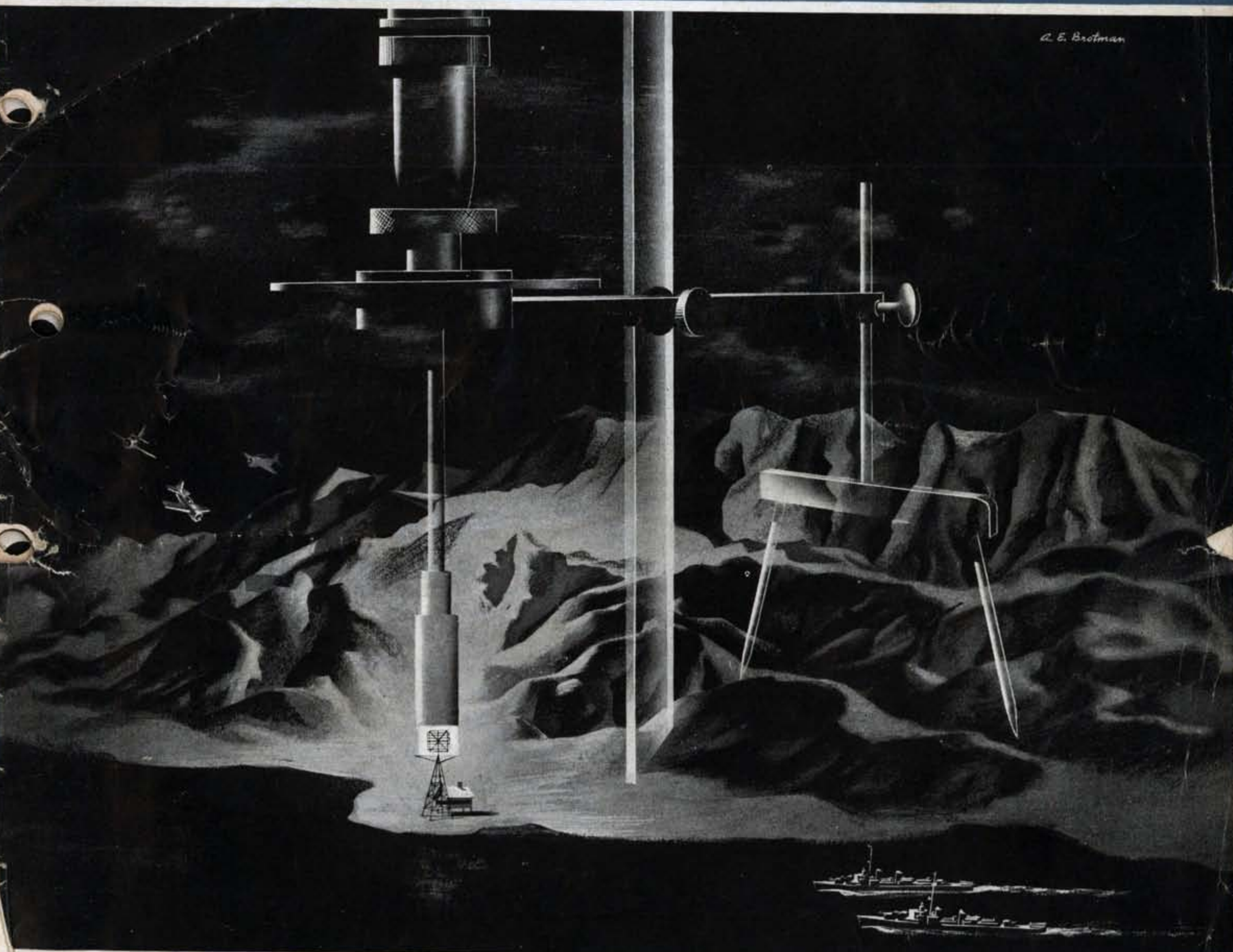
C.I.C.

COMBAT INFORMATION CENTER

VOL. I NO. 6 AUGUST 1944



OFFICE OF THE CHIEF OF NAVAL OPERATIONS

CONFIDENTIAL

C. I. C. COMBAT INFORMATION CENTER AUGUST 1944

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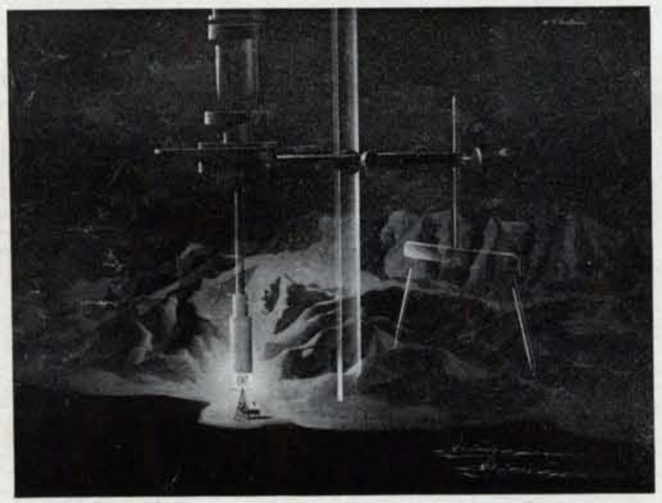

The August Cover features the new Radar Planning Device—RPD—developed by Special Devices Division, Bureau of Aeronautics, which in a short time has given promise of important tactical and operational uses in all combat theatres. See "PPI Pictures Can Be Predicted" for the details.

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.

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.

DISTRIBUTION OF "C. I. C."

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U. S. Army commands and activities are requested to send requests for copies of this and subsequent issues of "C. I. C." to: Operations Branch, A.G.O., Room 2B939, Pentagon Building, Washington 25, D. C.

How would this coastline look on a PPI?

PPI pictures can be predicted

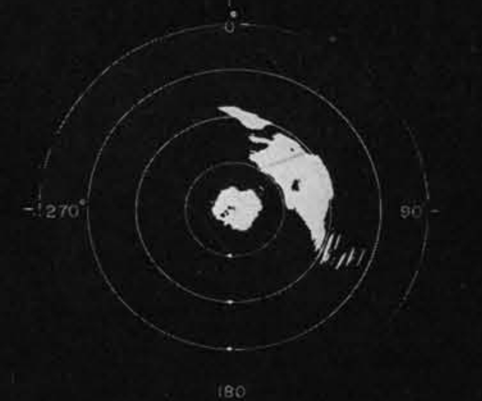
LANDFALL BY RADAR

Radar landfall when approaching an enemy coastline is greatly simplified if the navigator has photos of that coastline as seen on a PPI, for he can compare these with his own PPI and quickly fix his ship's position. But such photos are often not to be had, and then it is hard, sometimes impossible, to identify the areas "seen" on the ship's PPI with the same areas as represented on the navigational charts. A partial solution to the problem was found in a laborious technique of profiling areas and simulating PPI images with handmade coverage diagrams. However, need for a quicker, more accurate method has long been felt.

This need has now been met by the "Radar Planning Device" developed by Special Devices Division of the Bureau of Aeronautics. Its value is already being demonstrated in combat theatres.

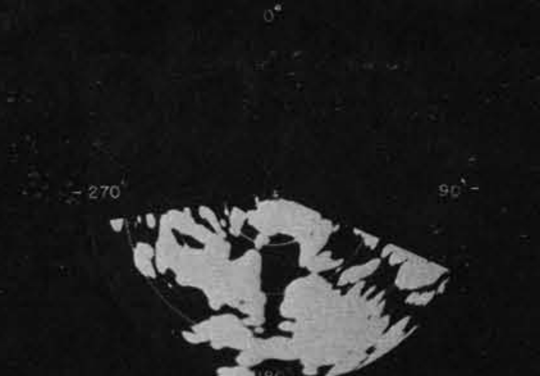
The RPD idea was born with the question, "Why not take advantage of the fact that light rays and radar waves act in many similar ways?"

Both light rays and radar waves travel in straight lines and cast shadows. Hence, when a point source of light is placed on an accurately scaled terrain model, the resulting lights and shadows make a pattern very similar to that on the PPI of a radar scanning the actual area. Specially processed photographs may be made for use in radar landfall.

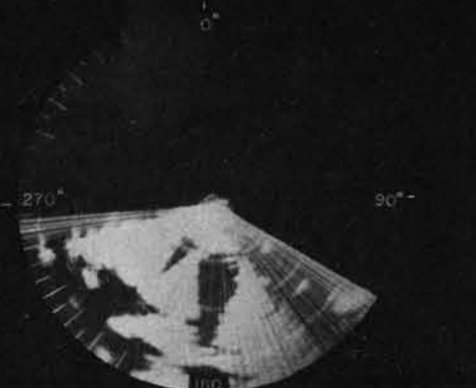


Simulated PPI photo made at mast height by the RPD method on a terrain model of Oahu.

Actual PPI photo of Oahu made at mast height from the exact position simulated above.



Simulated PPI photo of Smoky Mountains, made in test that proved validity of RPD.



Actual PPI photo of Smoky Mountains.

In the RPD method, "Evasion Indicator" Pins may be stuck on the terrain model and nickel beads adjusted on the Pins to indicate permanent echoes and shadow depths. Radar coverage for any site can thus be determined in advance. EI Pins on models of enemy territory where radar sites are known will reveal any gaps in enemy radar coverage and show how our planes may avoid radar detection.

TACTICAL USES OF RPD

Successful PPI simulations have been made with the RPD method for shipborne, airborne, and ground radar. The three major tactical uses of the method are: (1) To make PPI "preview" photos of coasts and land areas as navigational aids for task forces, amphibious forces, or air forces. Simulated PPI photos may be made in advance for any mission or the RPD may be taken along and photos made enroute as desired. (2) To locate gaps in enemy radar coverage to plot the safest approach for planes. (3) To locate the best sites for our ground radars. Other tactical uses will doubtless be developed.

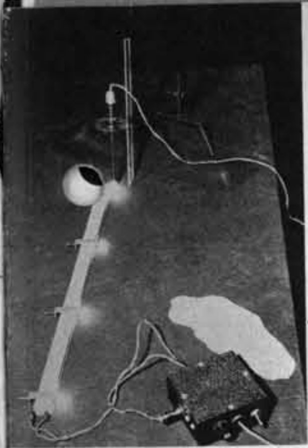
HOW IT DEVELOPED

When early experiments with RPD looked promising, Special Devices Division and the Radiation Laboratory of MIT sent an expedition to the Smoky Mountains in western North Carolina for a thorough test of the new method. PPI scope pictures made there on a mobile set were practically identical with simulated pictures made with an RPD on a terrain model of the Smokies. The validity of the method was proved.

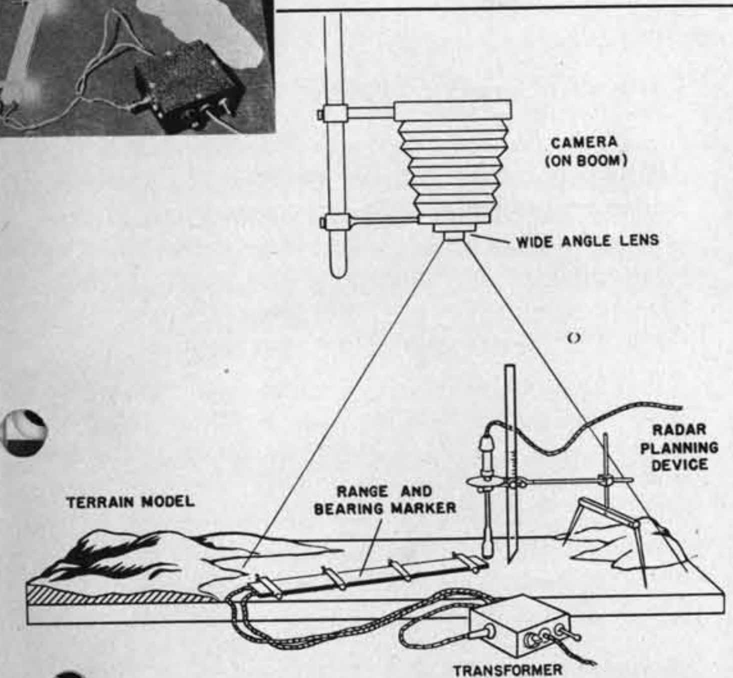
On request of Com Air Pac, the RPD project engineer was sent to the Pacific Fleet Radar Center at Pearl Harbor to demonstrate PPI predictions by the point source of light method.

During April and May, tests with a model of Oahu gave excellent results. Many simulated PPI photos were made and compared with scope photos previously taken at mast height at various locations around the island. The comparisons were convincing in every case, giving not only comparable shapes of PE's but accurate locations in range and azimuth as well.

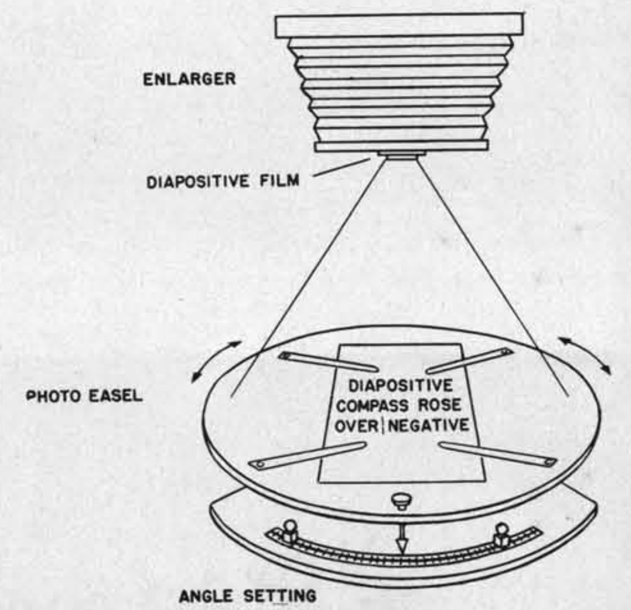
Tests were also made on the Oahu model for airborne simulation. These PPI photos were compared with actual ones taken from a plane and found to be as accurate as those taken from mast height.



