A VISUAL GUIDE TO THE U.S. FLEET SUBMARINES
PART FIVE: BALAO AND TENCH CLASSES
1942-1950

BY

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The origin of the *Balao* and *Tench* class submarines of the Second World War actually stemmed from an incident that befell the U.S. submarine construction industry during the building of the *Sargo* class submarines in late 1938. Although embarrassing and critical in nature, once corrected it led to a fortuitous chain of events that enabled the design of the rugged and well liked *Balao* class boats and their late-war progeny, the *Tench* class.

During the design and construction of the *Porpoise* and *Salmon* class boats in the mid 1930's, the two major submarine design entities for the USN, the Navy's Bureau of Construction & Repair (C&R) at the Portsmouth Navy Yard of Kittery, Maine, and the Electric Boat Company (EB) of Groton, CT. had developed a rather cavalier attitude when it came to weight control. In the interests of safety and ruggedness the designers had overbuilt the boat's framework and internal systems, the result of which was that by late 1938 the submarines of the *Sargo* class were badly overweight and could not pass stability requirements. This revelation came as a sharp slap-in-the-face to the designers and the yard workers, which then put themselves on a strict weight control initiative. The existing boats had their weight trimmed by redesigning and lightening engine mounts, by cutting away redundant sections of topside framing, and in the simplification and/or elimination of piping runs and redundant valves amongst other initiatives. These improvements were incorporated into the construction of the newer boats and by the time the *Gato* class began construction in late 1940 the mania over weight control had gotten to the point that the boats were now underweight and lead ballast had to be added to keep the boats within stability requirements.

Although far preferable to being heavy, the light condition of the boats and the necessity of correcting this with scarce and valuable lead ballast was a point of concern to the designers at C&R. In late 1941 two of the Navy's leading submarine architects, Armand Morgan from the Bureau and Andrew McKee from Portsmouth got together with the intention of addressing this issue. Their solution was to transform the weight of the lead into heavier steel for the hull. They sat down in a brainstorming session and literally did hand calculations on scrap paper and envelopes. They found that by increasing the thickness of the pressure hull plating, and by switching to stronger High Tensile Steel (HTS) they could increase maximum diving depth to 650 feet, a substantial increase over the 300 foot test depth of the *Gatos.* In the interests of safety they backed off the test depth of the new design to 450 feet. To expedite production they simply modified the existing *Gato* plans to incorporate the thicker pressure hull.

They had the design all worked out and finished just prior to the commencement of hostilities, but were unable to present it to the head of the Bureau until after he returned from an inspection of ships damaged at Pearl Harbor. Admiral Cochrane made one other change prior to approval in that he set the test depth to 400 feet over concern that the trim pump would be unable to handle the

pressure at the deeper depth. The design was so similar to the *Gatos* that it was simply rolled into the production schedule at Portsmouth (and her follow on yard at Mare Island, CA) with no break in production, although the change was on a strict need-to-know basis due to security concerns.

The keel of *Balao* (SS-285) was laid on 26 June 1942 at Portsmouth while the last of the *Gatos* were still under construction around her. Mare Island followed quickly with *Seahorse* (SS-304) on 01 July. Cramp Shipbuilding Company of Philadelphia had been brought into the submarine construction master plan and they used the Government (C&R) design. Although *Balao* was designated as the lead boat of the class, Cramp actually beat Portsmouth and Mare Island to the punch, laying the keels of *Devilfish, Dragonet,* and *Escolar* before the government yards got theirs started. However, Cramp was experiencing a severe labor shortage brought on by the swift defense buildup and when combined with other production problems the result was a substantial delay in the delivery of their boats. Electric Boat, by virtue of their substantially larger construction capacity had been awarded a huge contract for *Gato* class boats and therefore was unable to make the shift to the new design until January 1943 with the *Perch* (SS-313). EB's follow-on yard, Manitowoc Shipbuilding, laid the keel of their first *Balao* on 07 July 1943 with *Hardhead* (SS-365).

Although internally virtually identical to the late production *Gatos* with the exception of the heavier hull, the *Balao* class design incorporated a substantial change to the exterior appearance. The conning tower fairwater and periscope shears of these new boats were built from the very start with the cut down minimalist appearance that was being retrofitted to the existing *Gatos*. The original large fairwater of the *Gatos* (Figure 1) provided a smooth hydrodynamic water flow around the conning tower while submerged and a comfortable covered navigation bridge for the Officer of the Deck while surfaced. Unfortunately, this configuration also provided a massive visual target for the keen eyed Japanese lookouts with their excellent binoculars. Almost immediately after the start of the war, an effort began to reduce the huge bulk of the fairwater silhouette. First, the bulwark around the so-called "Cigarette Deck" aft of the periscope shears was cut away. This was followed by the removal of the plating around the periscopes themselves. The final steps involved the cutting down of the covered navigation bridge at the forward end of the fairwater and lowering the height of the bridge itself. Not only did this provide excellent platforms for mounting of additional anti-aircraft guns, but it provided locations for additional radar masts and auxiliary antennas. Three heavy I-beams rose up vertically on either side of the conning tower, then turned 90° inwards to provide structural support for the periscopes and platforms for lookouts. Once the plating was removed from around these beams, the visual effect gave rise to the *Gatos* being nick-named the "Covered Wagon Boats" (Figure 2).

