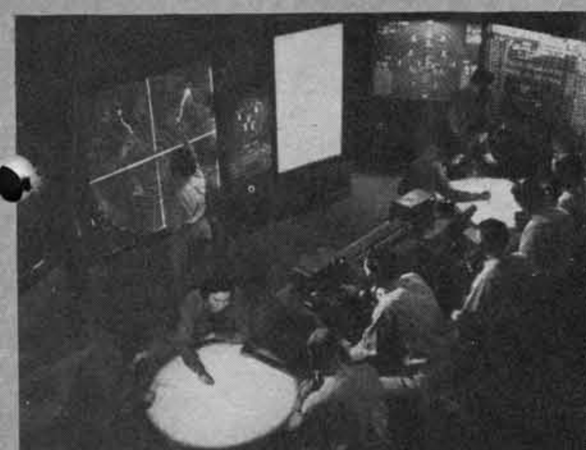
Operators must be taught to recognize Window and drilled in reading through it. Thus, the enemy may be prevented from successfully confusing our operators and jamming our scopes. It has been found by actual experience that the effectiveness of Window decreases with use. The response from Window appearing on the radar screen, characterized by a rapid beating of a higher order than that of a plane or the beating experienced between two targets, is readily recognized by a well-indoctrinated operator.

THIS IS FIGHTER DIRECTION

◀ Photographs on these pages were taken from the moving picture *MN–1006d This is Fighter Direction.* Prints will be available for shipment approximately 15 August. They will be forwarded to all Carriers; Pacific Fleet Radar Center; Radar Training School, St. Simons Island, Ga.; Aviation Film Libraries ComAirPac, Navy No. 140, Navy No. 145, Navy No. 115, Navy No. 117; NAS San Diego, NAS Alameda, NAS Seattle, NAS Norfolk, NAS Quonset, NAS Patuxent River, NAS Floyd Bennett Field, NAS Brunswick, NAS Atlanta; NATC Corpus Christi, NATS Pensacola, NATS Jacksonville; Fleet Air Wings 4, 11, 12 & 16; Marine Aviation Libraries and sublibraries MARFair West Coast, MCAS Cherry Point, Navy No. 61, Navy No. 156, and 4th MBDAW.

◀ The best defense against air attack is provided by the efficient use of our fighter aircraft.

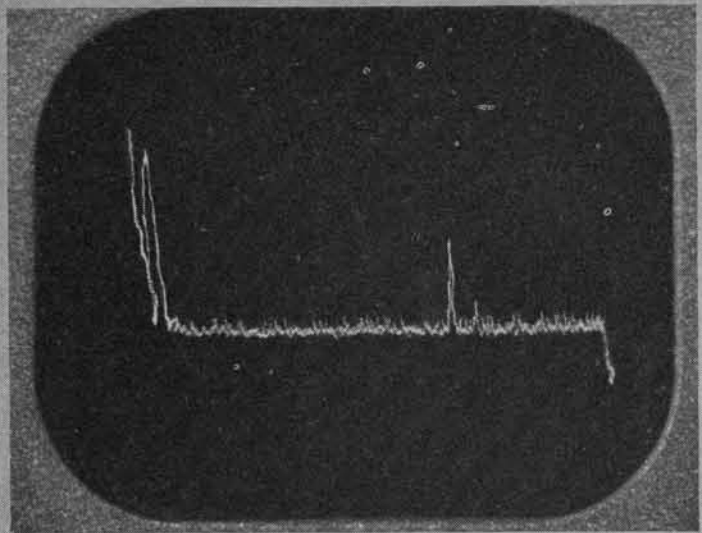
These aircraft, to successfully intercept the enemy, must be directed by radio from a center which has at hand the information on the attacking forces, their course and speed, altitude and size.



◀ Aboard the carrier is such a center.

Its function is continuously to furnish an accurate picture of the tactical situation and to take the necessary action to protect the task force from air attack.

◀ Unidentified aircraft—*bogeys*—are detected by the long range search radar. The operator reports to the Combat Information Center, giving the bearing and range of the aircraft.

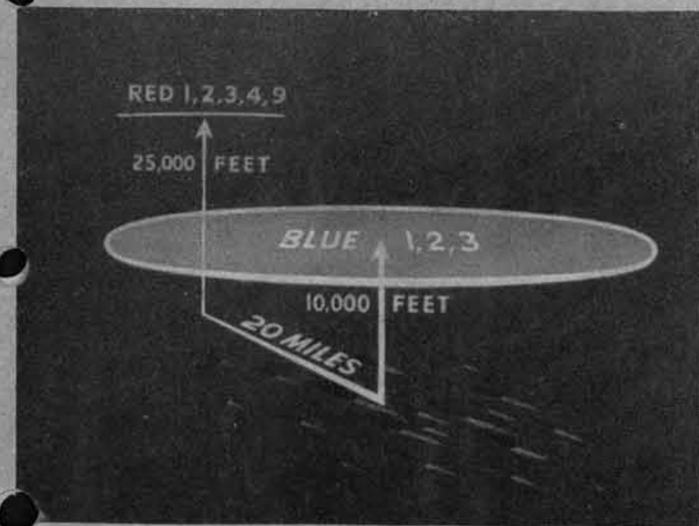


◀ When the planes are first detected on the radar scope it may be difficult to determine information other than bearing and range of the target. Subsequent reports will, when plotted and evaluated in Combat Information Center, show course and speed of the bogeys and the important information on altitude.

◀ The force fighter director designates the raid by number, gives instructions for the interception of the raid, and informs the task force commander of the action taken.

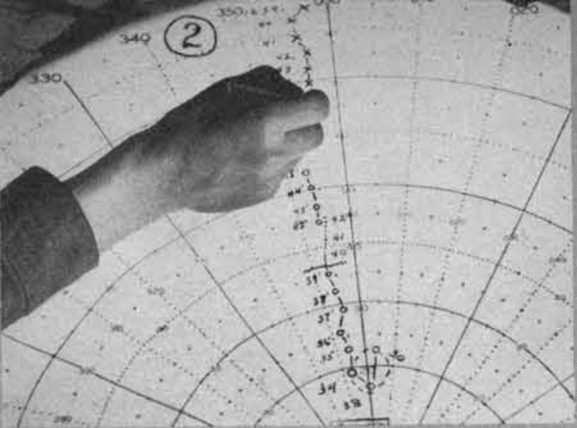
◀ The radio intercept operator furnishes valuable information to C. I. C. Such information—usually translations of the enemy's ship or aircraft radiotelephone conversations—may indicate, for example, that a "shadower" has seen our forces and reported our position to his base.

◀ When radar and air search information shows enemy air activity in great force, ship and aviation personnel are ordered to General Quarters. C. I. C. is then fully manned and ready to operate under battle conditions.



