COAST DEFENSE STUDY GROUP NEWS

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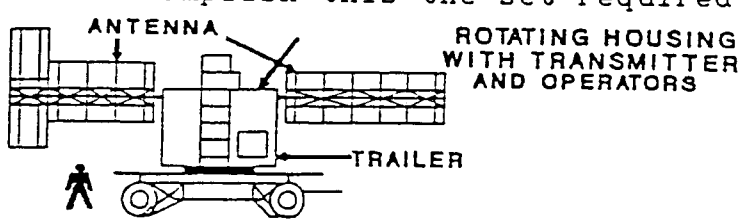
SEACOAST ARTILLERY RADAR 1938-46

DANNY R MALONE

In several articles and on several WWII fort maps mention is made of the types of radar which were utilized by the Coast Artillery. The following is a short summary of the development, capabilities, and operation of the various standard types. The Coast Artillery Corps expressed an interest in the development of a workable electronic ship detection device from 1937. During 1937 the coast artillery requested a set which would give advance warning of and provide azimuth and range data for non visual engagement by shore batteries. The first attempts utilized infrared type detection but by 1938 during trials radar had proved superior and a first set was developed. This first surface search set was type-standardized by the Signal Corps as the SCR 296, and following the SCR 268 and 270/271, became the third standard type of Radar to be produced for the American military forces. The development and production of this radar was at the time deferred due to the priorities of the late 1930s of seeing the bomber aircraft as the greatest threat to the United States. From 1937 the signal corps had taken over the development of the ancestor of all U. S. radars and produced the SCR 268. This radar was a large set which utilized a bedstead type antenna and operated on a long wave length of 150 centimeters at 205 mc frequency. It was mounted on a 4 wheel trailer for mobility, weighed over 14 tons, and could be emplaced and operational within two hours. Its chief function was to provide elevation and azimuth for direction of the 60-inch searchlights utilized for anti-aircraft defense. It was operated by a crew of three personnel and gave range, azimuth, and elevation(not height)of aircraft targets. The 268 was capable of 360 degree search and the antenna was capable of searching from +15 to +85 degrees elevation. To accomplish this the set required a 13.2 kilowatt power supply.

SCR 268



The set produced a effective range of 24 miles(although 60 was achieved on occasion) , but was credited with an poor showing in azimuth and elevation accuracy. It achieved a 4 degree average error, as opposed to the 1 degree expected. Post war the set was credited with being able to furnish reliable range on aircraft flying 10,000 feet or higher at distances up to 40,000 yards The principal failings of the 268 however were the poor performance against low-flying(500 feet or below)aircraft and the excessive interference of ground or water conditions which created' clutter' on the scope. Both of these were a direct result of the long wave

continued on page 3.

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COAST DEFENSE STUDY GROUP NEWS

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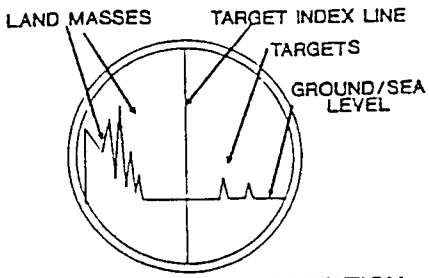
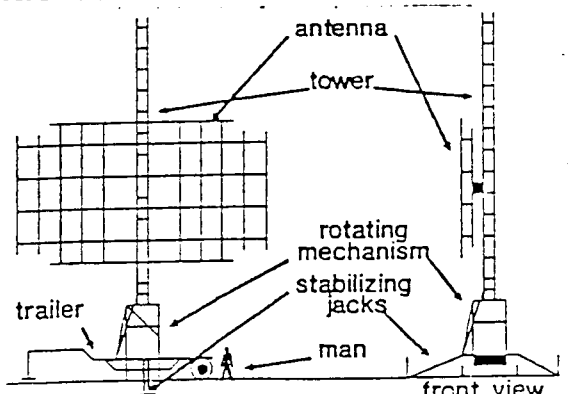
PLANS FOR THE ANNUAL ARE SUSPENDED FOR THE FORESEEABLE FUTURE

length operation and low frequency utilized. An additional restraint was the use of an simple linear occilloscope(A-scope) presentation instead of the later Plan Position Indicator still used today. This A-scope resulted in a less accurate presentation which was difficult for an operator to interpret.