Fig. 1. USN/Electric Boat photo courtesy T.R. Lamb and Navsource

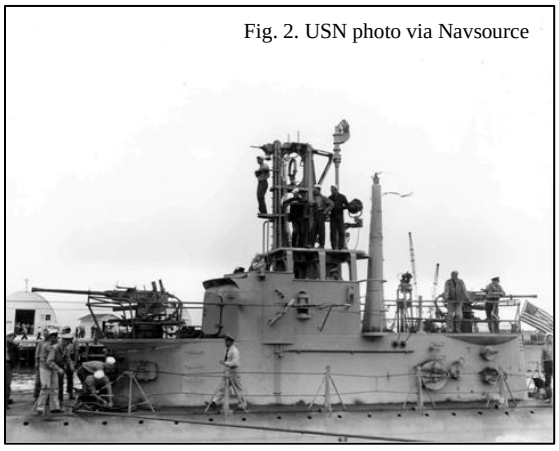


Fig. 2. USN photo via Navsource

The concerns over the bulk of the fairwater had been noted prior to the war starting, but bureaucratic

inertia and design conservatism kept any changes from being made to the *Gato* class and previous boats. Once hostilities commenced, all objections were quickly swept away and the reduced silhouette was incorporated into the new *Balao* design, with some distinct modifications aimed at simplifying construction and reducing the size even further. Although outwardly quite similar in appearance to the later look of the *Gatos*, a close examination of photographs will reveal those differences and allow the separation of the classes. The designations of the mast configurations that I describe below (Type 1, Type 1A, Type 2, etc.) are entirely of my own creation and do not reflect any official Navy nomenclature. I created them to make sense of the variations that I found.

BALAO CLASS – INITIAL CONFIGURATION (TYPE 1)

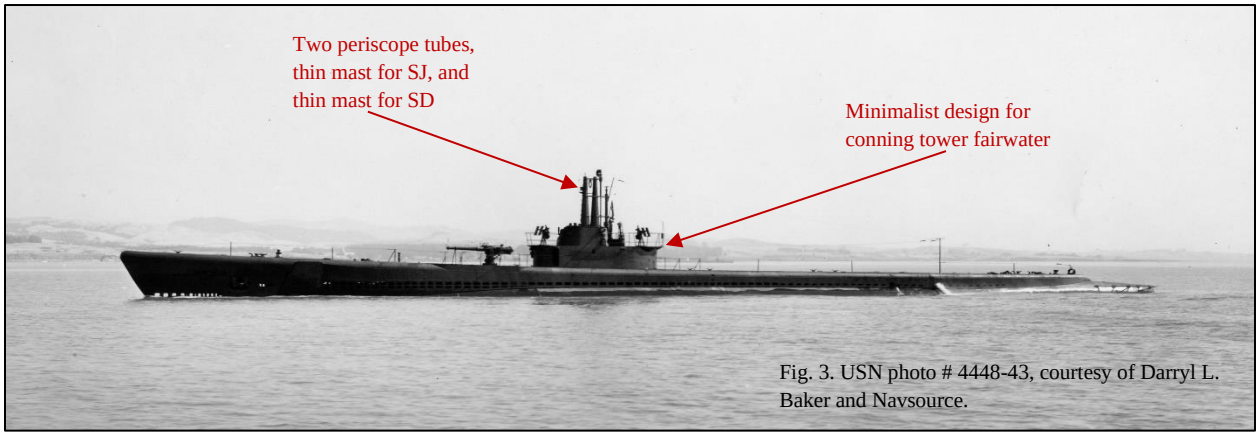


Fig. 3. USN photo # 4448-43, courtesy of Darryl L. Baker and Navsource.

Figure 3 is a 16 Jun 1943 photo of Mare Island's *Seahorse* (SS-304) and is a good overall view of the original as-designed configuration of the Government design for the *Balao* class. Her gun armament consists of a 4"/50 caliber Mk 9 gun in the forward position and a 20 mm Oerlikon automatic cannon with Mk 10 open tripod mounts on the forward and aft gun decks of the fairwater. This is the as-designed gun armament for the early *Balaos*, the efficacy of the heavier armament having been demonstrated by wartime lessons from the already serving *Gato* class.