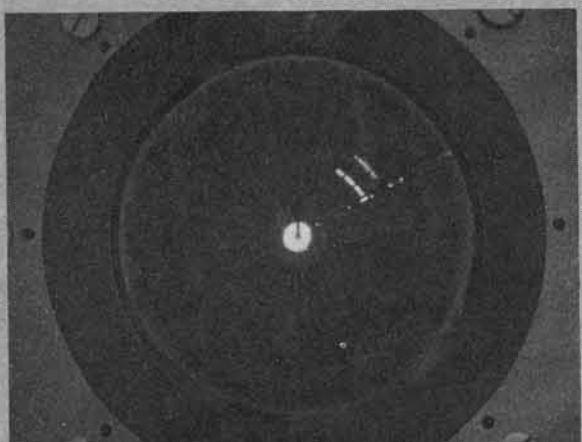
◀ The force fighter director orders the appropriate number of fighter aircraft to be scrambled and combat air patrols take station as directed, dependent upon the tactical situation. Some fighters will remain over the force, ready to intercept *bandits* which break through or sneak inside the twenty-mile circle.

◀ The officer in front of the vertical plot evaluates the radar plots visible to him through the board and marks the estimated position of the planes for a particular time. He is shown here marking the position of *friendlies* on their way out to intercept raid 3.



◀ The FDO has instructed the intercept officer to intercept raid 2. On the intercept board the position of the enemy and friendly planes is plotted continuously. The intercept officer endeavors, as the situation develops, to keep the fighters between the *bandits* and the task force.

◀ Beside the intercept board is a PPI unit on which is a radar picture of the situation. The intercept officer, as the interception progresses, refers to this indicator continually—sometimes exclusively, as the fighters overtake the *bandits.*

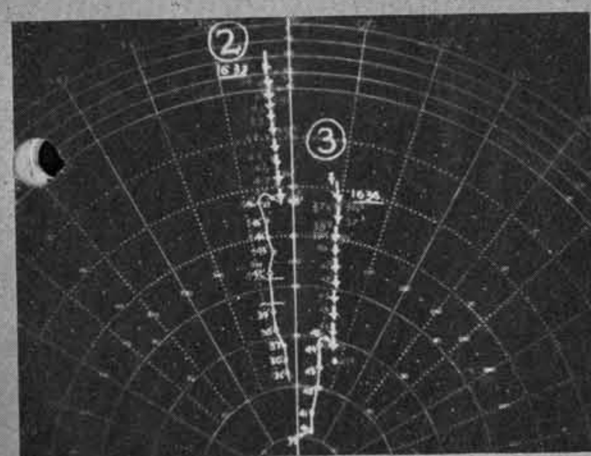


◀ Here is what the intercept officer sees when the fighters are close to the *bandits.* The bandits are shown as the outermost segment, the fighters slightly inside; the task force is at the center of the indicator. Notice that the VF are directly between the raid and *base.*

◀ As the fighters approach the enemy planes the intercept officer informs the pilot of the direction relative from the interceptor's course. In this case he would say, "Eleven thirty," and give the approximate distance. The fighters have been vectored to intercept above and in front of the incoming *bandits.*

◀ "Tallyho" from the pilot to base. The fighters have contacted, visually, the enemy aircraft. The fighters "have the ball" from here on in until the enemy planes are shot down or dispersed.

◀ "Splash." One enemy torpedo plane is downed, and the battle is on. If the enemy planes are protected by their fighter aircraft, the interceptors have a doubly difficult job.



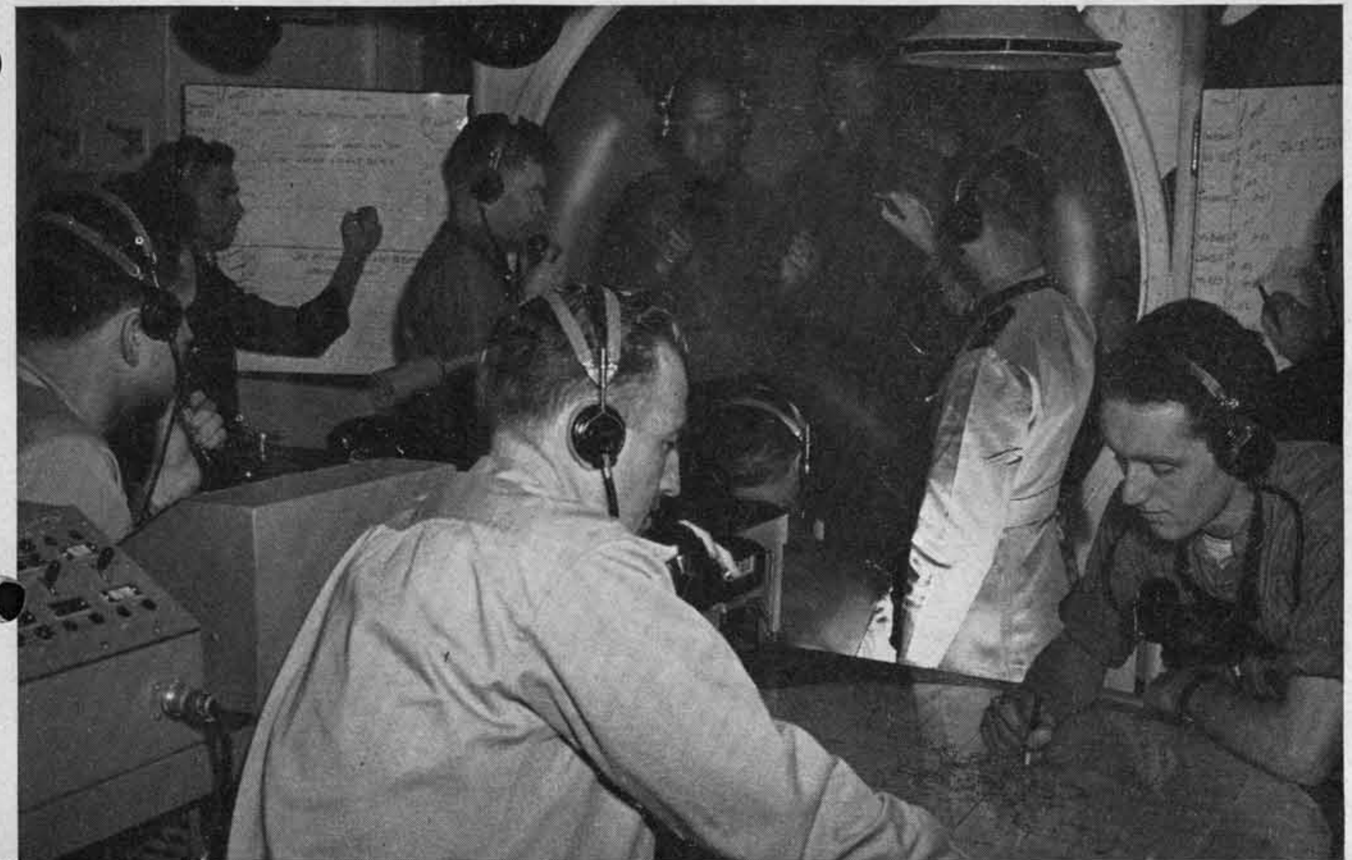
◀ This is how the vertical plot looks to the CIC personnel after two raids have been intercepted. The air battle is at a crescendo, and some of the enemy bombers or torpedo planes may break away and threaten another sector of the defensive ring around the task force.