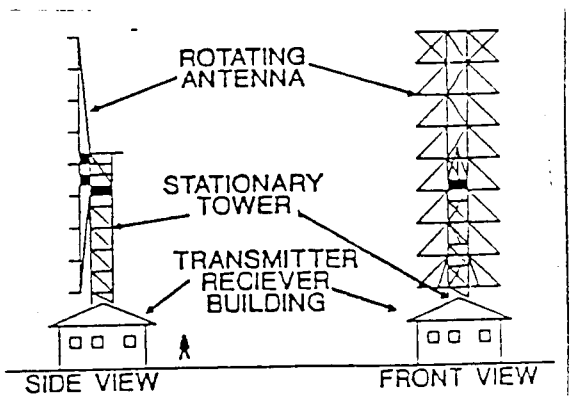


OCILLIOSCOPE PRESENTATION
SCR 268/296/270/271

Despite these problems the 268 remained in service throughout WW-II, serving until 1944 as a anti-aircraft fire control radar and short range early warning radar, and as late as 1944 1200 were still in service as searchlight control equipment. Later in the war the 268 was modernized with a PPI type scope, mechanically aided tracking, and operation on a shorter wavelength to become the improved SCR 516. As stated earlier two additional radars were developed at this time to perform the function of early warning of aircraft. These were the SCR 270 and 271. The 270 was a mobile(transportable is a better description due to the time required to emplace it) and the 271 which was a static version of the same radar.



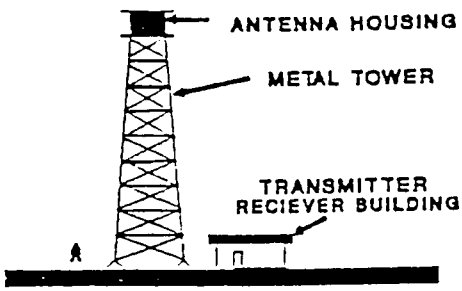
SCR 270 MOBILE SET



SCR 271 FIXED RADAR

Both operated on the long wave length of 300 centimeters at m/c and utilized the same oscilloscope presentation of the SCR 268. While achieving the credible detection range of 150 miles against aircraft, they suffered both from reliability, poor low-level(below 500 Feet) performance, and the inaccuracy and difficulty of interpreting the oscilloscope presentation. Wartime improvements, such as the addition of a PPI indicator (SCR 539) helped, but the long wavelength resulted in interference caused by ground and weather features which severely reduced their effectiveness. This was such a factor as to render them almost unusable in certain areas(PANAMA) and of questionable value in other areas. Despite these limitations as well as their later proven vulnerabilities to "jamming" they were produced as better

than nothing and by mid 1942 the United States coast was guarded by over 250 radar sets, consisting of 2-SCR-271s, 70-SCR-270s, and 194 SCR-268s. The majority of these sets allocated to the Pacific Coast. While the personnel of the period complained of the defiencies of these early sets it is noteworthy that the attack on Pearl Harbor was spotted, and tracked by one of these early SCR 270s at a distance of 132 miles. With the production and deployment of the air defense radars the army now turned to modernizing the coast defenses, whose requirement in 1937 generated the research, which resulted in the development of radar. Because of its lower priority the SCR 296 was not further considered until late 1940. Adequate quantities of the SCR 268, 270, and 271 types having been produced and successfully deployed the Signal Corps development began in earnest during 1941 when a SCR 296 prototype was obtained from the contractor and modified with lobe switching which enabled it to track a target. The set was tested, modification approved, and a production order was placed for 20 service sets. The SCR 296 was a surface search radar which had been developed from the navy's F D shipboard set.It was utilized for fire control and operated in the 40 cm frequency at 700 m/c/ wave length.