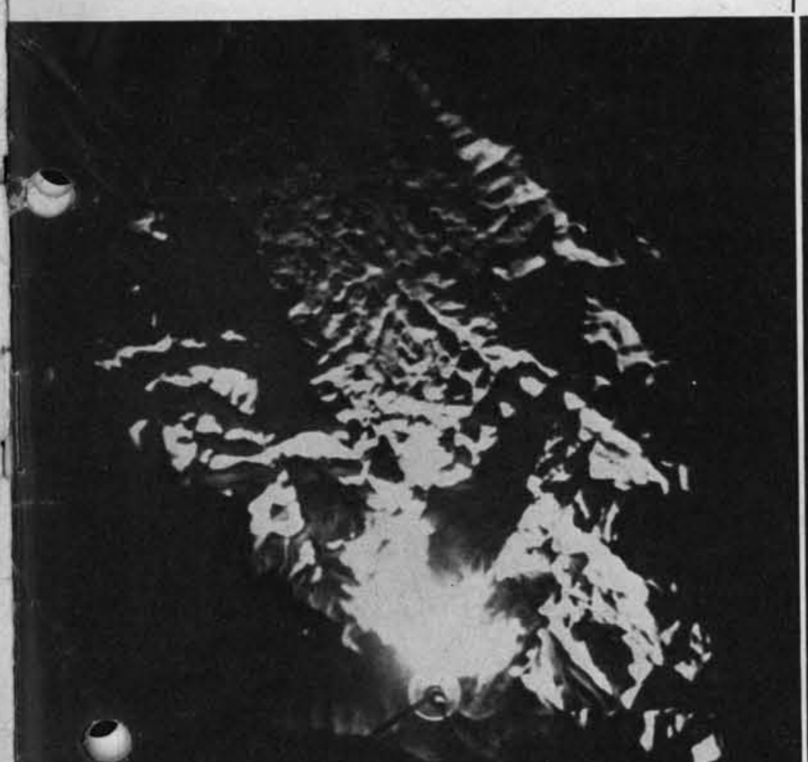
RPD applies a point source of light to a terrain model. The pattern of the resulting lights and shadows is very similar to the picture on a PPI covering the same area.



Making a simulated PPI photo by the RPD method.



Negative is rotated on this easel to obtain the effect of beam spread.



RPD photo before rotation.

RPD photo after rotation, with the effect of beam spread added.

RPD project at Pacific Fleet Radar Center, now serving the fleet.

Permanent Echo would conceal the first plane (left), shadow the second, but the third would be spotted by the radar.

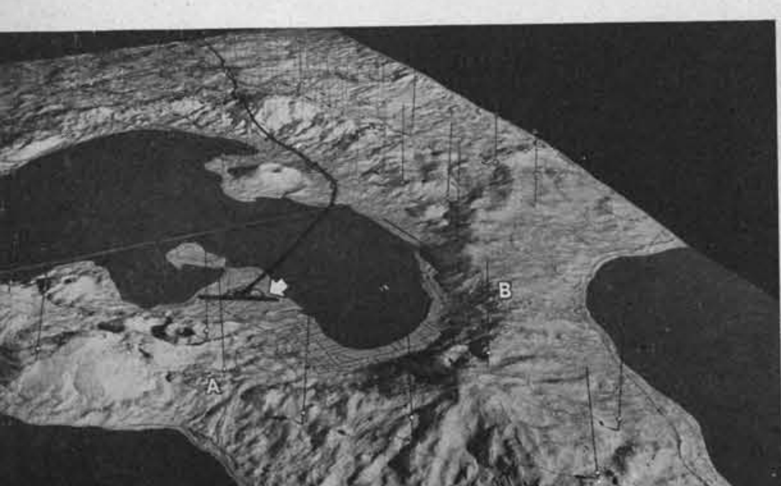
After study of these tests and the accurate PPI photos, it was decided that a regular RPD unit would be established as a permanent part of the Pacific Fleet Radar Center. A building was equipped to handle requests from units of the fleet.

USED FOR SAIPAN STRIKE

These facilities were utilized immediately for the Saipan strike. A large number of models of Saipan and other islands were constructed in record time and simulated PPI photos were prepared to supplement navigational charts of the islands. Carrier task forces and amphibious forces took these RPD aids along on the operation.

The problem of siting ground radar, while not an immediate concern for most naval activities, is an acute one in the field. Many costly mistakes have been made in the installation of search gear due to inadequate study of the problem of PE's. With the added facility and thoroughness of the RPD method, areas may readily be tested in advance for their characteristics as radar sites.

Just as we are able to predict the effectiveness of our own installations and effectively choose sites, we can apply the same method to a terrain model of enemy-held territory. Knowing from photo-reconnaissance the location of enemy installations, the model can be tested with the RPD instrument and approaches mapped to the target for maximum immunity to radar detection. This method, of course, is only as effective as the reconnaissance on enemy radar.



"Evasion Indicator" Pins show enemy radar coverage to pilots. A string laid on the model traces the "radar evasion" approach to the target area. Hypothetical enemy radars at A and B.

Measuring heights above sea level with a Map Conversion Scale. Heights of beads on the "Evasion Indicator" Pins reveal radar coverage.

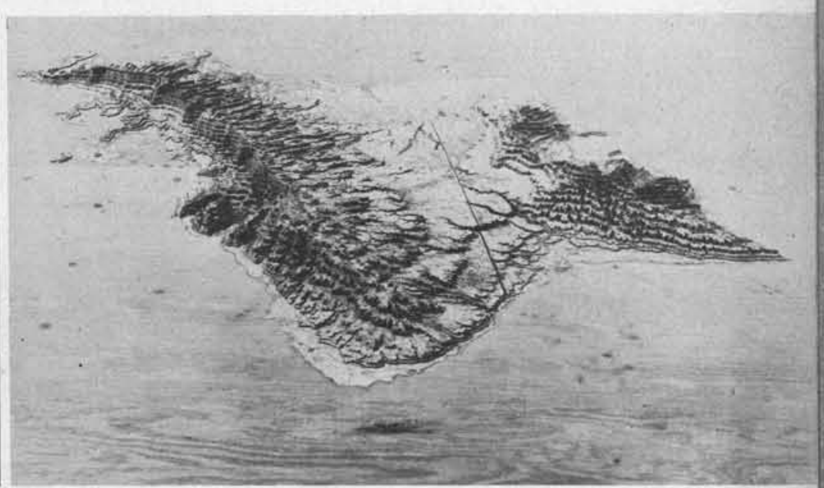
TERRAIN MODELS MADE RAPIDLY

Terrain models can be constructed by trained personnel in two to three days from reliable contour maps. When only fragmentary information is available, models still can be constructed within entirely practical limits of time by an expert landfall officer or experienced terrain modeller.

In most theatres, equipment and terrain modellers are available for construction of good models. Officers especially trained in the RPD method should be on hand to supervise the construction of models, as well as to test and photograph the light source on the completed maps.

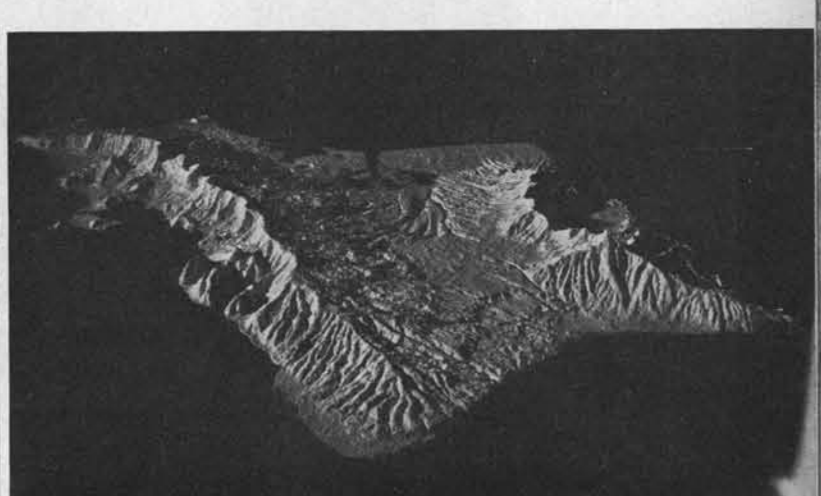
The photographic method not only records the line of sight PE pattern but also reproduces the effect of beam spread by rotation of the negative under exposure. Present methods also include means of recording complete data as to range, bearing, antenna height, beam width, identification of areas and range marks, date and job number on the negative to avoid possible confusion and improper use of the material.

Preparing the base of a terrain model from a contour map.

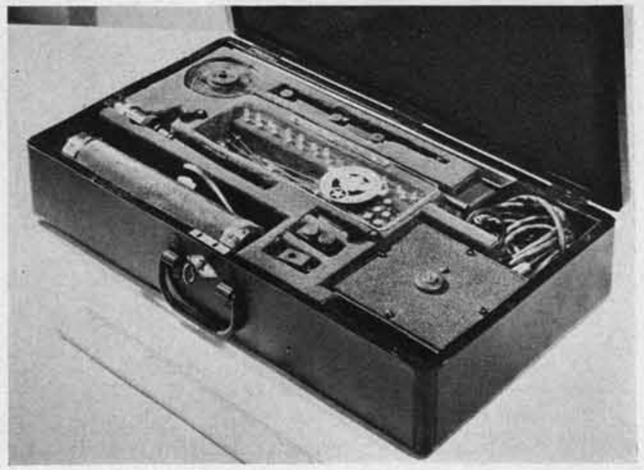


Elevations are built up on the base layer by layer.

Mass production of terrain models for an operation. Such facilities are becoming available in most areas.



Coating of the "elevation-layers" produces the completed, accurate, realistic terrain model.



The RPD kit is very compact.

HOW TO GET IT

An RPD kit is now in production and available through the channels listed below. It includes an RPD instrument, a transformer, a battery case with rheostat for use when power is not available, a sub assembly with plexiglass rod for simulating antenna heights, spare bulbs and fuses, a pair of pliers, a screw driver, and EI Pins.

The following devices needed for RPD planning are available to Navy activities through the Bureau of Aeronautics, under the following Special Devices numbers:

16-C-23	Radar Planning Device Kit
16-C-23 l	RPD Manual
16-C-28	Map Conversion Scale
16-C-23 p	Range and Bearing Marker
16-2-23 r	RPD Photo Easel

To Marine activities, the RPD will be available from Base and Field Depots through normal supply channels, in accordance with standard tables and allowances.

Army activities should address requests for the RPD to Headquarters, Army Air Forces, Assistant Chief of Air Staff, Operations Commitments and Requirements, Fighter and Air Defense Branch, Washington, D. C.

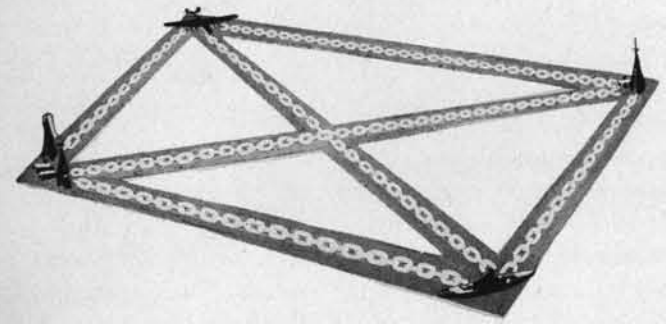
A WORD OF CAUTION

The RPD is merely an aid, not a complete solution to all radar problems. Its use should be supervised by an officer trained in its operation, and its results should be applied with proper regard for the limitations of the method. But properly used, the RPD should prove a valuable operational and tactical aid.

An article presenting the RPD from the Army Air Forces point of view appears in the current issue of "Radar," a confidential magazine published by the Army Air Forces, Office of Air Communication Officer.

This striking terrain model of Boston harbor shows the accuracy and realism which trained modellers can deliver.

"Proper operational use of Ionospheric Data," reports Squadron Leader A. L. Hall, Royal Australian Air Force, "ensures radio contact between any two points day and night throughout the year, guarantees direction finding, and makes signal identification positive."

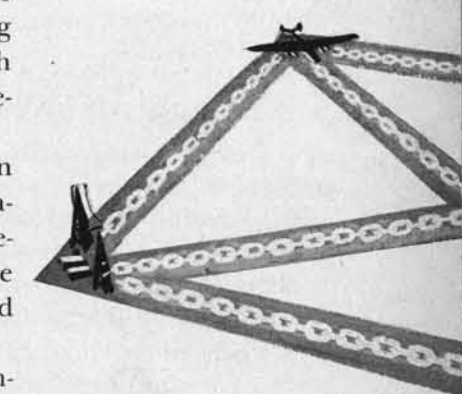


farewell to communication failures

From the Original Manuscript prepared by S/L A. L. Hall, RAAF

No sane man would finance the building of a railroad system and permit the expenditure of millions on stations without first ascertaining what difficulties were likely to be encountered in putting down the track, and by what routes the various stations would be linked. He would rightly hesitate to act before he knew a good deal concerning the nature of the country through which the line was to run. Nor would any careful pilot take off on a long oversea journey without first ascertaining the likely behavior of the medium through which he was to fly his ship.

Yet it seems to be a rather common belief that one has only to set up two transmitters and associated receivers, covering some arbitrarily-selected frequency range, to guarantee communication between any two points, any time of the day or night. It can be definitely stated from operational experience that millions have been spent on radio equipment which has done only half the work it was designed to do. One can see and operate transmitters and receivers, but one cannot understand the nature of the connecting medium without considerable abstract study, and it is this fact which causes some otherwise reliable communications officers to neglect the medium and hope for the best.