◀ If another raid develops as bombers break through the outer defenses, the FDO must vector some of the CAP immediately to put them *between the new raid and base.* Even with these measures some of the planes may get through to the ships.

◀ The FDO instructs the visual intercept officer to prepare for interception of the incoming torpedo planes, and his antiaircraft liaison officer keeps Air Defense and the gun crews informed of the positions of the enemy planes.

◀ Topside the plot and information are kept up to date and the visual intercept officer is ready to direct planes of CAP to intercept the *bandits* on the outskirts of the formation. *These men would be wearing helmets at this stage of the battle.*

◀ Fighter Direction plays a basic, vital role in modern naval warfare, giving the fleet greater mobility in both offensive and defensive operations, and enabling naval units and task forces to make maximum effective use of their striking power—with the ultimate target the home fleet of the enemy.

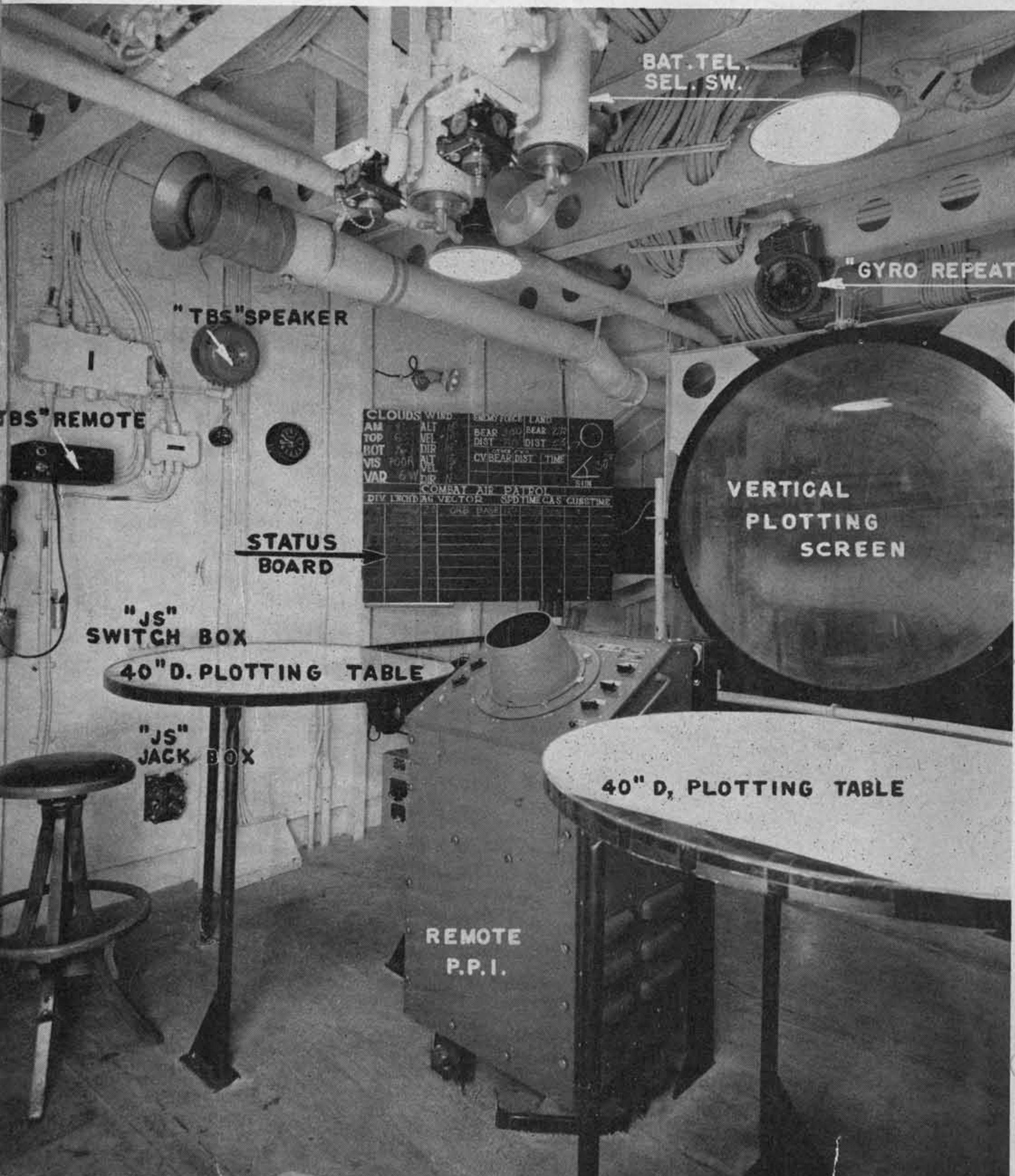


FIGHTER DIRECTION ABOARD AN AGC

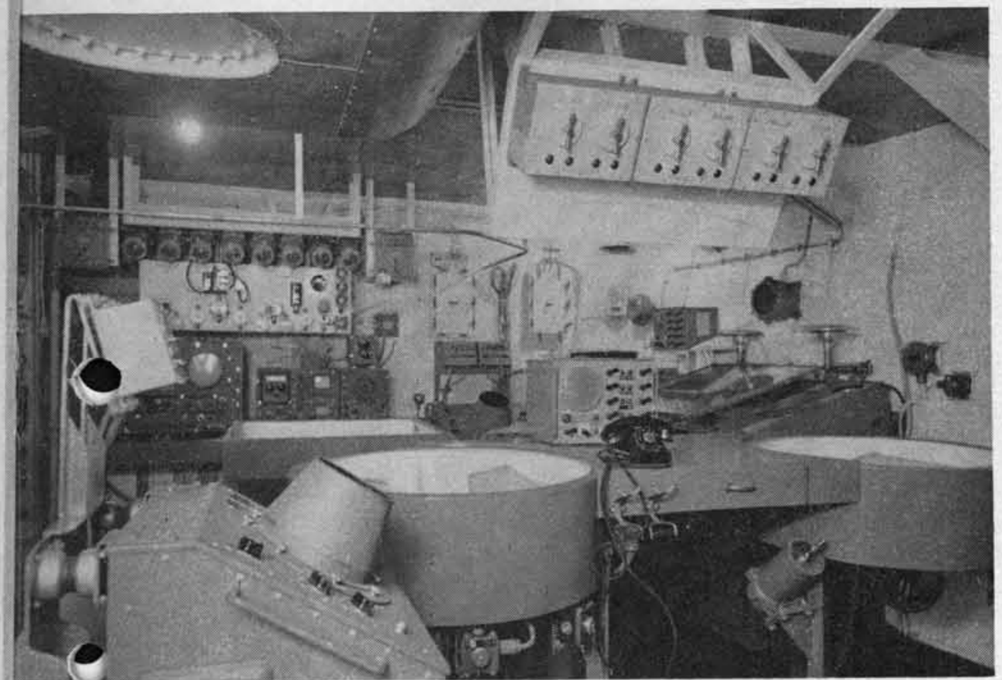
This view of an AGC CIC in operation indicates its complex duties in an amphibious assault. Both the Vertical Display and Intercept Pilot have polar coordinates with a grid overlay. The coastline, terrain, location of landing craft, and disposition of Allied and enemy forces are clearly drawn in. The AGC CIC presents an interesting combination of shipboard and shore-based methods.