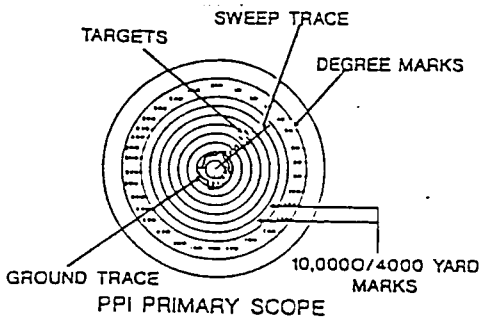


TYPICAL SCR 296 INSTALATION

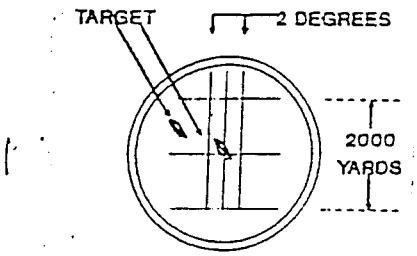
The antenna was normally enclosed in a large cylindrical housing mounted on a 100 foot high metal tower, the whole construction of which resembled a small water tower. Some exceptions to this method occurred, and several batteries in Hawaii mounted the radar housing on shorter towers(25 feet at battery Hatch) or directly on the battery command post(Battery 302). The transmitter/receiver with its consoles and operators was located in a small building close to the tower. The entire equipment weighed a total of 48 tons and thus was not mobile. It also required 2.5 kilowatts of power to operate the set alone. Due to a low priority production was slow and the first production set was not delivered until April 1942. The SCR 296 was considered a success in performing the fire control functions; however, it suffered from several defects. The first was that the long wavelength did not give a good clear radar return and thus its accuracy suffered. the second problem was that in common with most early American Radars it utilized an oscilloscope for visual presentation of the target. This device, instead of the Plan Position Indicator utilized on later, and indeed on current, radars was both less accurate and more difficult for an operator to use. Probably the greatest failing of the 296 was its inability to track multiple targets. With all these failings the SCR 296 was credited with a the ability to track and give warning of surface targets at a range of over 100,000 yards. This figure represents the maximum range. Postwar the 296 was credited with

being able to give reliable range on large targets(battleships and cruisers) at 40,000 yards, while smaller vessels(destroyers)could only be tracked at ranges of 20,000 yards. Such a limitation restricted its utility with the 16-inch weapons(44,900 yards). After various improvements in the system, including semi-automatic tracking, the system finished the war with a tracking error of + or - 30 yards in range and around + or - .2 degrees in azimuth. This was the best theoretical performance and a postwar source states that most operators could not do nearly so well. The same source stated that against moving targets the results were very much worse. These improvements did not solve the major problems which remained. Due to poor resolution of the signals it was almost impossible to spot the shell bursts to the degree necessary for adjustment of fire. In addition, without skillful help from a surveillance radar it was difficult for the SCR 296 operator to identify and range on a specific target if several possible targets were in close proximity to each other. This lack of resolution and azimuth discrimination meant that the 296 operator was only able to separate targets that were more than 275 yards apart and more than 12 degrees apart in azimuth. The final criticism of the SCR 296 was that due to its utilization of a long wavelength it was highly vulnerable to jamming by electronic and 'window' (foil strips) such as had been utilized to blind the German radar during the Normandy invasion.

While the SCR 296 was marginally acceptable as a fire control radar the Coast Artillery had a second mission for which, due to its limitations, it was unsuitable. This second mission was a need for a surveillance radar which would give early warning, and track multiple targets as well as showing their relationship to natural features within a defended harbor. The answer to this problem emerged late in December 1941 as the XT-3. This first set was tested between 27 and 30 December at Fort Dawes, Boston harbor. Type standardized as the SCR 582 it differed from the 296 in operating in the 10.7 cm wavelength microwave band at 3000 mc. It presented its information on a Plan Position Indicator scope which made the presentation more clear and easier to interpret by less highly skilled operators. This combination enabled the 582 to track multiple targets and thus enabled such organizations as the HECP/HDCP to function during periods of reduced visibility. The SCR 582 antenna was housed in a cylindrical plywood cover and mounted on towers, similar to the 296, but utilized a smaller 4-foot diameter dish shaped antenna which constantly rotated. The results were, for the period, excellent and against surface targets a maximum range of 90,000 yards was possible with the maximum effective range being listed postwar as 35,000 yards, with a range accuracy of + or - 25 yards, and an azimuth error of + or - 2 degrees. An additional advantage was that the entire installation weighed less than 2 tons when installed and required only 2.5 kilowatts of power. the SCR 582 was a fixed non mobile unit. During the operation of the SCR 582 the operator viewed two scopes. The larger, or primary scope was a Plan Position Indicator(PPI) which was graduated for up to 90,000 yards range and covered the 360 degree area of the radar coverage. The second smaller scope was called a Precision Position Indicator (P3I) or 'B' scope for short.