This habit of hoping for the best is not good enough, since it has been abundantly clear for a number of years that a high frequency communication system can be just as carefully engineered as a railroad, that the behavior of the medium through which the radio waves are to travel can be predicted more accurately than ordinary weather, and contact thus ensured between any two points day and night throughout the year.

It is hoped to dispel the habit of trusting to luck, and by citing a number of applications of ionospheric data—the key to the situation—in the Southwest Pacific Area from 1940 on, to persuade responsible communications officers not already seized with the importance of the problem that there is a better method; that there should, in fact be more widespread use of wave propagation data.

RADIO NETWORKS RELIABLE AS LAND-LINES

In peacetime, delays in establishing telephonic or radio communication between any two points can be tolerated to some degree since the consequences of short period failures do not in general affect more than a handful of people. In wartime, however, delays of the order of ten minutes or so may make all the difference between the success or failure of an important operation, defensive or offensive.

A survey of Australian communications made in 1939 revealed that the system was inadequate to withstand the strain imposed upon it by war. At that time there were practically no W/T point-to-point circuits in existence, and the services had to use already overloaded carrier telephone channels. Moreover, the trunkline telephone system embraced only the main capital cities and did not cover important areas north of Geraldton in Western Australia, nor the Northern Territory within which was located the important base of Port Darwin. In addition, W/T communication between New Guinea and the mainland of Australia was very unsatisfactory.

The situation was, in fact, critical, and some means of enabling rapid communication to be maintained between all important bases had to be established in a minimum of time. Moreover, because of limited equipment and personnel, resources had of necessity to be employed with the utmost economy of effort.

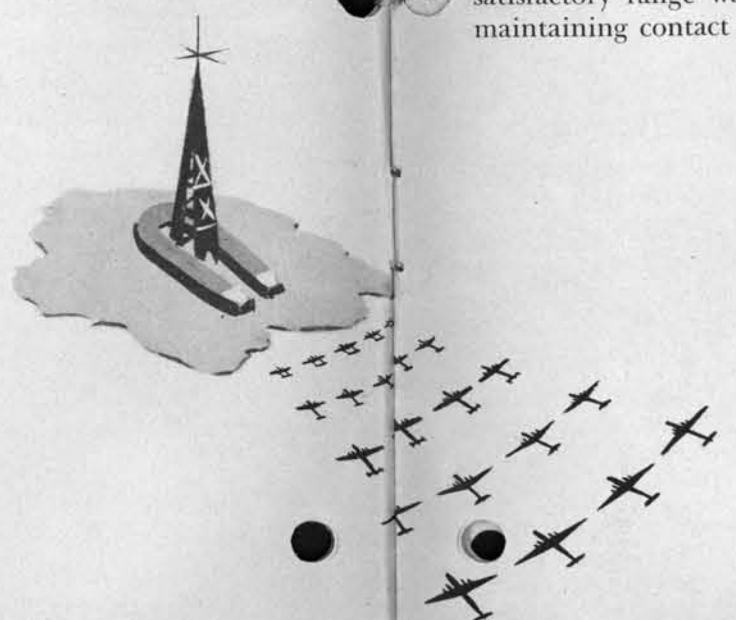
To meet the situation, it was decided to establish a comprehensive W/T point-to-point system, and, since it had been laid down by the operational staff that communication was essential 24 hours of the day, 365 days of the year, it was obvious that guesswork was not good enough. An appeal was therefore made to various scientific organizations which cooperated to the fullest degree in supplying wave propagation data based on earlier researches into the characteristics of the ionosphere. The success achieved in maintaining communication over point-to-point links encouraged the Australian services to expand the organization responsible for supplying predictions of wave propagation conditions.

Subsequent experience has shown that, provided frequency allocations are based on adequate knowledge of the ionosphere, communication is, for all practical purposes, as reliable as that over land-lines. The network of point-to-point services in Australia has grown from less than ten circuits in 1939 to well over 500 circuits at the present day, all operating with clockwork regularity.

AIR TO GROUND CONTACT ASSURED

The planning of air operations depends in a large measure on knowledge of enemy activities and thus regular reconnaissance flights are necessary. It is important that communication be maintained between base and aircraft at all times during the flight, since sighting reports must be made without delay back to base to enable appropriate offensive action to be taken against the enemy.

Prior to the application of ionospheric predictions in the Southwest Pacific Area, failures were frequent, in particular near the dawn period, but also quite often at other times of the day. It had been customary to employ frequencies in the region of 6Mcs., on which channels partial success had been achieved. At dawn, however, these frequencies were much too high, having skips of the order of a thousand miles or more, and at mid-day, having short distance ranges, due to high absorption. The selection of



frequencies based on ionospheric predictions completely eliminated practically all difficulties in communicating with aircraft; so much so that pilots came to look on operators who could not establish communication as being inefficient.

On strike missions planes may have to travel more than a thousand miles to their target. Schedules of frequencies and times of operation on each must therefore be carefully worked out in advance so that continuous communication may be ensured. The same care must be taken in selecting frequencies for communication between aircraft sent to protect convoys and both base and ships in the convoy.

SHIP-TO-SHORE FAILURES HAVE BEEN COSTLY

The need for fighter cover to protect battleships against enemy dive-bombers may arise. If the commander cannot signal base in time due to delays following the employment of incorrect frequencies, serious losses may result. There is evidence to indicate that inadequate knowledge of wave propagation was an important contributing factor to one or two earlier heavy losses.

Warnings must also be conveyed to ships if there is a likelihood of attacks by submarines or other vessels, and it has been found that unless frequencies are carefully chosen, some areas will be skipped altogether. Broadcast warning systems must therefore be carefully planned and ionospheric data used to assist in the selection of frequencies ensuring reliable passing of information from shore to ship at all times.

METEOROLOGY ELIMINATES FAILURES

In the Australian theatre, there exists a network of widely separated key meteorological stations. Each of these interchanges information with all of the others so that each may prepare synoptic charts of the area. Each must then inform all airfields within its area of meteorological conditions existing and predicted. A W/T network has been set up to meet this need. The frequencies used and their time of use are all planned on the basis of ionospheric predictions; thus no failures now arise. At first the equipment in use could not reach sufficiently low frequencies; later, equipment of satisfactory range was installed, completely eliminating any difficulties in maintaining contact between stations.

DIRECTION FINDING SAVES PLANES

In the Southwest Pacific Area high frequency direction finding is used as a navigational aid to aircraft. An instance of the need for ionospheric information to obviate the failure of such a system is given by the loss some two years ago in one theatre of war, of 42 aircraft returning from a mission, due to the selection of the wrong frequency, resulting in the aircraft being in the skip zone, and thus being unable to obtain navigational assistance.

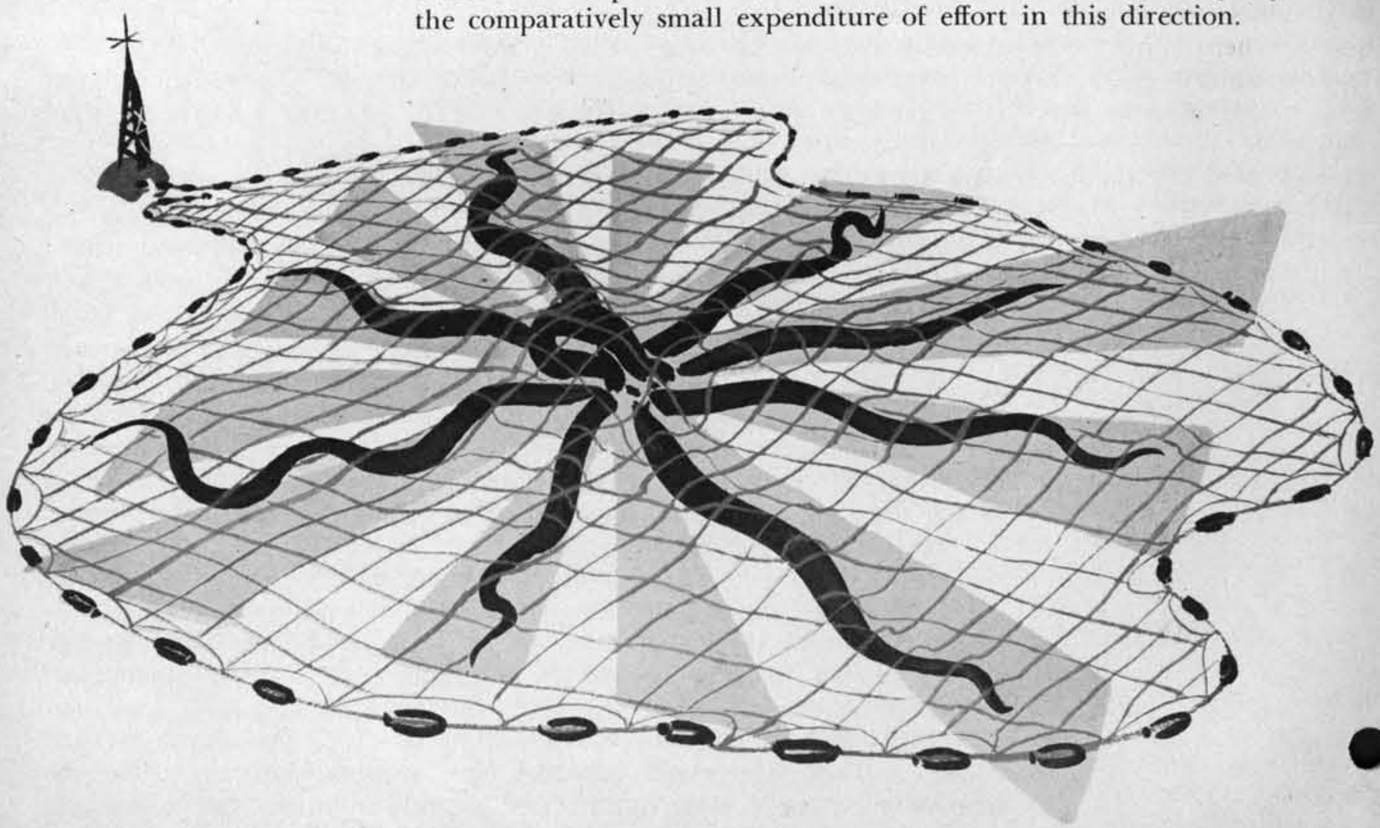
In the Southwest Pacific no such heavy losses have been experienced due to the fact that the Area has been divided into zones, time tables carefully drawn up and selected frequencies laid down for each zone, thus ensuring that no aircraft shall be within skip of the D/F station at any time of the day or night. No failures have arisen except where instructions have been disobeyed and frequencies used involving skip.

An example of this arose when a Hudson aircraft, No. A-16-198, with a crew of 5 and 5 passengers aboard proceeded from Horn Island to Brisbane on a combined reconnaissance and travel mission, arriving at Brisbane about 6 P.M. in bad weather. The aircraft called for bearings on an unsuitable frequency, and although the D/F station advised the ground station which was maintaining difficult communication with the aircraft, to change to a lower frequency, the ground station feared loss of communication and would not accept the advice given. No bearing of the plane could be given, and it finally crashed into the sea, 100 miles south of its destination, with total loss of life. An examination of ionospheric graphs at the subsequent enquiry showed that the skip on the frequency in use by the aircraft varied from 300 to 600 miles during the time it was endeavoring to obtain bearings.

OPERATIONAL CHANNELS SCIENTIFICALLY PLANNED

Just prior to the Coral Sea Battle, a meeting was hastily called at General MacArthur's Headquarters to decide ways and means of ensuring communication between ground stations, ships, aircraft and organizations vitally concerned with obtaining information which would enable them to follow the course of the anticipated battle and take appropriate action. Because of the number and disposition of the forces concerned, both in the South and Southwest Pacific Areas, the system had of necessity to be as simple as possible. Some communications officers at the conference therefore advocated the use of a single frequency. It was pointed out, by reference to ionospheric predictions, that if this plan was adopted, communication failures would inevitably result. The more scientific approach was finally agreed upon, and additional frequencies were selected, the hours of operation on each being specified in advance. The plan was completely successful, and as far as is known, there was not a single hitch during the battle due to a communication failure.

Since the time of the Coral Sea Battle reconnaissance, strike, convoy and broadcast frequency alocations in the Southwest Pacific Area have been based on ionospheric data, and the success achieved has amply justified the comparatively small expenditure of effort in this direction.



LOCATING SOURCE OF SIGNALS

Ionospheric information has proved of considerable value to Signals Intelligence Units. Taking the negative aspect first, past experience indicates that operations rooms may be unnecessarily alarmed by reports of strong signals picked up by nearby receivers, leading to the conclusion that an attack is imminent. A ship was, in fact, sent out on one occasion to endeavor to intercept a submarine which was finally proved to be some 10,000 miles distant at the time. Had reference been made to ionospheric data, it would have been clear that considerable skip distances were involved, and one could have predicted with certainty that the signal in question could not have come from a point closer than 2,000 miles from the receiver.

As a further example, in 1942 one of the Services believed a spy to be operating a transmitter in one of the mountainous regions of New South Wales. The frequency, on which strong signals were picked up, was in the neighborhood of 11 Mc/s. It was also noted that signals were exceptionally strong and steady by night. After considerable time and effort had been spent searching the area, a request was made for the supply of mobile direction finding equipment, thus bringing those familiar with the application of ionospheric data into the picture. It was then made clear that the transmitter was at least 2,000 miles away, and that errors in plotting the bearings, due to the use of rhumb lines instead of great circle bearings had caused incorrect inferences to be drawn. Further observations made by D/F stations more appropriately placed proved conclusively that the transmitter in question, although operated by the Japanese, was located in the Netherlands Indies.