Here is the Visual Fighter Director position on an AGC. The visual FDO operates with binoculars and chest phone, assisted by a plotter with a small board and chest phone.

CV, looking aft. Facilities for controlling Combat Air Patrols and numerous raids. Vertical Display Plot and Status Board tell the Fighter Director what the tactical situation is at all times.



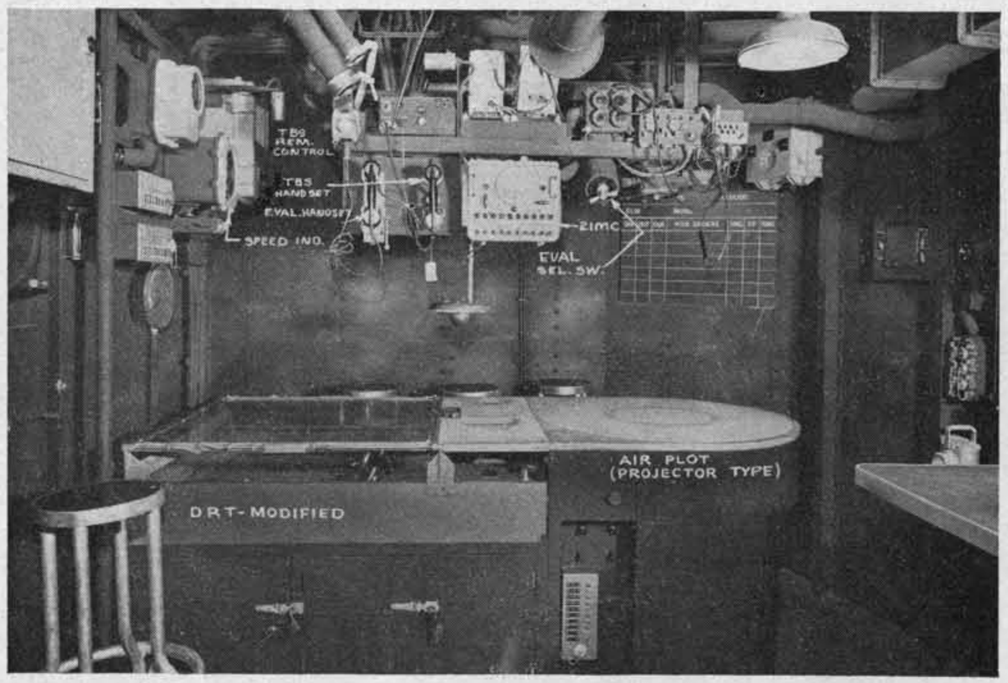
SOME SHIPBOARD CIC's



BB, looking forward. This elaborate set-up shows an SG and SK, two remote PPI's, DRT, plotting tables, sound power jack boxes and intercom units, radio remotes, clocks, and all other gear for complete controlling.

CA, with battle stations manned. Looming up in the left foreground, in front of the CIC watch officer, is a TDT (target designation transmitter) giving ranges and bearings to remote stations. Often, on Cruisers, the TDT is located beside the radars but here, interestingly, is stationed beside plot.

CL (6,500 tons), showing evaluator's position. This CIC contains (next to far right-hand corner of DRT) a chemical recorder from which the range rate of submarines may be determined, and the sound stack (behind the fire-control tube) giving range and bearing of submarines. Note the convenient location of the battle hand lanterns bolted to the overhead. The maneuvering board beside the DRT and Plot Table is an unusual feature.



DD, looking forward.—A simple, compact arrangement providing all facilities required for evaluation and control.

THE NIGHT FIGHTER, THE CARE AND FEEDING OF

A FORMULA for the ideal night fighter would include the mixture of one part dependable pilot, one part top physical condition, one part steady nerves and one part restrained imagination—plus a sprinkle of will to practice and a dash of dead-eye gunnery.

The night fighter is coming into his own. The enemy has forced his hand. How our night fighter plays that hand will have much to do with the course of the war. He must successfully meet the principal weapon left to the inferior Jap and German air forces: the threat of a decisive blow struck with cunning or surprise at night or in low visibility. The sting still left in the enemy's night offensive tactics, particularly the Jap's, is a damaging reminder of the necessity for effective night fighter counter-measures.

From the above formula, it is not to be assumed that the night fighter need be a carbon copy of Superman. A good night fighter is merely a top-notch day fighter—with added training and certain minor refinements.

Dependability, of course, is a prime requisite. The daytime "dive and zoom" boy can sometimes give a sloppy compliance to an order, then compensate for slight deviations and no harm will be done. Darkness is a demanding master. Chalk up an irretrievably-lost opportunity for the night fighter who is 30 seconds late in carrying out the fighter director's order or who takes a short cut on a standard turn. It is obvious then that the night fighter must be trained to ultra-precision. He must follow his instruments with the utmost confidence and ability.

The necessity for top physical condition needs no elaboration. Without entering into a controversy with the vitamin enthusiasts, some of whom claim that a few nibbles on a carrot will produce owl eyes, it must be admitted that physical fitness, which depends on proper diet, is closely related to one of the main requirements of a nightfighter; efficient night vision.

For in spite of the magic of radar which, through GCI (Ground Controlled Interception) and AI (Airborne Interception), can put a fighter pilot in position to make a kill, it is still the human eye which in practically every case must take over at the final and most crucial stage. Yet there is no mysterious key to effective night vision. Almost every pilot whose eyes were good enough to qualify him for flying has the native equipment to do the required job at night. Experience has shown that skillful training and determined practice pay amazing dividends to the pilot who must work at night. This involves no extravagant claims, for the basic system is one the Navy has utilized for lookouts for many years—night adaptation, scanning, and indirect sighting.

Naturally, recognition for the night fighter is a delicate and difficult proposition. It is just as impolite to shoot down your friends at night as it is during the daylight, even while granting that it is much more difficult to recognize a plane's features at night. Here again practice is essential (not in pot-shotting your neighbor, but in recognizing him). In a short time the night fighter discovers that even a tiny amount of lighting from the stars or the moon will give him a good deal to work with. The night fighter works by a system of deductions. His recognition must be so hot that even a small portion of a plane seen in a split-second spot will be enough to tell him the type. Such impeding variables as illumination, distance, and restricted sight area, plus a very tricky problem of odd distortions, make a night fighter's job more difficult, but he is proving that it can be done.

A word on night adaptation. Some pilots object to the boresome procedure of wearing adapter goggles before the scramble but—until a new type of human eye is manufactured—it is vital that the night fighter take off with his night vision at close to maximum efficiency. It still takes 30 minutes to reach that peak—and only one unguarded second, and a careless flashlight, to nullify the whole business.

The old saying that a pilot's learning days are never done is doubly applicable to the night fighter. Long after the night fighter has said good-bye to his training days, he must continue to practice. The reasons for this extra adherence to duty are obvious. Practice provides greater confidence in instrument flying, the backbone of night fighting. Practice keeps a pilot on edge to meet some of flying's most precision-demanding problems. Practice enables the night fighter to keep step with the latest tactics in a field acknowledged to be changing more rapidly than any other.