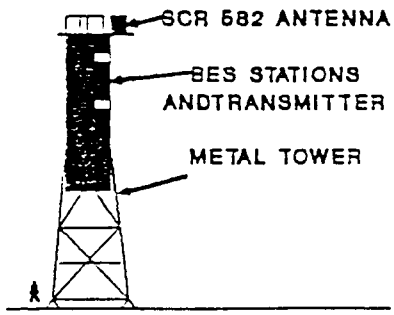


PPI PRIMARY SCOPE

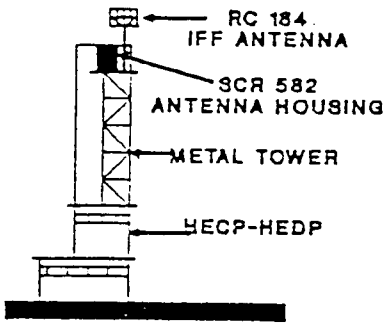


TRACKING (B) SCOPE PRESENTATION

This "B" scope was utilized to magnify a section of the radar search area by narrowing the presentation down to an area of 4000 yards in range and 40 degrees in azimuth. The scope was marked with a rectangular scale which clarified the targets position into smaller subdivisions. This magnification allowed both a greater accuracy and provided the additional capability of separating and tracking multiple targets which might appear as a single target on the 90,000 yard scope. This additional scope also ensured that the harbor remained under constant surveillance on the main (PPI) scope. An additional capability was that the P3I scope could be located up to 1,000 yards from the main radar and that up to 4 P3I/"B" scopes could be operated from the primary SCR 582. Such an arrangement gave the HECP and HEDP commanders the ability to track several specific targets while maintaining the continuous surveillance of the entire harbor area. Additionally a device called a VG remote indicator was utilized as one of the additional scopes. This device was a projection type remote unit which presented the information shown on the main PPI scope by utilizing lenses and mirrors to project the display on the undersurface of a 30 inch ground glass screen. This display was usually equipped with an outline map of the local area and was utilized for maintaining a plot of target courses. It had the great advantage of being able to be seen in a bright room, unlike the PPI/P3I scopes which needed almost total darkness to be seen. This was an obvious advantage to a HEDP/HECP commander. In addition the P3I was credited with being able to be utilized as an emergency fire control radar with a limited ability to spot both target and shell splashes. Due to its surveillance capabilities and its smaller antenna the SCR 582 was frequently mounted on existing structures, such as steel or concrete fire control towers or HECPs such as at Charleston, SC. In the latter case the structure also mounted an associated Identification Friend or Foe(IFF), SCR 184 antenna. This device transmitted a coded signal to the target which triggered a radio transponder which caused a coded signal to appear on the radar operator's scope and thus identify the ship or aircraft as friendly or hostile.