Prior to the more widespread use of ionospheric data in the Southwest Pacific Area, a sudden increase in the number of signals being received by radio intercept units lead to the impression, on one or two occasions, that attacks were impending, and hurried preparations were made to meet them. When nothing eventuated, there was, of course, some criticism of those responsible for the unnecessary alarm which had been caused. Investigation showed, however, that the sudden increase in traffic was due to improved propagation conditions on lower frequencies, due to the onset of an ionospheric storm, thus giving the impression that the enemy was more than usually active. Ionospheric forecasts, coupled with regular monthly predictions, are now in general use, and thus cause and effect can be more readily determined, and unnecessary warnings eliminated.

There are, of course, a number of other more important positive applications of ionospheric data for Intelligence purposes; such as correct siting of intercept units, location of D/F stations, assignment of duties to units—in many cases more remote from the desired targets—to avoid the effects of "skip", determination of the approximate area covered by each unit, the assignment of frequency bands to be watched, etc., but for reasons of security, it is not desired to go further than merely indicate the nature of the problems which may be solved by the intelligent application of ionospheric data.

Adequate wave propagation data enables high frequency communication systems to be placed on an engineering basis. Guesswork may be eliminated and questions posed by the operational staff confidently answered, either in the negative or affirmative. The need for such data is vital to the success of many operations and those who fail to make use of the knowledge now available must be considered guilty of negligence, should failures occur which result in heavy loss of life and equipment.

An enemy raid is being tracked on the display plot in this "action shot" of an Air Defense Control Center at Bougainville. Liaison officers have alerted the base. Island and Air Command, AA Batteries, and ADCC's of other bases and ships. The Fighter Director Officer has assigned the raid to an intercept officer (not in the picture) who, from an intercept table or PPI, is vectoring fighters to intercept the raid.

guardians of the sky

An Air Combat Intelligence officer briefs the pilots before they go out on a mission. Their tense attitude shows that they know from experience how vital is the information which he is giving them on landmarks, radar evasion, enemy opposition to be expected, weather conditions enroute, communications procedures, and plan of attack.

C. I. C. AUGUST 1944

what about low angles?

The Mark 22 (small antenna to the right) installed alongside the Mark 4 radar. Gun director is Mark 37 with round-backed shield.

Enemy air attacks at low altitudes challenge our ability to answer the question, "What About Low Angles?" The Mark 22 radar can answer the question. In conjunction with its "big brother", the Mark 4 or Mark 12, it provides the fire control data for shooting down low flying enemy aircraft.

The "big brothers" furnish accurate range and bearing. Accurate elevation above about 10° is determined also by the Mark 4 or Mark 12. But these equipments are subject to serious limitations in position angle accuracy when they bear on low-flying aircraft. The diminutive Mark 22, with its antenna alongside the Mark 4 or Mark 12, will permit accurate pointing down to less than 1 degree above the horizon, and lower if skillfully operated.

NARROW VERTICAL BEAM

The beam of the Mark 4 or Mark 12 is broad vertically. At low angles the energy reflected from the surface of the ocean combines with that above the surface to cause position angle errors as great as 2° or 3°. The Mark 22, with its narrow vertical beam and 12° vertical scan (twice a second) is accurate in tracking to ±3 mils.

HOW IT OPERATES

Having selected the target on the Mark 4 or Mark 12 scopes, the trainer and radar range operator rely on the pointer to adjust his handwheels until the director is on in elevation. The pointer looking at his Mark 22 indicator sees only the selected target. The pointer's target, on the Mark 22, appears as a *vertical* strip of increased illumination superimposed upon the dim *vertical* sweep trace. At right angles to the vertical trace a short bright *horizontal* marker indicates the line-of-sight of the director. The illustrations on the opposite page show clearly what the operator sees and does when a target is coming in.

Antenna alignment and other adjustments notwithstanding, the pointer can bisect a normal target signal within a ratio of 4 to 6—a pointing accuracy of ±2 mils. But on aircraft the accuracy may drop to ±3 mils.

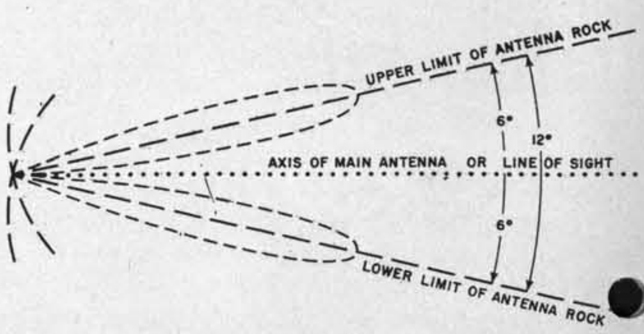
If two aircraft targets are on the same bearing and within 400 yards of each other in range, the signals on the range scope of the Mark 4 or Mark 12 become a composite of two signals and ranging precisely on one or the other is difficult. However, if the planes' angular separation in elevation from the director is over 1.2°, the Mark 22 can point accurately at one or the other. If the angular separation is less than 1.2°, the director will point to a position between the two aircraft—if the merged signal is bisected.

When on target at angles below about 3°, the target will produce two signals on the indicator but this presents no problem. The upper signal is the true target. However, below about 6/10 of a degree the two signals merge into one. Skillful operation at this point will keep the elevation error to within a quarter of a degree, presupposing an accurately functioning system.

Ordnance Pamphlet 1153, *Radar Equipment Mark 22 Mod O* should be studied by all operating and maintenance personnel whose duties are connected with the Mark 22 and associated Mark 4 or Mark 12.

STATUS OF INSTALLATION IN THE FLEET

All fleet ships having Mark 37 gun directors with Mark 4 or Mark 12 radars are slated for the Mark 22. New ships will get the Mark 22's during the building or shakedown period. Installation in Pacific Fleet and West Coast ships will be as allocated by CincPac. On the East Coast allocation for installation is made by the Bureau of Ordnance.

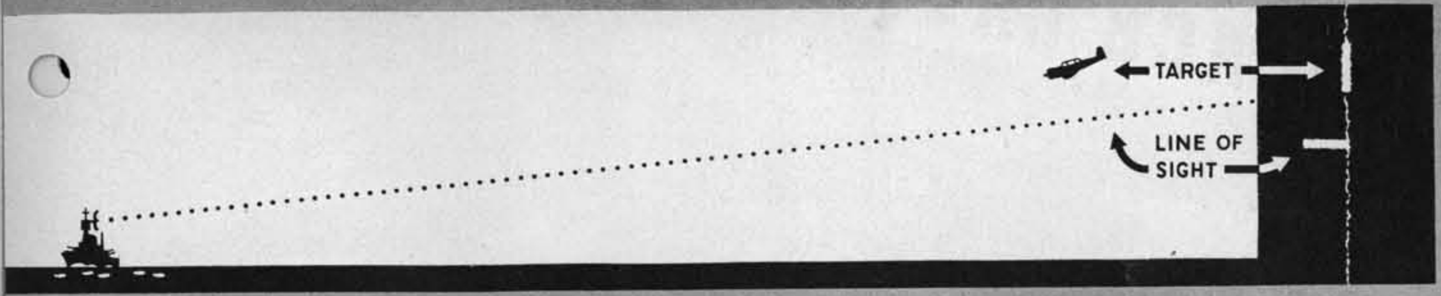


The antenna of radar Mark 22 rocks in a vertical plane.

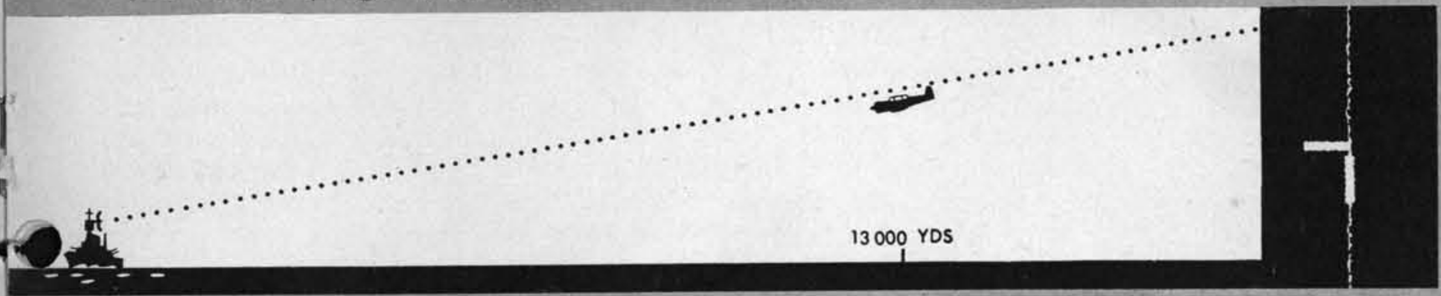
MARK 22 IN ACTION

Enemy Plane comes in low—The Range on the Mark 4 or Mark 22 Scope is 16,000 Yards.

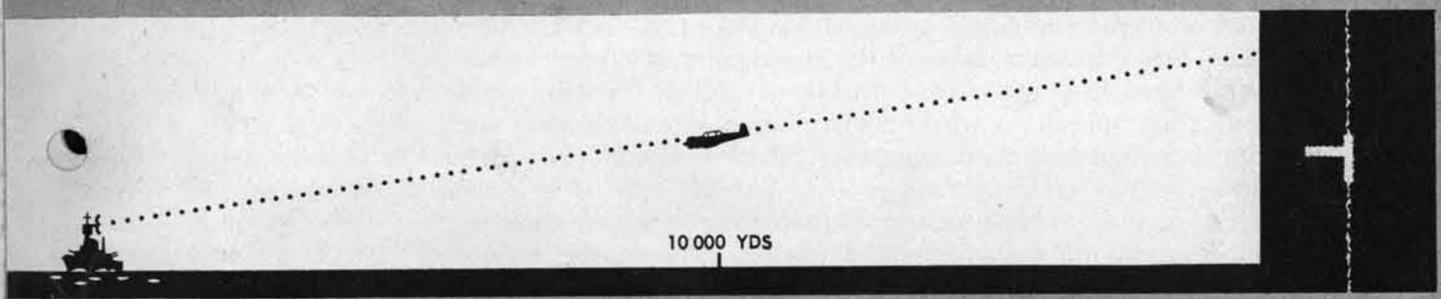
On Mark 22 Indicator



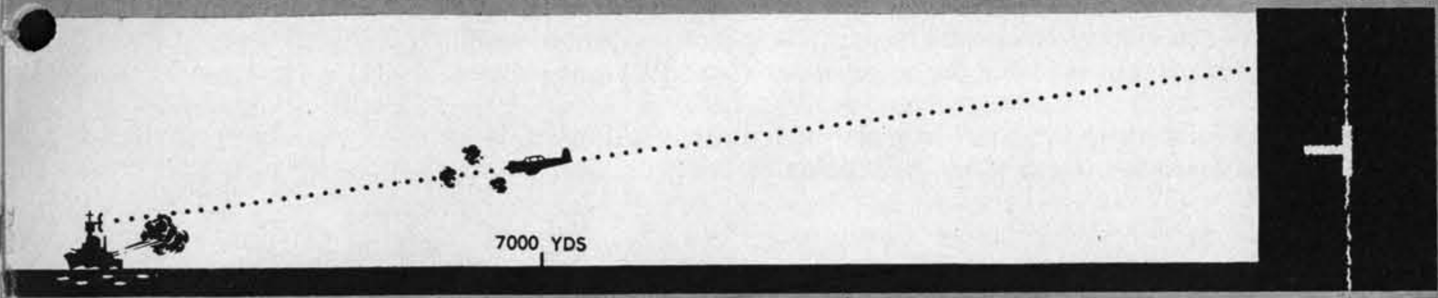
The Pointer picks up the Signal—Sees, on his Mark 22 Indicator Scope, that he is low, and elevates—(*Height of the plane above water is exaggerated in these illustrations*).



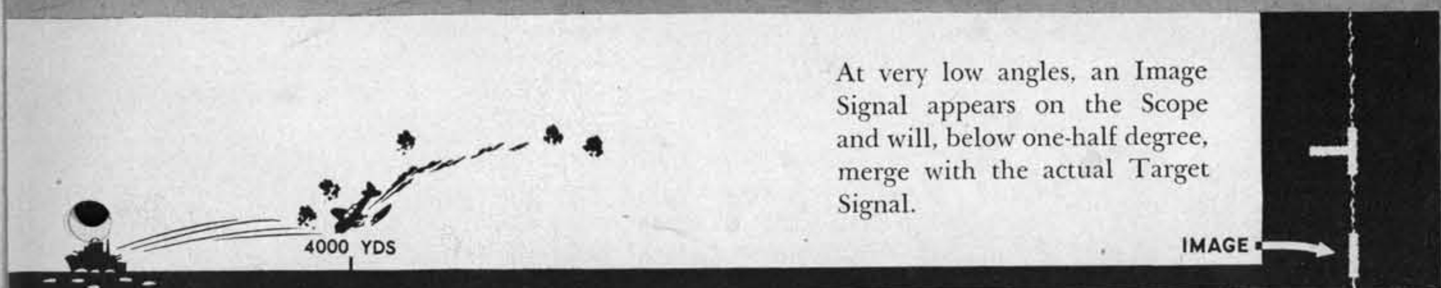
He may Elevate too much—Here he is about 2° above the steeply gliding Torpedo Plane.



"On the Target"—The Signal however is not bisected by the "Line of Sight" and the Operator Depresses slightly.



Commence Firing—The Signal is bisected and the enemy is within range of the guns.



The Pointer stays on—If the Plane gets through to close range, the 40's and 20's let go.