In the knowledge and testing of his equipment the night fighter has a heavy responsibility. It is not only that he operates more complex equipment. Any failure to understand or give the proper check could cause a bumbled interception. At the same time, any mechanical failure at night puts a pilot much farther out on the limb than the same failure during daylight.

Night fighters are not taught to be purely defensive fliers, though the dispersal or harassing of an enemy bombing attack is one of his primary duties. When accompanying a task force the job of taking care of enemy snooper falls importantly within the night fighter's department. (It may be noted where night interceptions are concerned that success does not entirely hinge on shooting down enemy bombers; to force the enemy attack into evasive action often fouls up their navigation so badly that the raid results in a complete dud.) As the war moves along, the night fighter will play a larger part in the offensive scheme. As a swift-striking intruder he already makes life miserable—or impossible for the enemy's railroads and shipping.

Having confidence in the abilities of his AI gear, but recognizing its present limitations, are necessary for the night fighter. He knows that his GCI unit can bring him into contact, preferably behind and below the target. Often this demands a great deal of patience; to make a successful stern chase of an evasive target takes time. No matter how long the chase takes, the night fighter must adhere implicitly to the judgment of the fighter director until such time as

the chase is put into the pilot's hands or abandoned. The night fighter realizes that his AI should bring him from within three miles to less than half a mile. He cannot assume that the enemy will always be so cooperative as to fly a smooth, nonevasive course which would enable the night fighter to make the kill purely from information gained through his AI. He must know the science of a successful night approach and he must be ever wary of radar counter-search measures now being employed in enemy bombers.

The night fighter possesses something of a Jekyll-and-Hyde personality. He is, at once, a lone wolf and the most important cog in a closely-knit team. He must use ingenuity and imagination in the final and crucial stage of a chase, yet in the preliminary vectoring he must give 100 percent obedience to the fighter director. He is on his own in a mysterious element, but, if the fighter director is on his toes, the pilot is constantly aware of the enemy's course, speed, altitude, and relative position—and any changes in those factors.

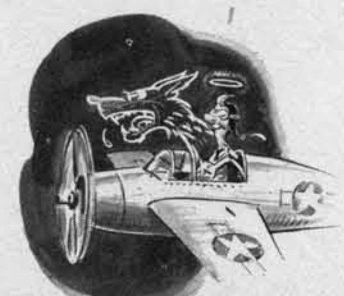
As the enemy's daylight bombing attacks become more costly he is being forced to strike under cover of darkness and bad weather. The night fighter—who will also get the call during daylight low visibility—must be prepared in every way to deal with this challenge.

The preliminary phase of Night Fighter Training takes 6 weeks. After opening with several hours of SNJ instrument hops, the night fighter then has 60 hours of F6F work designed to familiarize him with night flying problems—instruments, precisions flying, safety, control, camera gunnery, homing on ZB over land and water, cloud flying, and FDO controlled flying without a target.

Paralleling this, the ground training phase begins by acquainting the pilot with fighter director procedure, his AI radar, use of VHF and ZB. He concentrates on low visibility recognition and gets further navigation training. A large part of this phase of the ground training covers the Link Trainer and includes more instrument flying, FDO vocabulary, voice procedure, and FDO interceptions. Physical conditioning of night fighters gets a high priority on the program. About one-fifth of the class time of this preliminary phase is given to valuable lectures by ACI officers and pilots with combat experience. Aircraft familiarization, weather, flashing light communications, and emergency identification complete the syllabus for the first six weeks.

The final 4-week phase involves another 60 hours of flying, 22 of them in radar classrooms, and the rest in service-type night fighter planes. In this phase the emphasis is on the airborne radar sets and the vital necessity for the pilot's understanding the performance and capabilities of his radar. A thorough course in the AI gear covers interceptions, beacon approaches, and homing. Ground-controlled interceptions with searchlights are included in this phase, as are lengthy sessions designed to produce bulls-eye night gunnery.

Ground training for the final phase goes into AI theory and procedure, demonstrations of the Combat Information Center, searchlight cooperation, night gunnery technique, more low visibility recognition and night flying field control. One of the standout features of this final training phase is liberal use of the AIA Link Trainer which, with its electronic devices, enables the pilot to coordinate in very realistic fashion the varied yet vitally related problems of instruments, radio, and radar.



HARBOR UNDERWATER DETECTION

THIS NEW, little publicized field of endeavor is part of our answer to the enemy submarine threat to ships in our harbors the world over. As the name implies, Harbor Underwater Detection is a Navy activity, whose function is to detect the approach and location of enemy vessels (both surface and submerged), give warning, and provide subsequent information necessary to coach counter-attacking surface and aircraft in for the kill.

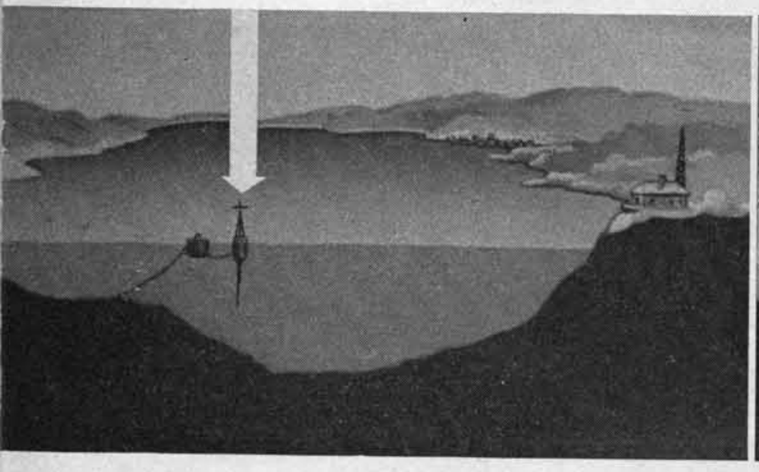
That the activity is successful is evident from the fact that not one effective penetration of any harbor guarded by United States harbor detection equipment has been made since the Jap midget subs slipped into Pearl Harbor December 7, 1941.

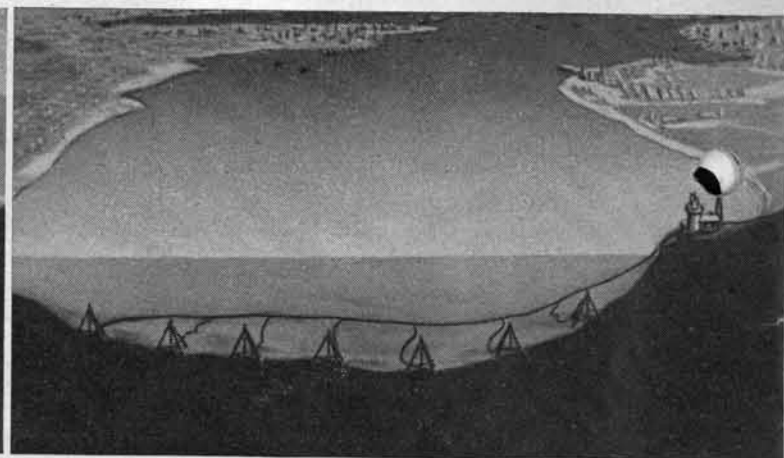
Let it be clearly understood that Harbor Detection devices are not in themselves capable of offensive action, but instead perform much the same function against surface and submersible craft that Radar does against aircraft.