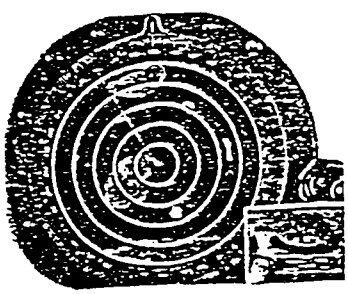


TOWER TYPE SCR 582 INSTALATION

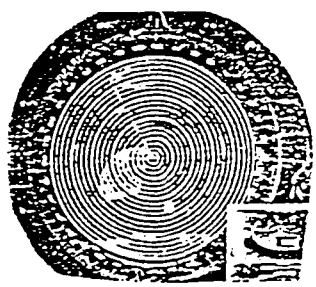


RADAR AND IFF ON HECP-HEDP

While designed as a surface search Radar,the SCR 582 very early in its career while in use in North Africa, demonstrated a credible aircraft warning capability by being able to track low-flying aircraft between 500 and 1000 feet at a range of 40,000 yards. As a result the SCR 582 was modified with the ability to tilt its antenna. This tilting was possible to preset manually between 0 and + 25 degrees on both sets and after beginning operation could not be changed, thus lessening the radar's ability to perform both air and surface warning simultaneously. Its success in this form led to it being made mobile by being mounted on 3-2-1/2 ton trucks to become the SCR 682-A. The mobile SCR 682A unit operated on the 10 cm wavelength, weighed 7 tons, and operated from a 30 foot tower. It was capable of being emplaced and operational in 3 to 5 hours. In addition to its mobility and antenna modification the SCR 682-A operated with a power output about 5 times greater than its parent SCR 582. This resulted in a maximum range of 240,000 yards, with a postwar quoted effective range of 35,000 yards against surface targets. The 682 was credited postwar with having the same azimuth accuracy as the 582 but considerably superior range accuracy. In addition the power requirement was reduced to 2.4 kilowatts The 682 did not(1944)utilize the "B" or spotting scope but had four separate range settings for the primary PPI scope. It was capable of presenting its information on the PPI at 10,000, 40,000, 160,000, and 240,000 yards ranges. The electrically produced rings on the PPI divided the scope into "coarse" and "fine" range markers, which varied with the main range settings. The 10,000 yard was subdivided into 2000(coarse) and 500(fine), the 40,000 into 10,000(coarse) and 2000(fine), the 160,000 into 40,000(coarse) and 10,000(fine) yards while at the maximum 240,000 yard setting there was only a 40,000 coarse setting with no fine adjustment. According to the manuals of the period this system was not accurate enough for fire control and was(1944) for surveillance purposes only. Initially the 582 was authorized for fixed harbor defense installations and the 682 was for mobile batteries(155 mm). This situation was changed due to the low numbers of SCR 582s produced(55 total)and the low serviceability rate from which the set suffered. This situation was made worse by a failure to procure adequate repair parts for the 582. The result was the wartime use of the mobile 682 set being modified to use the "B" scope and VG scope, which enabled it to be used in lieu of the "official" 582. The parts shortage and low serviceability rate combined to cause the SCR 582 to be declared obsolete and officially replaced by the SCR 682 by 1946.