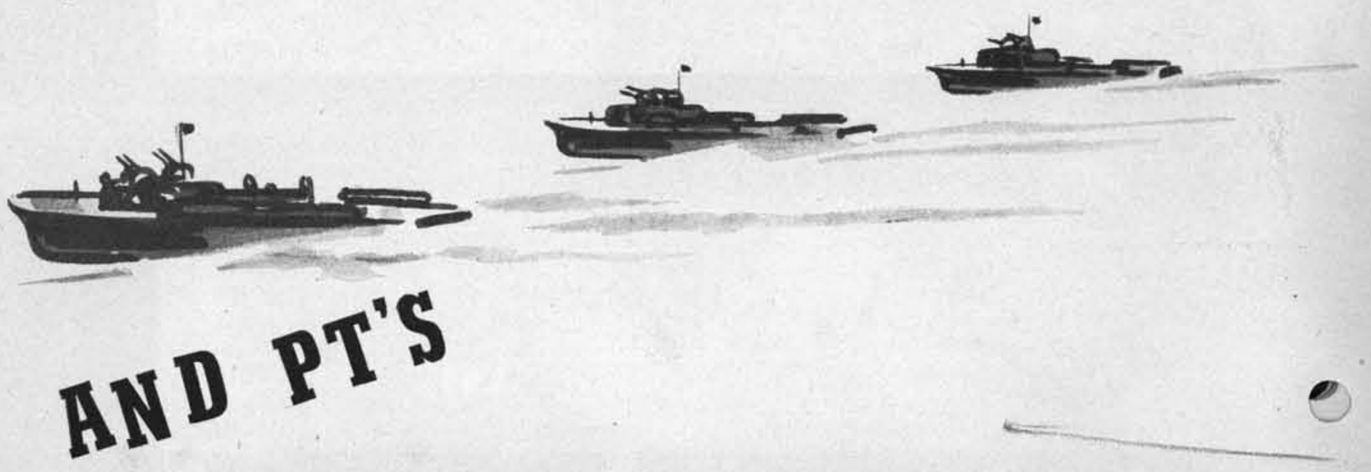
BLACK CATS AND PT'S

Radar and radio facilities in the PT boats and Black Cat planes were of the utmost importance in their joint operations. VHF has contributed more to these operations than all other radio equipment together.

Operations of enemy and Allied planes and surface craft in the earlier days of the Solomons Campaign exposed the inadequacy of our identification and communications procedures, especially at night. We were often forced to restrict air operations where surface units were operating and vice versa, and as a result the success of many offensive missions was definitely reduced.

The solving of this problem is a story involving tactics, equipment, and painstaking promotion of better understanding between the various combat units. Task units of cruisers and destroyers, PT forces, night fighters, Black Cats, and other planes used to track and spot for surface forces, worked together on the problem. The result of their efforts is shown in current action reports of joint offensive missions against enemy shore and surface forces—that result is increasing success. It is perhaps best exemplified in the joint operations of PT boats and Black Cats (PBY-5As painted black).

Success of joint operations reached a new high during the Bougainville Campaign in November 1943 and has been going higher ever since. Shortly after Black Cat Squadron VP-81 reached the Bougainville area, a conference was held between the squadron officers and PT commanders. They staged a series of day and night exercises, during which simulated attacks were made on enemy shipping, and established the procedures for actual offensive missions. It was found that the Black Cats would direct PTs to a target, spot PT fire, illuminate the target, and, when advisable, deliver a bombing attack with strafing runs. The PTs could align in a favorable attack position on information from the plane and deliver a simultaneous attack with almost no guess-work or preliminary calculation. Frequently the plane could slow down the target by bombing until the PTs could close in with their greater fire power and torpedoes and effect complete destruction. Against targets operating close to shore and taking evasive action, the combination showed great promise.



The PTs had very short range radar without IFF interrogator, could only detect planes close at hand, and then could not identify them. Numerous attacks by enemy aircraft induced a natural distrust of any plane which drew near. Accordingly, the first essential for "air-surface" co-operation was identification. The Black Cat would pick up the PTs at twenty miles or more and, before homing on them, would contact them over VHF, identify itself, give its position in range and bearing from the PTs, and advise the boats that it was to work with them for the night. If at any time the plane went beyond VHF range, it would identify itself again upon return.

The Black Cat and PT radars proved to be excellent complements to each other. The plane's ASE could identify many more targets, at greater distances; however, it was seldom able to pick up small craft moving close to shore, whereas the PT's radar could do so.

Both planes and PTs report that VHF has contributed more to joint operations than all other radio lumped together and is indispensable. HF is unsatisfactory because of the high noise level created by the plane's radar; turning off the ASE sacrificed target-detection for communications, obviously unsatisfactory. VHF is the completely satisfactory solution, providing excellent voice communication at all times, especially since a channel has been set aside expressly for joint operations.

The ability of the plane to transmit CW messages for great distances was also an asset to the combination. If aid was needed, contact with bases was assured. This ability to remain in touch with the outside world was an innovation to the PTs and opened up wide possibilities from a tactical viewpoint, particularly in large naval operations.

Following our successful landings at Empress Augusta Bay, the enemy was forced to rely on large numbers of barges, moving close to shore at night, to supply and evacuate Choiseul and lower Bouganville. The inception of regular, organized PT-Black Cat co-operation at this time was a stroke of luck. Experience showed that PTs could not see Black Cats at night, hence it was logical to assume that the enemy barges could not; but the plane crews could see both PTs and barges, primarily because of their wakes. Conversely, the planes could seldom determine the damage inflicted in attacks, but the PTs could do so readily by observing silhouettes and using their surface radars.

Night after night, the Cats and PTs cracked the enemy in their assigned areas. At first the Black Cats were forbidden to bomb targets in the PT area without express permission of the boats, but experience soon proved the feasibility of letting the planes attack when the PTs were out of range. The plane, of course, notified the PTs of its intention, gave location of

the target, and then illuminated the target when the PTs arrived. If the PTs made the original contact, they notified the plane, and requested any aid needed, such as bombing or strafing to let them pull away from the target temporarily.

The following excerpt from VP-81's action report on joint operations during the night of 7 January 1944 gives a representative picture of problems faced and actions taken:

"When this plane arrived on station, PTs operating at the Northern end of Choiseul Island warned us of a bogey in the area. PTs operating off the Southeast coast of Bougainville Island soon asked us to relay a report to the Choiseul PTs that planes had just bombed and strafed them, 'one bomb hitting close.' The PTs requested flares dropped and later requested frags dropped on Sipaisi Island; both requests complied with, results unobserved. Dropped numerous flares for PTs in both areas, but no sign of enemy.

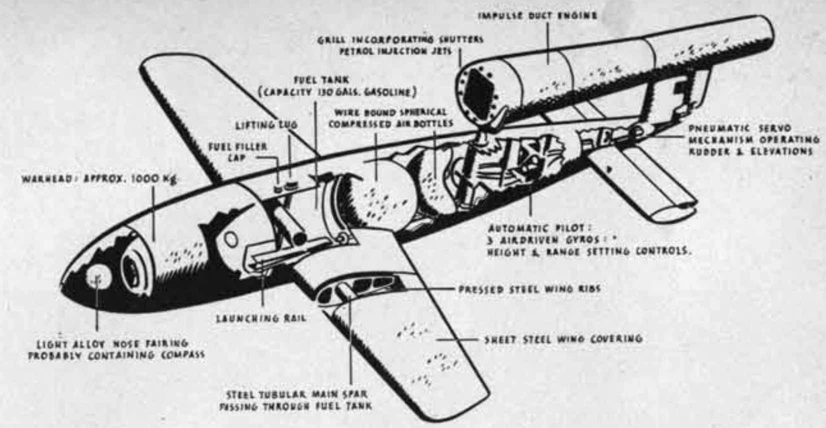
"At 1400 GCT the PTs off Bougainville requested flares dropped at the mouth of the Luluai River. On reaching this point, Cat saw six or seven barges in single file, on a Southerly course. Reported to PTs who directed plane to bomb the barges while the PTs got into position to open fire. Cat dropped flares and the barges immediately began to scatter; released three DBs with instantaneous nose fuses from altitude of 1600 feet spaced by intervalometer for 100 feet at 140 knots. Only the first stick of the three bombs detonated, landing 200 feet behind the barges. Three barges were seen leaving the column and the Cat singled them out for its second attack. Its last 325 lb. depth bomb was released manually from 1600 feet with the center barge as the point of aim. This bomb exploded forward of the center barge's wake, and when the plane banked, a 100 foot oil slick was seen. Results other than this could not be seen. By this time the barges were well scattered, two continuing on course, two reversing course, and two apparently making for the shore. The PTs then asked the plane to strafe the barges making for the beach, and the plane's gunners covered the decks of two of them with 30 and 50 caliber MG fire. Three PTs made runs on these barges, completely covering them with their fire, and receiving accurate fire in return. Heavier fire, estimated to be 37mm., was directed at the PTs either from the barges or from the shore. After each run by the PTs, the plane kept track of the barges while the boats reloaded. During the action a torpedo tube was damaged on one PT, a hole was put in the hull of another, and one man was wounded facially by shrapnel. A doctor was aboard the PBY, but the pilot decided not to risk an open sea landing at night amid heavy ground swells.

"Evidently out of ammunition, and unable to get further aid from the plane whose bombs and flares were expended, the PTs withdrew. The Cat then proceeded to Choiseul and reported to the PTs in that sector the action which had just taken place off Bougainville. At their request, the plane searched Northward along the SE coast of Bougainville as far at Kieta Harbor for a large vessel reported coming down from Buka Island, without success. After reporting again to the PTs still on station, the Black Cat departed for its base."

Methods were continuously improved with experience. Minor navigation problems were solved by providing both planes and boats with identical charts and detailed maps of specific operating areas. With these and VHF, planes and boats could direct each other to targets or search positions. Even in bad weather, planes could thus drop flares where needed. PT ordnance gear was standardized and experience soon determined the best load for the Black Cats, generally, forty flares (carried internally and thrown out the tunnel hatch, compensated for wind and drift so as not to illuminate our own PTs), four 325 lb. or 500 lb. bombs carried externally on the wings, and, often, twenty-five or more 20 lb. anti-personnel fragmentation bombs, which may be thrown from the blister during a run; many targets have been straddled with these and effectively damaged.

Neither Black Cats nor PTs claim the attainment of perfection in their joint operations. But both are enthusiastic about the substantial progress made thus far and are energetically striving for continued improvement. PT officers are flying in planes during joint missions and pilots are to be found aboard the PTs, all trying to learn the best way to handle mutual problems. Results to date promise much for the future.

the flying bomb



The pilotless airborne bomb which was first used by the Germans on June 13, has been officially designated as the "Flying Bomb". (Newspapers have referred to it also as "Doodle Bug" and as "Buzz Bomb".)

This weapon, known to the Germans as V-1, appears to be one answer to Allied air supremacy in the Channel area. While the inaccuracy of the missiles as used to date is such as to make it impossible to assign specific military targets as objectives, approximately 35 percent of the bombs have landed in the London area causing considerable damage to non-military installations.

The bomb, as may be seen from the illustration, is of relatively simple construction and apparently designed for mass production.

From an examination of fragments and parts of unexploded bombs recovered in England, it has been possible to determine the method of operation. The bomb is originally launched from an inclined ramp on the mainland, by means not yet determined, at an initial speed of approximately 270 miles per hour and continues under the drive of the jet propulsion motor which operates as a result of the increased pressure developed on the forward side of the air intake grill by the high speed of the missile.

A clockwork mechanism which precesses the gyro normally under control of the magnetic compass allows the bomb to be put into a turn within three minutes after launching. The maximum duration of the turn is one minute and corresponds to about 40° in azimuth. After being put on course by this method, the missile flies in a straight line under control of the magnetic compass which precesses a gyro controlling a servo motor actuated by air pressure from two high pressure air bottles located in the fuselage. The gyro is further precessed by a barometric capsule which can be preset for any desired altitude up to [illegible],000 feet. A small two-bladed propeller, 10 centimeters long, mounted on a shaft geared to a veeder counter, registering to 9999, constitutes an air log. By pre-setting the counter, which is turned backwards during flight, the electrical fuse can be armed, the radio transmitter turned off, and the detonators in the tail assembly exploded. The radio transmitter, which appears in approximately one out of every twenty missiles, is provided in order that shore D/F stations may obtain fixes on the bomb for the purpose of correcting errors in flight. A prisoner of war has reported that the fix must be obtained and telephoned to the control central within ten seconds in order to insure sufficient accuracy. The detonators in the tail assembly operate at a pre-determined time prior to the end of the flight, shutting off the fuel supply and causing the elevators to operate and put the plane in a dive. At the same time, two small spoilers of different sizes are projected from the surfaces of the elevators presumably causing the plane to spin in.

Some instances have been reported in which the plane glided in to the target after the motor had stopped instead of diving. Later reports have indicated that some of the bombs circle before going into a dive. The exact reason for this is not known, but it is assumed that it is for the purpose of obtaining a fix as a check on the accuracy of the flight.

Countermeasures to date have consisted of:

a. Bombing launching sites.
b. Destruction of missiles by fighter planes.
c. Destruction of missiles by antiaircraft fire.
d. Use of barrage balloons.

On one instance a fighter pilot who had run out of ammunition succeeded in crashing a bomb by tipping it over with his wing tips.

A summary of the results of the flying bomb attacks on England (as excerpted from Prime Minister Churchill's address of July 6th) appears in "German Flying Bombs" in the July 12, 1944 issue of The O.N.I. Weekly.

u-boat killers

Captain D. V. Gallery, Jr., U.S.N., and Commander J. G. Johnson, U.S.N., of the USS GUADALCANAL.

CVE C. I. C. Operations in Anti-Submarine Warfare

While the tremendous Pacific carrier strikes have held the spotlight, the Atlantic carrier forces have been building up an impressive score against the once dreaded U-boat. Thanks to these small but hard-hitting sub-hunters and their DE escorts, shipping losses that once reached alarming proportions no longer hamper the conduct of the European war.

These versatile forces operate under all conditions of sea and sky. Flight operations once considered impractical are normal routine and today include forty to sixty percent night patrols. To witness a night recovery of a TBM on a pitching deck in squally weather is an education in itself and creates a healthy respect for these six thousand tonners, the crews that man them, and the TBMs.