THE SONO-RADIO BUOY

A listening device anchored in the harbor approach from which position it transmits underwater sounds to a shore radio receiver. It incorporates a nondirectional supersensitive underwater microphone, a high-frequency radio transmitter and antenna, and a large dry-cell battery.

Dependable underwater listening range for the Sono buoy is 1,000 yards, while the unit transmits a radio signal receivable to between 12 and 15 miles. The Sono-radio buoy is usually the first of the detection devices to be installed, since it is lighter, and lends itself to rapid handling.





"Harbor Underwater Detection," Surface and Submarine Warning Notes, is a bimonthly confidential bulletin published by The Chief of Naval Operations for personnel whose duties are connected with Underwater Detection.

Requests for copies of issue No. 1-44 may be addressed to The Chief of Naval Operations, OPNAV 30-3E, Washington 25, D. C.

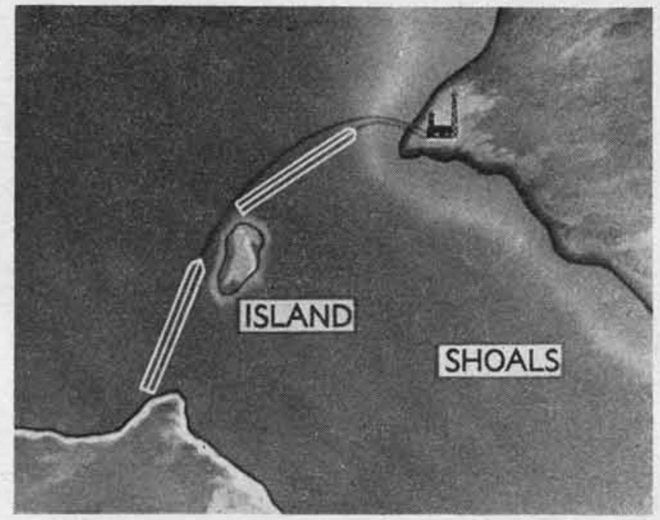
THE CABLE-CONNECTED HYDROPHONE

A listening device laid on the ocean floor in a harbor approach consisting of a number of hydrophones connected to a shore listening station by means of a multi-conductor cable. Once laid, the cable-connected hydrophones require little attention and are very dependable.

THE MAGNETIC INDICATOR LOOP

Most positive of the devices in use, it is laid on the ocean floor in the outer harbor approaches. It is very sensitive when properly laid and operated. The distortion of the earth's magnetic field by a metal object over the loop causes magnetic unbalance between the two areas enclosed by the loop cable, generating minute voltages which are indicated by a sensitive galvanometer in the shore station. One of these devices recorded the entrance of Japanese midget submarines into Sydney Harbor.

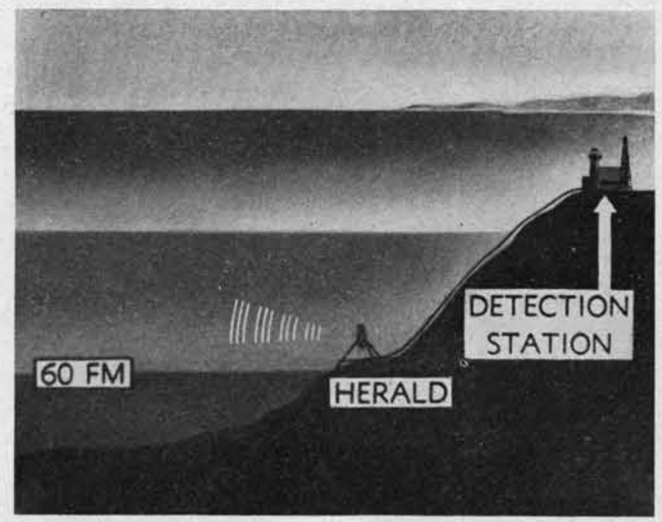
Magnetic loops are installed in many important harbors the world over.



THE HERALD . . .

. . . or Harbor Echo Ranging and Listening Device is laid on the ocean floor usually in the "hunting area" of a harbor entrance where it can both detect and track an enemy ship. Most precise of the devices, it enables the operator to coach the counterattack to the exact location of the enemy vessel.

The Herald operates at supersonic frequencies and will give range and bearing on any target within its maximum range. One of these devices detected the approach of enemy sneak craft into Alexandria Harbor enabling harbor facilities to break up the attack.



COMBAT LESSONS

Night-fighter controlling must be constantly practiced. The controllers of VMF (N) 531 were fortunate in going straight to their squadron from controllers' school. The squadron spent 3 weeks at El Centro, Calif., where the pilots flew every night—allowing considerable team training for controllers and pilots. There the basic job of making a *team-play* out of an interception was accomplished.

Later on at Pakoi Bay, Vella LaVella (after "staging" at Espiritu Santo and combat operations on Liapari Island), the crews really began to get expert at reading altitudes, plotting, and computing. The reading of altitudes was sadly neglected in training schools, whereas it is one of the most important and difficult jobs a crew is called upon to perform. It has been said that heights cannot be read accurately with the antennas turning six to seven times per minute—*a good height reader can do it, however.*

A practiced crew can obtain sufficient plots to determine the ground, true air, and indicated air speed *in 3 minutes*, allowing 2 minutes and 40 seconds for plotting and 20 seconds for computing. This, as in the case of height reading, is a matter of practice.

At Pakoi Bay jobs were rotated daily so that each man had 1 hour's work at height reading, azimuth reading, plotting, and computing, and controllers met weekly to discuss unusual situations arising in action.

The 531's controllers used the current system of snap vector, cut-off vector, safety vector, and finally tarket's course. (See GCI Technique in June issue of C. I. C.) This worked well on bombers flying a straight, steady course to target or rendezvous point; however, the technique was modified somewhat to counter the tactics used by Japanese float planes in search of ships, consisting of sharp turns alternating right and left.

Evasive tactics observed consisted of sharp turns, squares, and violently jinxing course with varying altitudes. Sometimes planes dove for the water and streaked for home. The Betty has great speed—one losing altitude gradually from 15,000 feet was clocked at 270 knots. This magnifies the importance of putting your fighter in close behind the bandit and makes stern chases futile.