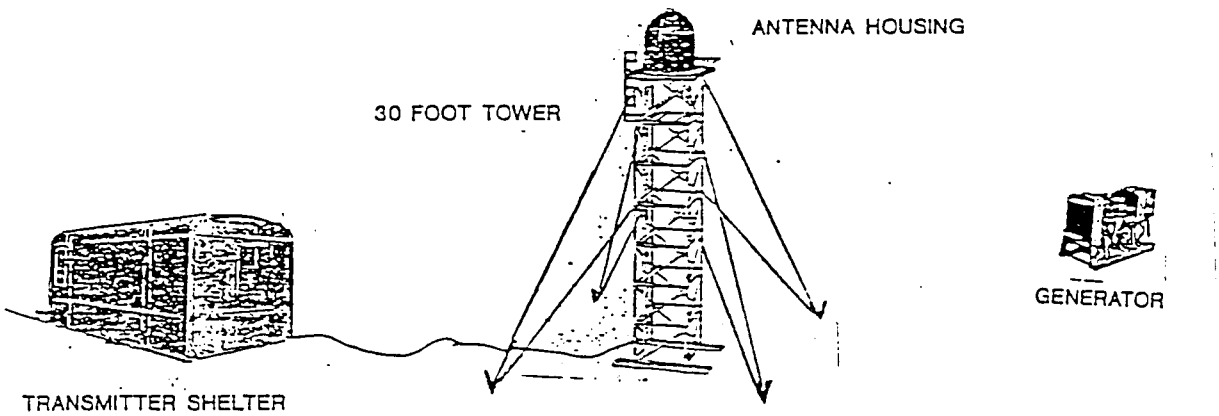
COARSE RANGE MARKS



FINE RANGE MARKS

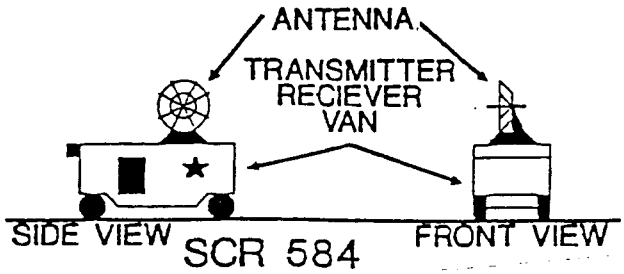
PPI SCR 682

Both the 582 and 682 were effectively employed in the Mediterranean and Pacific theaters in independent organizations Called Coast Artillery Surface Warning Batteries. They were used in forward areas to warn of air or surface attack and to give convoys navigational assistance in dangerous areas. during WW II The SCR 296 and 582 were primarily used for heavy gun batteries while the SCR 682 was authorized for Coast artillery mobile batteries of 155 MM. While these radars performed adequately the Coast Artillery developed several other radars to perform functions for which the SCR 296 and 582 were unsuitable. The first requirement was voiced in 1941 when the Chief of Coast Artillery recognized that while he had weapons and searchlights capable of illuminating what was perceived as one of the greatest threats of the period, the motor torpedo or PT boat. The SCR 268, which was the standard searchlight control radar, was incapable of operating at zero degree elevation and thus was unusable.



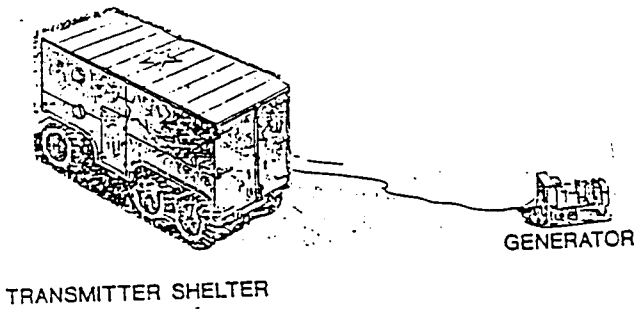
SCR 682

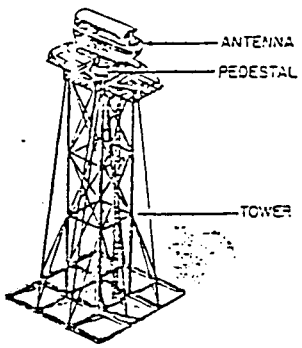
The first result was the development of the SCR 598, which was a modification of the SCR 296 with shorter range but improved accuracy against small, fast, rapidly maneuvering targets. As a interim set the SCR 584, which had been produced for directing the 90MM anti-aircraft guns, was modified to enable it to be used for surface fire control in the mobile 155 MM batteries. Additionally this set was standard equipment for the 90 mm AMTB, and the mobile 90 mm coast artillery batteries. This modified SCR-584 was used with the 155 mobile batteries to protect the forward island bases of the Pacific. The SCR 584 was housed in a mobile van and differed from the 296/582/682 family in utilizing a parabolic antenna mounted directly on the van roof instead of on a tower. It operated on a 10 centimeter wave length and due to operation with a narrow transmission beam and certain wartime modifications(N2 gate)it not only was able to screen out the surface clutter caused by wave action it was also virtually immune to enemy jamming by the aluminum strips(window).



SCR 584

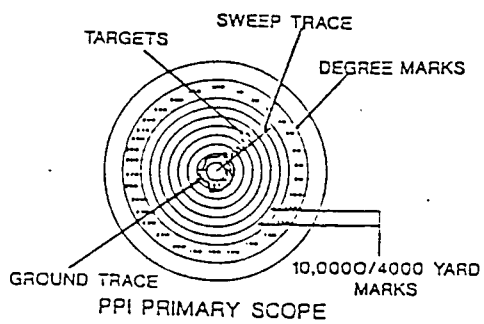
The final result of the research on coast artillery radar fire control was produced too late for service during WW II, but when introduced postwar, corrected all of the previous systems defiencies. By all accounts this radar, which was standardized as the AN/MPG-1, was one of the best sets produced for Coast Artillery service. The MPG-1 operated on still a shorter wavelength of 3 centimeters, and was mounted in a single semi-trailer which was towed by 6 ton tractor. The trailer, which functioned as the operating shelter, contained the radar consoles, the antenna a 17 foot tall collapsible tower, a portable generator, test equipment, and spare parts. The antenna consisted of a constantly rotating 8 foot unprotected array, on a 17 foot collapsible tower. The entire equipment weighed 11 tons and required 10 kilowatts of power.