Each task force group is usually composed of a destroyer screen of four to six DEs with one CASABLANCA or BOGUE class CVE. The closest possible coordination between the screening vessels, the carrier, and the aircraft is essential to successful hunting as maximum use of all available facilities must be made to develop a contact and press home the attack for a kill. The contact may be by escort sound gear, aircraft patrol sighting, airborne radar blip, dispatch information, radio DF, search radar, or visual, and may develop at any time day or night from a range of a hundred miles to within the screen.

Deployment of the screen and movement of the carrier vary with every contact as operations are not confined to a fixed pattern.

C. I. C. IS THE NERVE CENTER

The carrier C. I. C. is the nerve center of the force and must be constantly alert to evaluate and prepare to act on all types of contacts. Air defense and air interceptions are a remote possibility and are of minor importance and operations are of a more specialized nature than in the usual carrier type C. I. C. While operations are essentially the same in the two carrier classes in use there is some variation in physical arrangement. Figure shows layout of the CASABLANCA class C. I. C., with modifications as found in U.S.S. GUADALCANAL (CVE 60). This shows the general arrangement of equipment in Air Plot and C. I. C. which are adjacent and combine operations.

The master submarine chart in Air Plot carries all available information on location of submarines, convoys, neutral MVs, and Anti-Submarine Warfare task groups. The task group movements are determined in a large measure by information on this chart.

A detailed track chart is maintained of all force movements, contacts, aircraft patrols, and other pertinent data. A universal chart table has been developed by the ship for this purpose and is located in Air Plot. The two illustrations show the general construction of the table which was built of material available on board. In general, a latitude-longitude grid on tracing cloth is carried over an underneath lighted plexiglass sheet on two rollers. By turning the rolls any latitude required can be brought over the plotting surface. An overlay of tracing paper is used for plotting and all land in the area is sketched in.

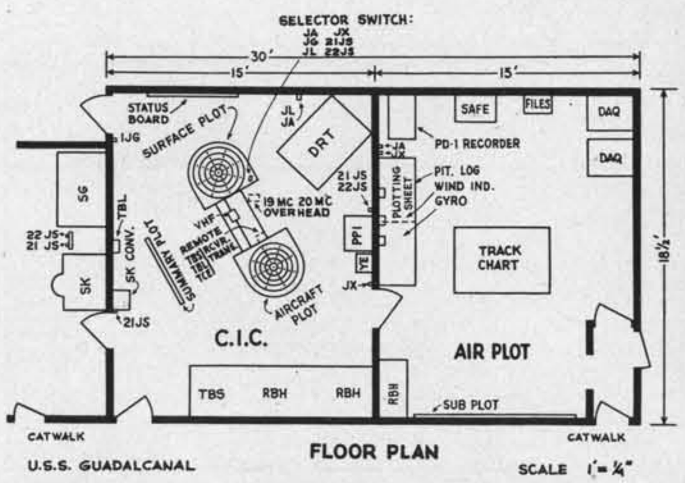
The C. I. C. equipment follows the general carrier type with a summary vertical plot, two horizontal relative plots, a DRT, and a remote PPI. The radar equipment consists of an SK, an SG, ABKs and a BN and BL with YE and YJ navigational aids. The remote PPI has been converted to use the 12″ scope so that grease pencil plotting can be done directly on the PPI for rapid course determination. This conversion is shown in the illustration and was made according to instructions in PacFlt Radar Tactical School Bulletin No. 8.

Communications equipment covers all the usual frequency bands including TBS and two channels of VHF. Aircraft traffic is usually handled on VHF channels 1 and 4 with two HF channels for alternate use. The escorts maintain a listening watch on VHF which can also be used as a standby for the TBS. A DAQ (High Frequency Direction Finder) is installed in the carrier and some escorts. A constant listening watch is kept on the submarine traffic frequencies and bearings reported on any contacts made. An important use of the DAQ is in locating lost planes or fixing a plane reporting a contact when off the radar screen. To accomplish this the aircraft reports on HF channel which can be DF'd in a very short time. If simultaneous IFF code range can be obtained a deficit fix is established. One TBM crew forced down at long range and recovered because of a good fix by this means will testify to the value of this procedure.

Two PD-1 recorders are installed, one in air plot and one in communications. A continuous recording of the TBS and VHF traffic is maintained and is of valuable assistance in preparing action reports.

DRT THE MOST VALUABLE PLOT

The DRT remains the most valuable plot in an ASW C. I. C. Each carrier has its own method of use but in none of them can the importance of the DRT be overemphasized. During low visibility, plots of the screening DEs are tracked for use in the event of sonar contact. Aircraft contacts, DAQ bearing, downed planes, long range patrols, and escorts away from the formation are plotted on the DRT. In fact, in every operation or contact the DRT is of prime



C. I. C. and Air Plot are closely co-ordinated.

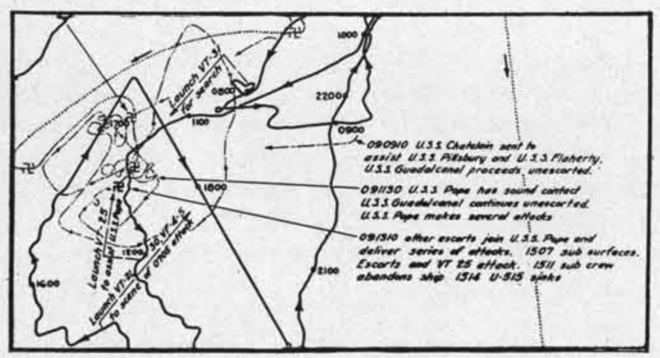
importance. Dead-reckoning of patrols beyond radar coverage can be accomplished more satisfactorily than on the relative plots.

The presnet C. I. C. complement is one FDO and three intercept officers, one officer and seven men (including a CPO) for maintenance, and sixteen operator-plotters. The officer watches are six hours each and the operators four hours for each of the three sections. In addition there is mutual assistance with the Air Plot and ACI officers. Communications monitoring and maintenance are the responsibility of the communications department.

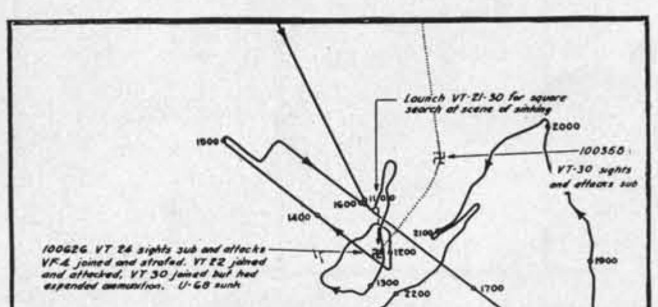
FIVE KILLS IN THREE CRUISES

The USS GUADALCANAL is a comparative newcomer in Anti-Submarine Warfare. With the present scarcity of U-boats and the disappearance of the wolf packs, finding, tracking, and holding down a sub to exhaustion requires the most persistent offensive tactics. Her five sure kills in three cruises are evidence that her method of operation is successful.

After originally maintaining air search radar silence, it was decided that the possible advantages did not balance the disadvantages. The use of the SK and escort SAs is unrestricted and apparently had no effect on the contacts by warning them of Task Group's presence.



Swastika marks the spot.



Another U-Boat is sunk.

Air patrols were maintained day and night when in the area of a suspected U-boat. Constant tracks were maintained on the patrols (extending to 100 miles) by SK plots until below the radar horizon when they were dead reckoned on the DRT. Plots were periodically transferred to the vertical plot from the DR position on the DRT.

During night operations, C. I. C. maintained control of the aircraft flying at sufficient height to remain on the screen for most of their patrol. Radar contacts were investigated and additional planes vectored to the area when necessary. Merchant vessels were challenged and identified in all contacts with them. At the time for recovery, the planes were returned to the task group usually by their own navigation on the YJ and YE but occasionally by steers. When over the force, the escort vertical lights (not visible from the surface) and the carrier vertical identification flashing light and the deck lights were turned on. No deck flood lighting was used. Each plane was then ordered into the landing circle and ordered to switch to channel one. The landing signal officer then took over and "talked" them in on VHF in addition to use of the illuminated signal wands. To do this a chest "mike" with a switch on the signal wand was used and as the remarkably low number of crashes indicates, was highly successful.

The following is an excerpt from the FDO's notes on DRT operations which is of interest in illustrating the C. I. C. operations:

DRT OPERATION ABOARD THE USS GUADALCANAL

Recent operations against submarines have amply demonstrated the tremendous value of the DRT in conducting continuous search when in the vicinity of enemy units. A variety of situations, from tracking and vectoring planes to areas of night contacts on U-boats, to rescuing survivors from forced landings were constantly kept up to date on this instrument. In fact, the DRT as much as any other factor made possible an accurate current plot of movements of the Task Group and its various units, and contributed greatly to the effectiveness of the search which eventually resulted in 2 U-boat kills, after 18 and 26 hours respectively.

During flight operations at night, the DRT scale was kept at 8 miles per inch. If an aircraft at 100 miles reported a contact and a good position was needed, the plane was ordered to climb until picked up by the air search radar. The position obtained was then given the Navigator to plot on his DRT; meanwhile, the scale of the one in C. I. C. was changed, a clean section of tracing paper rolled out, and when ready to plot, a reference plot was obtained from the Navigator, and the distance and bearing of the spot kept up to date from then on in C. I. C. Under conditions where extreme ranges made it difficult to get an accurate bearing on the plane, emergency IFF was requested plus a brief transmission by the plane on the primary a/c frequency (usually 6000-7000 kcs). The HF/DF equipment was then used to get accurate bearing and the IFF signal for accurate range, and the fix thus obtained was plotted.

Atlantic weather is sometimes not too favorable.

Using this procedure, it was possible to direct one of the escorts to a spot to pick up the crew of a plane which had become lost and had made a water landing. This forced landing occurred during rather bad flying conditions and high winds with the result that the raft with the survivors, originally 140 miles from the carrier, drifted downwind at 3 to 4 knots, from the original sighting by a search plane. The sequence in this case was as follows, with communications between the carrier and the lost plane at best intermittent due to the storms in the area:

(a) The plane returning from anti-sub search had communication failure, was unable to receive base either on VHF or HF and could not hear the YE.

(b) A wind estimated about 50 knots was blowing the pilot off his course.

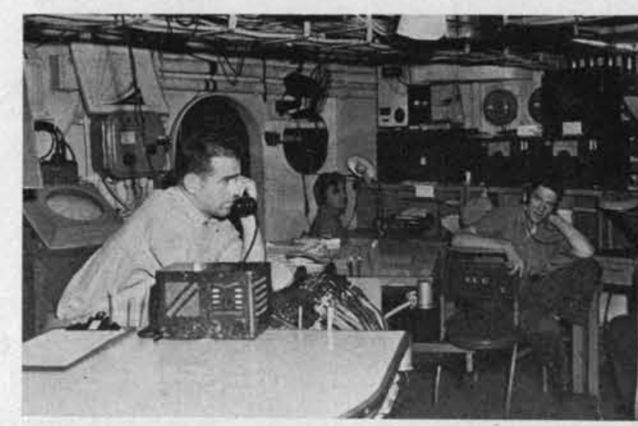
(c) While on the radar screen, no communications could be established to give him a homing steer, and when finally was established, via another plane, he was off the screen so that no intelligent instructions other than climb, orbit, and show emergency IFF could be given.

(d) Two upwind vectors were given during about one hour of attempting to locate the plane, but these were of short duration and did not compensate for his down wind drift while climbing. He was eventually picked up down wind by IFF at 128 miles and immediately given the correct steer. At this point, however, he was 1½ hours from the carrier with ½ hour of fuel. He therefore maintained altitude as long as possible during which a fair IFF position was obtained and another plane was launched to locate him when he went in the water a little later.

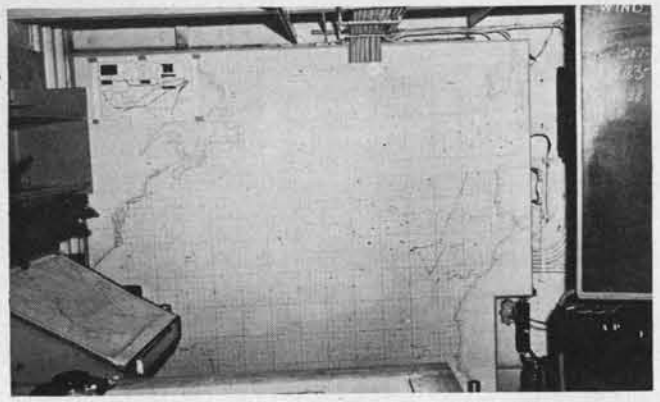
(e) Fortunately, the vector to the relief plane proved accurate as he located the survivors in their rubber raft before they had drifted very far from dye slick markers.

(f) By means of HF/DF bearings on the relief pilot's transmissions plus his own navigation on distance, a second plane was launched and sent to the spot to assist in maintaining contact. An escort meanwhile had been ordered to proceed in the direction of the original vector to pick up the survivors. The second plane made contact with the first and proceeded to orbit above an overcast from which a further reference position was obtained.