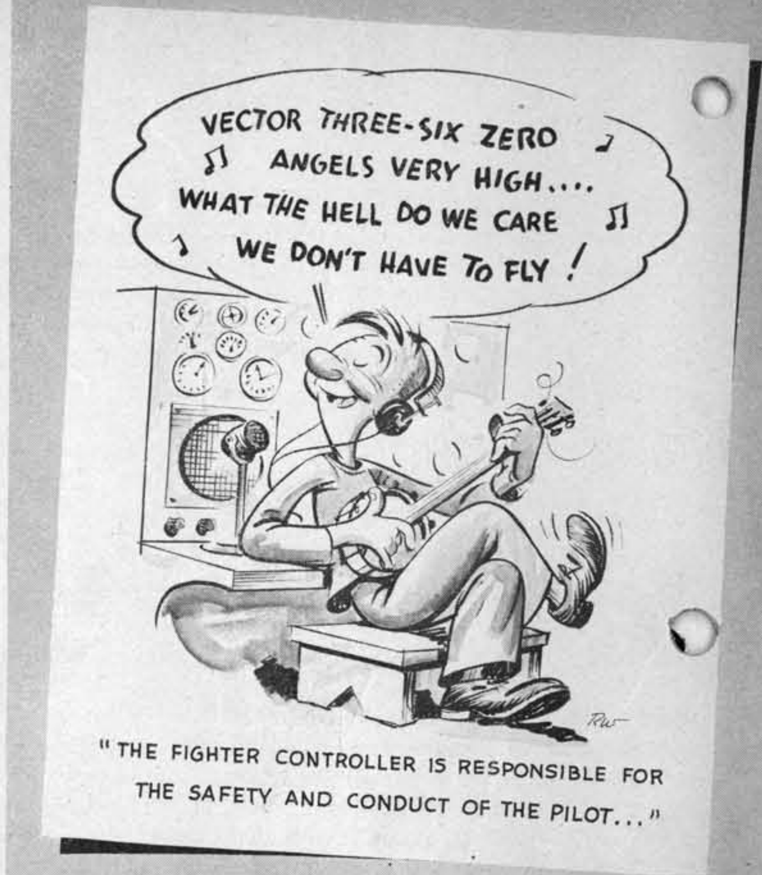
Japanese tactics at Stirling Island (531's fifth location) employed "Window" and the splitting up of raids into several flights. Two planes about 20 miles apart would drop "Window" in a large circle and then continue to fly lazy eights, imparting to the Window an illusion of motion on the PPI Scope. The solution to this problem was to send out fighters after one and not more than two of these bogeys.

Experience has proved that interceptions are best controlled from the PPI. It is essential that the track of both fighter and bogey be kept, and it does no harm to write with grease pencil on the face of the tube the vectors given the fighter. The controller must keep the fighter informed almost constantly of his relative position to the bogey and the bogey's altitude, course, and speed, and he should keep his eyes on the tube at all times during an interception.

In 2 months, 531's controllers directed scores of AI contacts, got six kills plus one probable, and made matters so hot for the Japs that they gave up night raids on Pakoi Bay and Stirling.

Leatherneck GCI

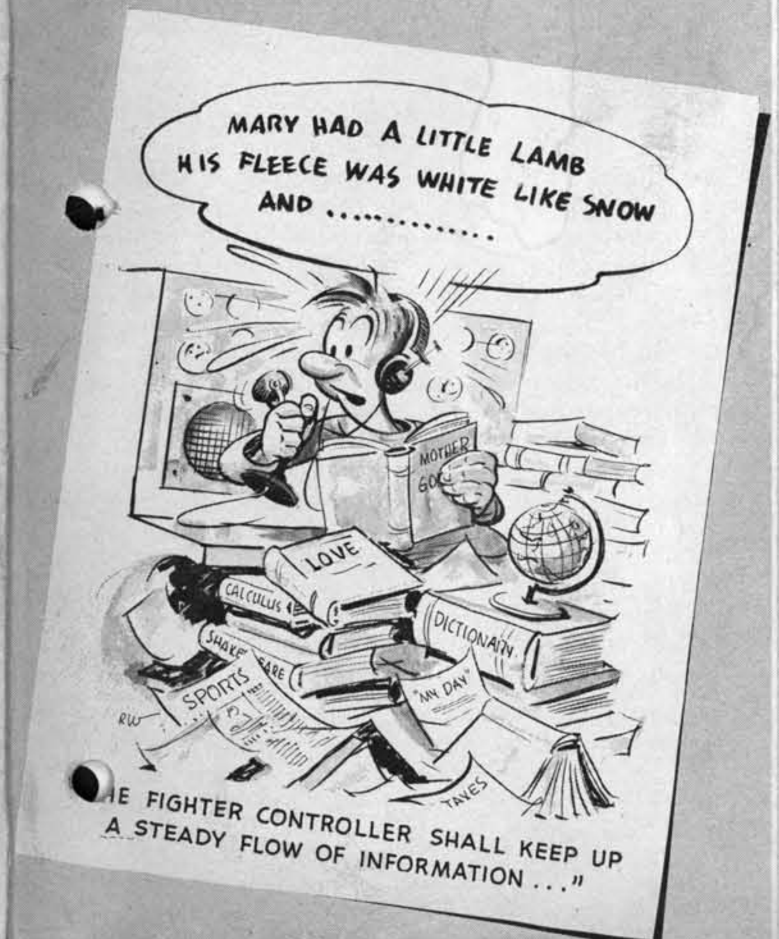
Thanks to Capt. John F. Wilson, now on duty at AWG-1, MCAS, Cherry Point, N. C., as GCI instructor, who did the original sketches from which "Leatherneck GCI" was drawn.



"THE FIGHTER CONTROLLER IS RESPONSIBLE FOR THE SAFETY AND CONDUCT OF THE PILOT..."

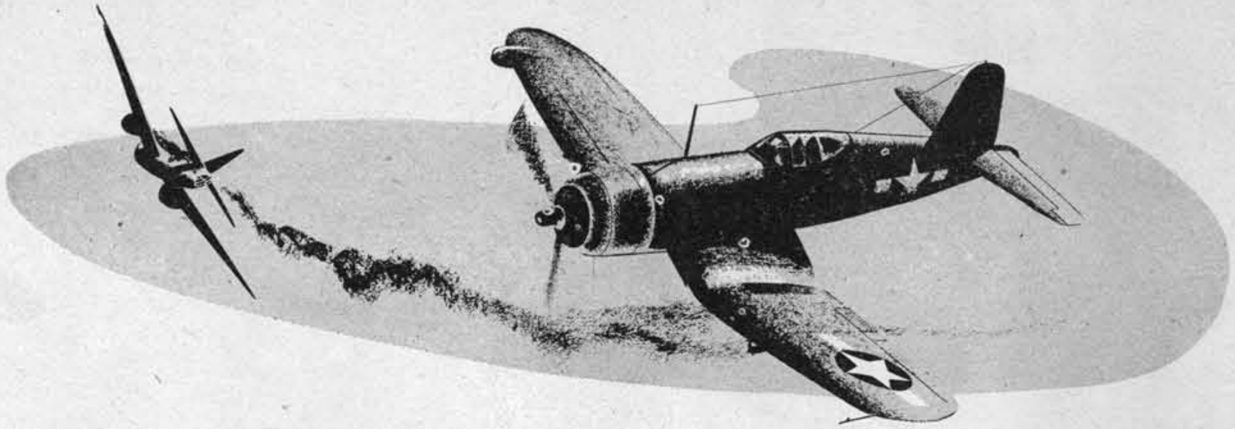
"AN IDEAL G.C.I. SITE AFFORDS...."