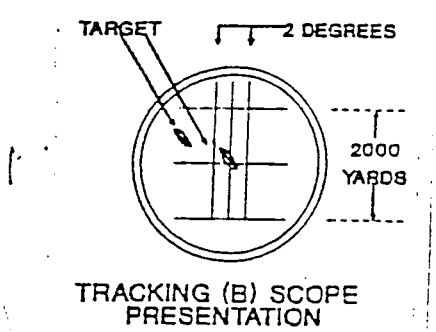


AN/MPG-1

The shelter contained the transmitter and two 7-inch scopes. The first was the PPI and the second was the Tracking or "B" scope. The PPI scope was capable of operating in two range scales, 30,000 yards and the maximum 80,000 yards. This scope was marked in 10 degree increments to give a 360 presentation on the defended harbor.



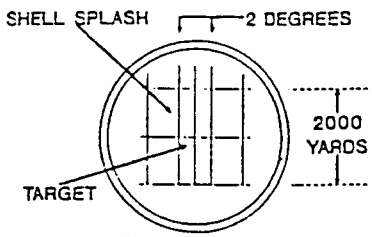
PPI PRIMARY SCOPE



TRACKING (B) SCOPE
PRESENTATION

The PPI was also divided into 8 concentric circles which represented 4000 or 10,000 yard range marks depending on the range scale in use. As in the earlier series this was used for surveillance and when the target range decreased to 28,000 yards or less the image was transferred to the Tracking (B scope). This

second 7-inch scope magnified the target presentation which represented an area 2000 yards wide an 10 degrees in azimuth. The "B" scope was divided by electronically produced lines, three vertical and three horizontal. The horizontal lines were located at the top middle and bottom of the scope and represented 1000 yard range deflection from the center or target locator line. The vertical lines were closely spaced in the center of the scope and represented 1 degree azimuth deflection on either side of the center or target locator line. The operator tracked the target so as to keep the blip at the intersection of the center horizontal and vertical lines of the "B" scope and the range and azimuth were read off dials on the console. This presentation was accomplished in such a manner as to be in the same plane as the target signals so that it was automatically aligned with the target signals on the main scope. The smooth tracking of the target was made easier by the inclusion of mechanically aided tracking. The set was equipped with two tracking rates, a fast rate for fast close targets such a PT type craft, and a slower rate for larger, slower, or distant targets. In addition to this the MPG-1 had a third scope utilized for spotting the shell bursts. This Spotting scope was the prime difference between the MPG-1 and the earlier 296/582 families.



SPOTTING SCOPE PRESENTATION

It gave an identical presentation to that of the tracking "B" scope. The spotting operator utilized a "joystick" to move a transparent plate with 5 vertical and 3 horizontal lines to position the center on the shell splash which enabled him to read the deviation in range and azimuth of the shot. Utilizing these improvements the AN-MPG-1 system achieved an accuracy of being within + or -10 yards error in range data and within .05 degrees error in azimuth data. It was credited postwar with a reliable range of 50,000 yard against large(battleship or heavy cruiser) targets. A fixed version, the AN-FPG-1, was developed for use with the heavy fixed installations such as the 16-inch batteries. Other than the lack of mobility the primary change was that the Tracking "B" scope,and thus the spotting scope also, was modified to allow use at a range of up to 50,000 yards. This modification allowed the armament to be used at maximum range, something not possible with the earlier 296/682/MPG-1 systems.

[Ed - The SCR-296 radar in this article is the SCR-296-A used as fire control radar in most World War II harbor defenses and isolated batteries. SCR-296-A operated on a wavelength of 40 cm, a frequency range of 680 to 720 Mc. (which we now term MHz) which was achieved using (per set) one of four different magnetrons.]

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2. By direction of the President, and under the provisions of paragraph 216 of the Regulations, names of seacoast forts and batteries are announced as follows:

ON FORT PREBLE, MAINE, MILITARY RESERVATION

Battery Kearney, in honor of Brevet Major General Stephen W. Kearney, U.S. Army, who served with distinction in the war with Mexico and who died October 31, 1848, at St. Louis, Missouri.