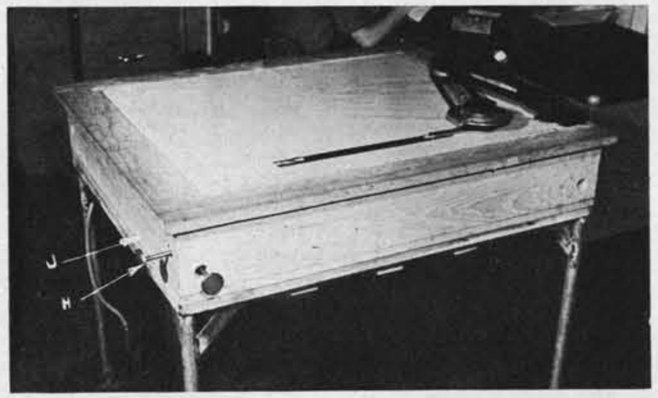
(g) Meanwhile, one pilot maintained contact with the raft by remaining low over the water, and the second provided radar fixes by flying at



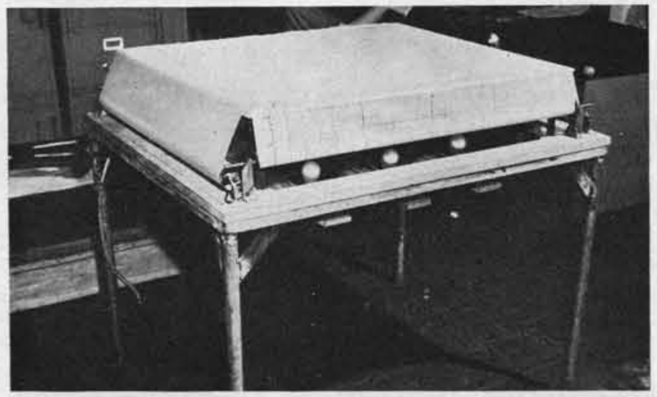
Remote PPI converted to 12" scope is seen behind the FDO in C. I. C.



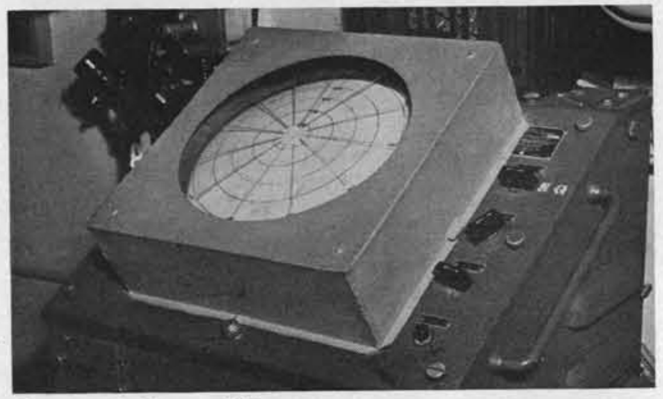
The master submarine chart displays vital information.



This track chart table has proved very useful.



Showing construction of track chart table.



Close up of Remote PPI.

sufficient altitude, every so often checking his position by going down close to the surface.

(h) Since it was possible at times only to receive IFF signals, the HF/DF was used frequently to obtain accurate bearings on the planes circling the survivors with ranges obtained from the plane at altitude.

(i) In addition, bearings were taken by HF/DF on the escort proceeding to the scene and these bearings plus a DR of his speed of advance, enabled the CTG to direct the headings of the escort to compensate for drift of the raft, and until the escort could pick up the circling plane on his own radar.

(j) As a result of this coordinated action plus launching of relief planes to maintain constant visual contact with the raft, the survivors were picked up from a very rough sea within six (6) hours from the time they made their water landing.

Throughout this situation, the DRT made it possible for the CTG to keep an accurate picture of the bearing and distance of the planes, the raft, and the detached escort from himself, with corrections in these positions made on the DRT whenever any new information so warranted. Furthermore, whenever the plane at altitude appeared to drift away from the spot where the raft was, he was vectored back to his orbit station by means of the latest DRT position showing bearing and distance.

Under similar circumstances, but under conditions where a given spot was not as critical from the navigational standpoint, the DRT was used to maintain 2 planes searching an area around a wake sighting during a late afternoon flight. These planes conducted an expanding square search of the area and were maintained in the limits prescribed by means of radar fixes plotted both on the vertical summary plot and on the DRT. Thus the summary plot showed the relative picture at any time for purposes of vectoring, and the DRT kept a plot of the actual area covered by the searching planes.

DRT TRACKS A U-BOAT

On the occasion of the first sighting of a U-boat by one of the VT pilots on night radar search, the sighting was plotted on the DRT as of 2130 one evening. On the basis of this information 2 other planes were sent to search the same area, and at 0027, (three hours later), the U-boat was attacked and it submerged, but the plot was maintained on the DRT and, in addition, a sonar contact by one of the escorts which had arrived in the same general area. Another attack on the same U-boat was made when he surfaced at 0725 the same morning, again driving him below the surface.

Since all of these contacts were within a radius of about 25 miles, the importance of the DRT in maintaining an up-to-date picture of what was transpiring both as regards aircraft and surface craft cannot be over emphasized. As a result, operations with air and surface craft were maintained in the area continuously for 18 hours, contacts were made, lost, regained, and a kill eventually registered at 1515 the following afternoon when one of two U-boats was forced to the surface and sunk.

Contact, possibly with one of the U-boats met during the above attack, was made by aircraft on night radar search at about 0400 the following morning; attack was delivered and position obtained by radar fix 70 miles south southwest of the scene of the first sinking. This fix was plotted as were previous ones on both the navigator's and C. I. C. DRTs, and additional planes launched and vectored to the area to continue the hunt. As dawn was breaking, one of the planes made contact on a surfaced U-boat about 10 miles south of the previous attack. The U-boat fired back at the attacking planes, scoring a hit in the port wing of one of the TBFs. Meanwhile, additional planes were launched and vectored to relieve those on station over the scene of the sinking. Intermittent heavy overcast prevented quick contact with the orbiting planes but eventually they were relieved, and the reliefs in turn aided in guiding two escorts to the scene of the attack to pick up survivors and debris reported in the water. While the HF/DF was not employed as effectively in this instance as in the previously mentioned rescue, the range and bearing to the point of attack both of the carrier and the detached escorts was maintained on the two DRTs, based on the original radar position and any improvements in this position established meanwhile.

In situations of this sort, accuracy of radar bearings both on the original fix and in vectoring additional planes or escorts to the scene is of the greatest importance in saving time. It is suggested therefore that where any doubt as to a bearing exists, HF/DF be used to check this by requesting brief calls on a frequency which will give a good bearing sense on the DAQ equipment.

For the purposes of using the polar type chart in vectoring aircraft, the position of a fix should be corrected on such a chart or plotting board every ten minutes. Since it is a better display for rapidly moving aircraft and simplifies vectors, it is more suitable for this purpose than the rather small scale DRT plot.

Ready accessibility and practise in plotting on the DRT for radarmen cannot be over emphasized. Furthermore, all personnel should be so indoctrinated in its value that the moment any situation develops, no matter how apparently trivial, the position of the "bug" and the time will be marked immediately on the tracing paper and as soon thereafter as possible, the range and bearing of the fix plotted and given to the Navigator to do likewise. The latter is extremely important from a geographical position standpoint.

Where an accurate record of either aircraft or surface searches is desired in a given area, no better means of obtaining this exists than to plot the bearings and ranges from the radars directly on the DRT as called by the operators. Furthermore, the permanent record in the form of the DRT tracing is of inestimable value in reconstructing the situation for study and criticism.

Another kill came about in a much different way. For some time the task group had patrolled the area of a suspected U-boat. The night patrols had picked up disappearing radar blips from time to time which were investigated on orders from C. I. C. but nothing definite was established. Sono buoys were used frequently. The force was ordered to reverse course to take one last look at that area. About 1100 one of the escorts reported a sonar contact via TBS. Two VF in the air were ordered by C. I. C. to the contact position and a killer group requested. The contact developed to a depth charge attack just as the VF arrived, 4 miles from the carrier. The fighter pilots spotted the U/B below the surface and reported to C. I. C. and then called the escort. The escort was directed back over the U/B by the VF. The sub then surfaced and opened fire. The killer plane had been launched and was directed to the area by C. I. C. After it had surfaced, the U/B was strafed by the VF, driving the men from the guns, and finally under combined escort and VF fire the crew abandoned ship and another Nazi flag adorned the bridge of the carrier.

During these operations C. I. C. was the coordinating center and maintained control of the aircraft to the point of actual attack.

BLOCK ISLAND HAD IMPRESSIVE RECORD

The USS BLOCK ISLAND (Bogue class) accumulated an impressive submarine score in her numerous cruises. Her C. I. C. method of operation was developed from long experience and the FDO's informative notes on C. I. C. for ASW are included at the end of this article.

The USS BLOCK ISLAND, while patrolling in a suspected U/B area was torpedoed and sunk. Six VF were airborne and were returning to base when two torpedoes struck the ship. C. I. C. personnel then on watch continued their duties and general quarters was sounded. All radio receivers and the SK radar were out of commission but the VHF transmitter still functioned. The FDO took charge of communications and broadcast to all planes on VHF that the carrier was severely damaged and probably could not recover planes. He also broadcast position of the nearest land and the vector to it for information of the pilots and he then told pilots to use their own judgment.

At this time a periscope was sighted on the port quarter and the VF were given this information and ordered to strafe. This was put out over VHF and primary frequencies. A third torpedo struck the ship ten minutes after the first and put out all power and remaining C. I. C. equipment. At the time the FDO did not know that any transmission had been acknowledged as all receivers were out of commission. On the order to abandon ship all hands made an orderly departure and arrived safely at the rescue ships. The FDO made a final check of all C. I. C. spaces and attempted to recover the C. I. C. log but the safe had been jammed.

PRACTICE NEEDED FOR "ABANDON SHIP"

In reviewing the action the FDO had the following comments and suggestions:

1. The squadron was not thoroughly indoctrinated and briefed in advance, by C. I. C., on what procedure should be followed in the event of an emergency which would make it impossible for airborne planes to make normal landings aboard.
2. A standby Fighter Director ship should have been designated at the beginning of the cruise, and, while communications were still intact, a summary of the situation relayed to that ship, together with any instructions.
3. The pilots of airborne planes might have been given a report of the situation immediately rather than a few minutes later followed by amplifying reports as additional information became available. In this particular instance, however, the short delay had no bearing on the situation, as all planes were en route back to the carrier, and all pilots received the necessary information before arriving over the task group.
4. Definite provision should have been made in advance for the salvaging of those C. I. C. records and reports which would be needed later and which would otherwise have to be reconstructed in a less complete and accurate form.

Most of the difficulty experienced by C. I. C. in this emergency could be eliminated by doing two things—briefing the squadron on what procedure to follow (although in most instances the final decision concerning what action the planes should take would depend on the individual situation)—and by holding C. I. C. drills for attacks on the carrier as well as drills for contact with, and attack on, the enemy. The BLOCK ISLAND C. I. C. had concentrated almost exclusively on offensive rather than defensive tactics.

In connection with the briefing of the squadron, the following suggestions are made:

1. Include the name of a standby Fighter Director ship on the fly sheet for each flight; this ship to be contacted automatically by the senior officer in the air in the event that communications with the carrier are cut off.
2. So far as practicable, handle the emergency transmissions between the Fighter Director ship and planes in the air through one plane, to cut down the load on the channel being used and to avoid jamming. Normally, this would be the senior pilot in the flight or the pilot with the best communications.
3. All transmissions from C. I. C. that should not be regarded by all airborne pilots as specific orders should be preceded by "information only" or some such pre-arranged phrase.

In connection with C. I. C. drills, the following suggestions are made:

(A) C. I. C. officer, assisted by section leader—

1. Maintain order and see to it that all stations are manned.
2. Check for safety measures such as life belts, battle lanterns, extinguishers, helmets, gas masks, as situation seems to require.
3. Quick survey of the condition of equipment and personnel. Report results to FDO. Report results to Bridge, using officer messenger if communications are out.

(B) ACI officer—

1. Assemble these records and reports previously designated to be salvaged in the event of such emergency and stow these in a waterproof container designed for the purpose, and which could either be taken over the side in a raft or boat, or strapped to his person. If time permits, the logs and records might be distirbuted among several officers.
2. Other records to be destroyed or locked up, according to security needs.

In the event of actual "Abandon ship" orders, all officers not otherwise occupied see that enlisted men get over the side in an orderly manner.

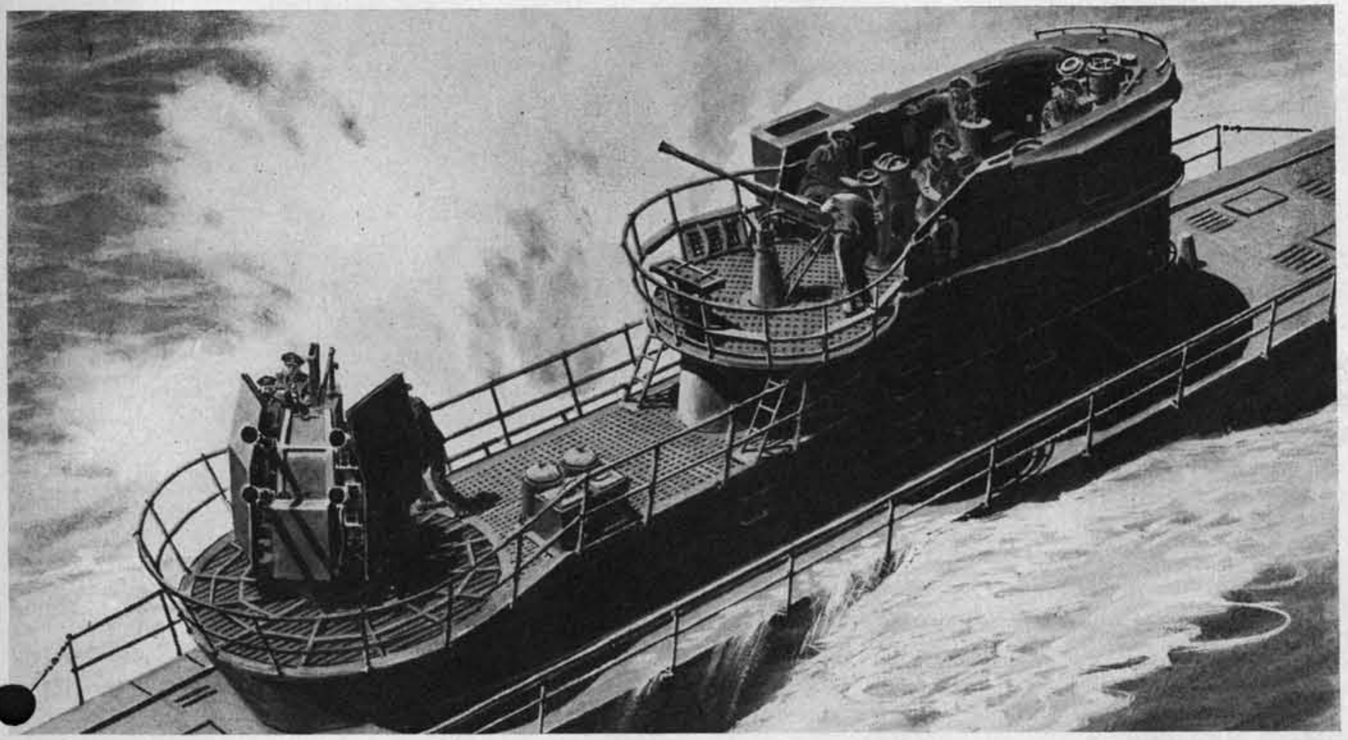
In summing up, it appears that C. I. C. operations during the emergency were effective, but a more efficient performance might have been turned in if a definite doctrine had been established and drilled in advance, rather than to plan the course of action and make the decisions at the time of the attack.