"BE DECISIVE, NEVER SHOW HESITATION OR DOUBT, HAVE CLEARLY IN MIND..."



E FIGHTER CONTROLLER SHALL KEEP UP A STEADY FLOW OF INFORMATION..."

TWO KILLS, ONE PROBABLE . . .



Report of AWS-1 Operations During Enemy Night Raid, 14, April 1944.

Initial bogey picked up at 0013, 83 nautical miles, bearing 235°. At the time one night fighter, P-10 (Lt. J. E. Bonner) of VMF(N)532 was on patrol at 10,000 feet. He was immediately ordered to Angels 20 on a vector of 240° and put in orbit to wait for bogey when 40 miles from base.

After initial bogey plot was picked up, 7 additional bogies appeared between 220° and 320° at ranges of 60 to 100 nautical miles. Four additional night fighters were scrambled by Lt. F. M. Knoblauch, CIC Controller. P-18, Lt. F. C. Lang; P-2, Capt. W. Bollman; P-7, Lt. E. A. Sovik; P-21, Lt. Donald Spatz. P-21 on reporting airborne was switched to channel No. 3 to call Viper Base (Argus 22 at Eniwetok) for control.

P-10 made contact on our initial bogey at 0034 and tallyho at 0036, range 30. After tallyho P-10 called controller to confirm whether contact was real bogey and was ordered to fire. (NOTE.—In the past, numerous night interceptions have been made on friendly bogies.) P-10's next transmission requested a steer, advising that windshield was covered with oil. Lieutenant Bonner was very calm and advised, "I gave him a burst and he gave me a burst." P-10 bailed out at 4,000 feet, range 21, bearing 205° and was picked up by DD, after being located by search planes using our information. This bogey continued to close, dropping gizmoes, until range 15, then turned away on vector of 240 and plots faded at 38 miles, indicating he was below 5,000 feet. Credit is given as "Probable" account enemy plane's action. Controller—Captain Reinert M. Torgerson.

By this time P. P. I. scope had at least 50 gizmoes on it covering 180°.

P-2 and P-18 were controlled by Capt. Reinert M. Torgerson on VHF, and P-7 by Lt. F. G. McClintock on H. F. Many false contacts on gizmoes were made making AIA interceptions quite difficult. In one instance, P-18 was on tail of bogey dropping gizmoes which undoubtedly prevented tallyho being made.

At 0111 P-7 controlled by Lt. McClintock accomplished preliminaries and shot down a *Betty* in flames. Range 12 bearing 270°, altitude 22,000. Performance was repeated by P-2 controlled by Capt. Torgerson at 0122. Kills confirmed by ground observers. These were second and third enemy planes closing on base.

By this time approximately 100 gizmoes were plainly visible on P. P. I. scope making GCI and AI interceptions extremely difficult. Gizmoes covered 360° out to 40 miles.

At 0135 two planes were closing and AA was released. Jarring from 90-mm. battery close by shorted 527 cables and did other minor damage, knocking it off the air. It required several hours to put it in working order. At the time this occurred P-18 was being vectored and was closing interception.

During action bombs were dropped in lagoon and on reef but none on Engebi or Eniwetok.

Searchlight interceptions were not practicable on account of 6/10 cover.

During action 268's reported submarine contact at 20,000 yards and 155-mm.'s were released to fire by CIC, but contact did not come within range.

At one point when GCI interceptions were being attempted, and unidentified transmission was heard over VHF radio as follows, "Flight one, flight one, get out, get out." It is thought enemy monitors our VHF radio.

Condition Red called at 0030; all plots identified as friendly or gizmoes by 0300 and all clear sounded. (NOTE.—IFF in one night fighter was faulty.)

Shortly after 0200 a call asking for a steer was received from P-21 (Lt. Donald Spatz, who had been controlled by Viper Base). He gave Happy the Homer (SCR-575) a long count but was weak. Happy did not obtain a good fix but estimated 340° as his bearing. A message from Viper Base informed us he was range 30, due west of Eniwetok (about 200° from our base). We could not confirm this information from our radars and by this time had lost radio contact with P-21. Viper Base relayed vectors of 010, 360, and 090 to P-21 through P-18. P-21 by this time was at Angels 4 and advised he could not climb as gas was too low. Finally at 0400 P-18 received a weak call "Mayday" from P-21 and P-18 was pancaked at 0410, being very low on gas. Another plane was sent up and continued to call P-21 without result.

A search is in progress for P-21 based on the following assumptions.

(1) Happy's bearing was approximately correct.

(2) P-21 was over 150 miles from base when we lost radio contact. (Our VHF antennas are 90 feet.)

(3) P-21 followed Viper Base's vectors relayed through P-18.

Conclusions: Gizmoes in quantity are fairly effective. Two experienced controllers can work from one P. P. I. tube and handle three or four night fighters. H/R reader must be highly qualified, as gizmoes make for confusion. (Lt. William W. Thames, SCR-527 Radar Officer, took over and was of tremendous help to controllers.) Some gizmoes rise, as we picked up a number with no indication of plane in vicinity. It would be possible for enemy to jam our radio. Night bombing raids on Atolls can be made ineffective.

(Signed) WM. D. FELDER, JR.

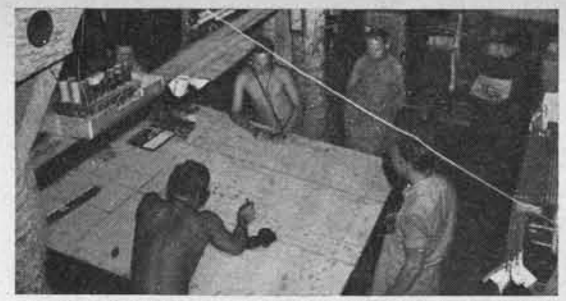
▼ ▼

RETORT PROVOCATIVE

During an interception problem at Port Hueneme (ARGUS TraDet), the intercept officer lost all trace of bogey. He asked friendly to scan in all directions in hope of locating the mysteriously vanished target plane. Friendly reported nothing in sight, and then himself called bogey, asking, "Where are you, bogey?"

Bogey replied succinctly, "Ha! Ha! Find me!"

The jointly indignant intercept officer and friendly finally smoked bogey out of his hiding place behind a mountain on Santa Cruz Island.



AWS-1 CIC interior snapped while a lost B-24 was being homed. Note VHF loudspeaker above beam at left.

527 operations and power vans revetted. One antenna beyond far end well sited at the water's edge.

270 revetted to the point of concealment except for the stately antenna.

299 radios in revetments, with Corsairs lined up on landing strip behind.

AWS-1's "home," with mess hall at far end of street.

U. S. GOVERNMENT PRINTING OFFICE: 1944

IT'S A PIP!

"You mean that you've contacted the enemy?"

"Not as yet, sir, but I HAVE contacted a reliable source of post-war security!"

"How's that?"

"I've registered a War Bond Allotment, an investment that will pay me back $4 for every $3 I kick in!"

"Where's that Disbursing Officer? It sounds like a good idea!"

IT'S A PIP OF AN IDEA! WHY DON'T YOU REGISTER A

NAVY WAR BOND ALLOTMENT!