Due to the variable type of contacts and variety of operation no specific detailed plan can be given for C. I. C. operation. Briefly the watch must be continuously alert and the watch officer must be ready to handle every possible situation. These ASW task groups and their C. I. C. personnel can be proud of their record as they have been in no small way responsible for the great change in Atlantic sub operations and the safety of our convoys.

C. I. C. ON THE USS BLOCK ISLAND

During the last cruise of the BLOCK ISLAND, the personnel organization and the duties of C. I. C. were as follows:

One C. I. C. officer and fighter director officer— He was responsible for the organization and opera-



Drawing from O.N.I. 220-G, "German Submarines".

tion of C. I. C. and the training of all personnel. He assumed full responsibility in C. I. C. at GQ or during enemy contacts, although normally his watch schedule was the same as that of the other FDOs.

Three assistant fighter director officers—These officers rotated a fighter director watch during all times of air operations. During times of no air operations, they stood regular C. I. C. watches.

One ACI Officer—Principal tactical adviser to CTG, in charge of the preparation, accumulation and dissemination of all reports and data of a tactical significance to the task group. One of his major duties each day was preparation of CTG's operational report, based on the C. I. C. log.

Two Assistant ACI Officers—C. I. C. watch officers and assist ACI officer in handling tactical data.

Two Radar Maintenance Officers—C. I. C. watch officers and responsible for proper maintenance and upkeep of all ship-borne radar and homing equipment and all air-borne radar and radio equipment. These were excused from C. I. C. watch when pressure of maintenance work necessitated.

One Anti-Submarine Warfare Officer—C. I. C. watch officer and adviser to CTG on ASW tactics.

One Air Plot Officer—Permanent air department duty officer and responsible for setting up flight plans and navigation therefore in accordance with CTG's desires. However, all C. I. C. officers could and did check aerial navigation.

Twenty-Two Enlisted Men—Sixteen radarmen, divided into four watch sections; two information board keepers who stood twelve on and twelve off; and three radiomen who rotated on monitoring and recording VHF. Lack of available men prevented the primary frequency being recorded except automatically on PD-1. A yeoman striker operated both recorders and assisted in keeping tactical board up to date.

During air operations, the FDO on watch is, generally speaking, responsible for radar plot while the C. I. C. watch officer is responsible for air plot.

The operations of C. I. C. in preparing for and carrying out flight operations in the daytime is usually as follows: Night operations are taken up separately.

1. CTG advises the air plot officer, as far in advance as possible, of the desired flight schedule including type of search, number and type of planes to be used, type of armament to be carried, and PO data.

2. This information is immediately passed to the ready room, hangar deck, flight deck, so that preparations may be made.

3. Approximately an hour and a half before scheduled take-off, the C. I. C. watch officer or FDO on watch prepares the flight sheet which includes the following information (a) flight number, (b) type of search plan to be used (from CTG), (c) variation (from chart house), (d) PO, time, course, speed (from CTG) and position (from DRT) at time of take-off, (e) planes available including standbys (from hangar deck), (f) pilots assigned, according to sectors and planes, plus standbys (from ready room), (g) any special instructions for the mission (from CTG), (h) possible sightings (from ship and sub plot), (i) weather data (from aerology), (j) ZD and times of sun and moon rise and set (from chart house), (k) nearest land and bearing and distance to it from PO position (from DRT & plot), (l) recognition and approach data (from signal officer), (m) aircraft frequencies and calls, (n) YE code in use.

4. Search plan corrections are determined by the air plot officer and given to the ready room. Pilots' navigation is checked by him or C. I. C. watch officer.

5. The navigation on a relative movement basis is passed to radar plot and the search plan is accurately set up on both the No. 1 horizontal and the vertical plot. (This enables dead reckonings of the planes throughout their searches, thereby presenting at all times a fairly accurate picture of where the various searches should be. The SK radar is frequently not operated for security reasons and often the length of the searches is greater than the effective radar tracking range.)

6. The status board is brought up to date in accordance with the latest fly sheet information.

7. Prior to take-off, VHF communication with the planes is checked by the FDO.

8. After launching, communications are again checked and after each plane or group of planes has checked and joined up satisfactorily, it is given a BTK (proceed on mission assigned).

9. The C. I. C. watch officer is responsible for having all BTK's noted appropriately on the DRT. (This permits a reasonaby accurate plotting of all contacts or sightings on the DRT of anything seen. The pilot reports positions, in terms of range and bearing from last BTK position of the carrier.)

10. The C. I. C. watch officer is responsible for the correct plotting on the DRT of all contacts, HF/DFs and sightings as they are made.

11. The C. I. C. watch officer is responsible for maintaining the "contact and sighting book" up to date at all times. This book contains a one-line summary of all contacts and sightings, giving the date, time, range and bearing from base, DRT position and brief evaluation.

12. In the event of an enemy contact by a plane or search group, the pilot immediately reports it by VHF, giving range and bearing as accurately as possible. IFF is switched to code No. to identify him as contact plane or group.

13. The following actions are taken by C.I.C. immediately on receiving such a report:

(a) SK radar immediately turned on (if not already in operation) and search made for contact group in area determined by DR plot.

(b) Nearest armed airborne planes immediately are vectored to general area of contact. A more accurate vector is given when contact planes have been picked up on the SK or their position otherwise determined.

(c) Bridge, ready room, and flight deck are notified to make immediate preparations for launching a "killer group." Planes are launched as soon as preparations and Captain permit.

(d) Horizontal and vertical plots are both marked with DR positions of contact and later corrected to show radar fix on contact when obtained.

(e) Killer group is given most accurate possible vector to point of contact; this is done both by blackboard and VHF.

(f) Horizontal plotter discontinues dead reckoning and plots only radar positions of contact group and planes being vectored to contact.

(g) Vertical plotter continues DR plot of planes remaining on regular searches but sketches in vectors as given.

(h) C. I. C. watch officer sees that contact is plotted on DRT and entered in contact book.

(i) C. I. C. watch officer keeps readyroom and bridge informed of all developments. Request is usually made that one or more escorts be sent to scene and information as to course and distance is supplied.

The following additional functions of C. I. C. are under the responsibility of the C. I. C. watch officer.

1. Maintenance of all equipment in C.I.C. and responsibility of notifying proper persons in case repairs or adjustments are necessary; seeing to it that at least one receiver, speaker, and transmitter in C. I. C. are tuned in at all times on both primary and secondary frequencies.

2. Keeping convoy and neutral vessel plot up to date at all times and setting up new sheet at 1200 daily. (ACI officer is responsible for plotting daily positions of subs, although C. I. C. watch officers may assist in this.)

3. Determination by geographic plot, the course and speed of radar surface contacts, passing this information with any possible evaluation to the bridge as quickly as possible. Also, seeing that one petty officer simultaneously solves course and speed problem by relative movement and that another enters information properly on DRT and in contact book.

4. Keeping of accurate TBS log by monitor with split headphones on both TBS and on RBK receiver, and rapid translation of same so that decoded messages are quickly available to the bridge, if required.

5. Evaluation and entering of all pertinent HF/DF and MF/DF intercepted transmissions on DRT and in sighting book.

6. Keeping task group fuel reports up to date, also all information of tactical importance concerning any unit in the task group.

7. Turn on YE ten minutes before any search group was due back over base. To assist in this, a red ring was drawn ten minutes out on the vertical plot. When dead reckoning of plotter brought

a plane within this ring he notified CIC watch officer. YE code was also maintained on vertical plot to assist in locating position of planes.

8. Frequent checking of station keeping of escorts during the night and notifying tactical watch officer if any escorts are out of position. However, the primary function of SG was surface search rather than station keeping.

9. Keeping of complete and accurate log of all happenings during watch that are of tactical importance to Task Group.

10. Seeing that enlisted men man their correct stations in an efficient manner.

Night flight operations were primarily the concern of the FDO on watch. In addition to his normal daytime functions, he was responsible for the following:

1. Keeping all search planes or groups in position so that there were no loopholes in the areas being covered.

2. Changing or expanding the search as conditions or the CTG dictated. This necessitated both joining up groups and working out new navigation and passing same to the pilots over VHF.

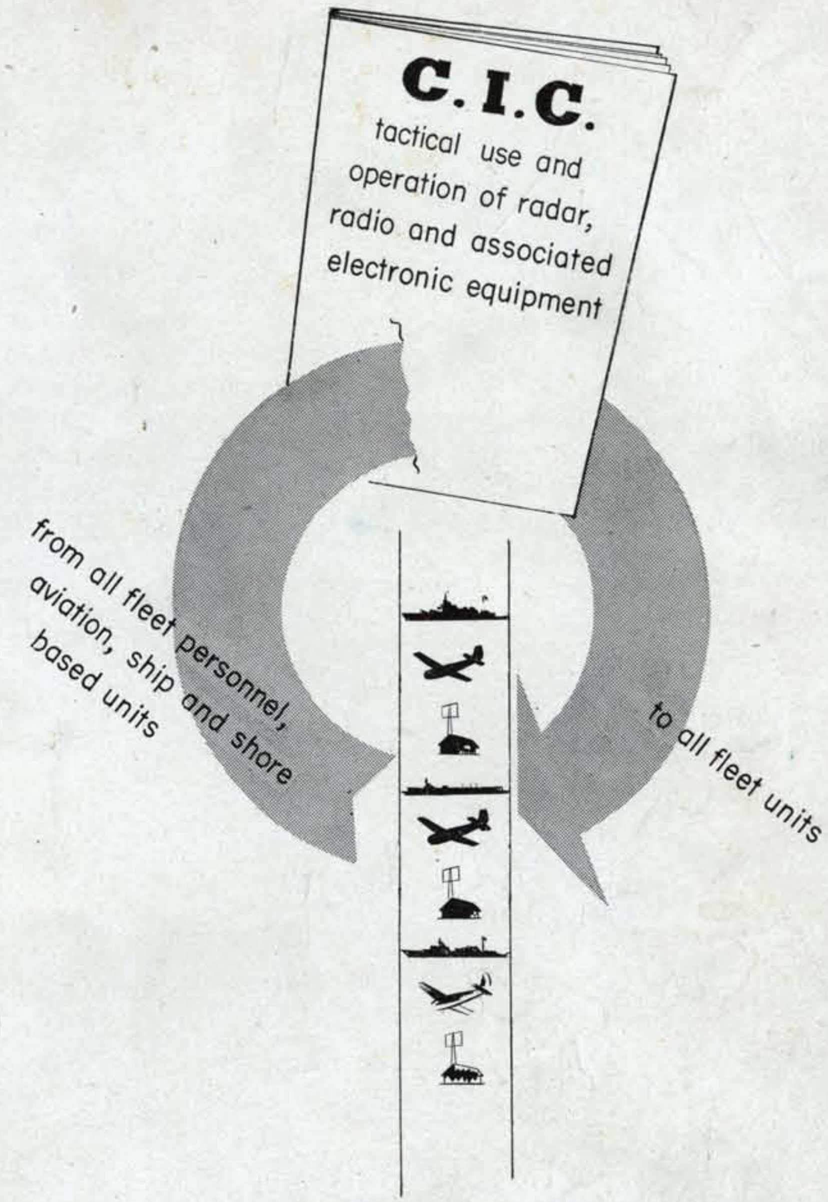
3. Rigid control of altitude of each plane or group so as to prevent possibility of collision. All planes approaching the carrier at the same time had to be placed at levels at least five hundred feet apart. The same was true of any two planes approaching each other.

4. Maintaining an accurate up-to-the-minute picture of the position of all surface vessels in the area so that any plane picking up a radar contact could be told immediately, or preferably in advance, whether it was worthy of further investigation.

5. Passing on barometer readings and emergency wind (magnetic direction of surface wind) to pilots at least every two hours and always thirty minutes before their final estimated time of arrival (ETA).

6. Stationing planes at different altitudes and positions in relation to the carrier so as to expedite recoveries with minimum risk. Plane with least gas was placed at angels .5 and the others stacked five hundred feet apart; the lowest plane landed first while each of those still airborne were simultaneously brought down five hundred feet.

7. Keeping carrier and escorts informed as to position and condition of night search planes and notifying them as necessary when truck lights should be turned on or some other form of identification given.



The usefulness of this vital information depends upon how fast it completes this circuit. Expedite it all you can!

RADAR OPERATOR'S HANDBOOK

The Radar Operator's Handbook is not available for distribution at this time. Sufficient notice will be given as to when this publication can be obtained. Since wide distribution is contemplated, copies will be forwarded to all ships of the fleet and schools concerned *without request.*

By direction of Chief of Naval Personnel.

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