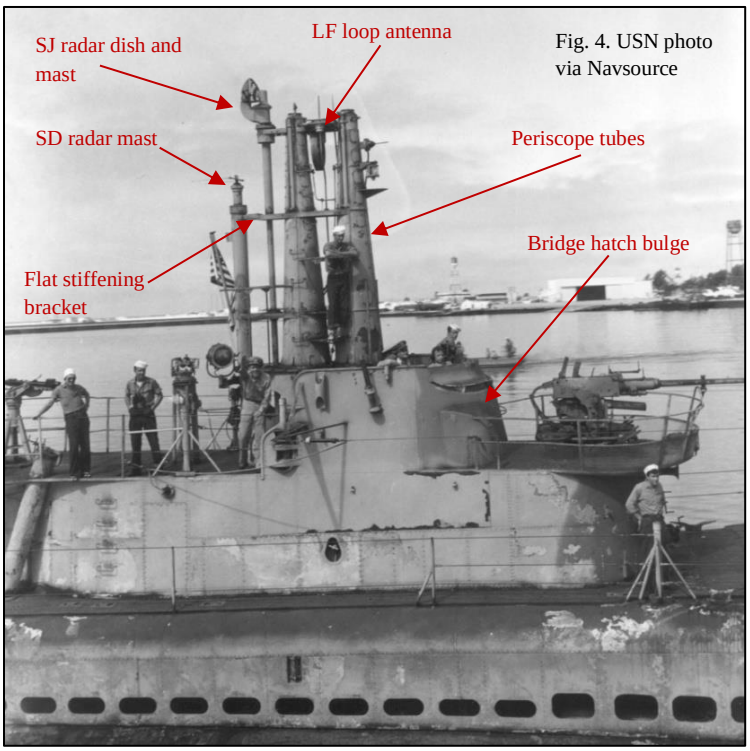


Fig. 4. USN photo via Navsource

Figure 4 is a closeup of *Lionfish* taken in May 1945. It shows the periscope shears and mast arrangement. Noticeably absent are the covered wagon ribs of the *Gato* class. The shear structure has been reduced from the previous class and greatly simplified. The scope tubes are gradually tapering cones connected to the deck via a tapered support bracket out of view here directly behind the bridge. The two tubes have a horizontal stiffening bracket connecting them at the top and about one-third of the way down. Directly behind the two scope tubes is the non-extendable SJ surface search radar mast, and directly aft of that is the extendable mast for the air search SD radar. Both of these masts are braced to the shears with flat horizontal

stiffening brackets. This configuration of two scopes, followed by the SJ and SD masts spaced closely together is called the Type 1 configuration. In this late war photo, *Lionfish* has received a heavier Bofors 40 mm Mk 3 gun mount forward of the bridge. The starboard side of the bridge fairwater has been bulged outward. The overall size of the fairwater had been reduced so much that the *Balao* design didn't allow enough room to swing open the hatch leading up from the conning tower. This bulge rectified that problem and is a prominent feature of these boats. Immediately aft of the SD mast is a pedestal for a Target Bearing Transmitter (TBT), used to send target bearing information below during a surface attack. In this photo of *Lionfish* and in the photo below a circular loop antenna for low-frequency radio reception is visible between the periscopes. This allowed reception while the boat was submerged at periscope depth. By 1944 reception ranges exceeding 2,000 nautical miles were possible with this antenna. Also visible on the superstructure below the fairwater are the oval shaped limber holes used to allow water to freely flood the superstructure while diving. This shape and pattern are indicative of the Government design, as are the horizontal stiffening brackets on the shears.

Another Type 1 boat is *Hardhead*, a Manitowoc built version of the EB design, shown in Figure 5 on trials in Lake Michigan in December 1943. The EB design contained a few minor but noticeable differences from the Government version. Most prominently, the flat horizontal stiffeners between the shears have been replaced with a "bow-tie" shaped version. Notice also the half-moon shaped limber holes in the superstructure. These two features set the EB design apart from that of the Government's. The fairwater under the aft 20 mm mount is quite short here on *Hardhead*, with the gun deck having a prominent overhang. This is due to a revised design for the man sized, mushroom shaped main air induction valve, located inside the fairwater in this space. Smaller than the one in the *Gatos*, it allowed for a further shortening of the fairwater. The Government version of the fairwater had it tapering to a fine point here, with less of an overhang. Some late war modifications to the Government design removed this taper and replaced it with a configuration very similar to the EB original design shown here. Figure 6 shows a portion of *Kete*'s fairwater in August 1944. Directly beneath the 20 mm mount is a vertical oval shaped opening that leads into the fairwater and an access trunk to the control room below. This watertight trunk allowed direct access to the main deck for the gun crew, eliminating the need for them to pass through an already crowded conning tower. In this photo the door to the trunk is swung open to the right and the opening to the trunk is just visible to the left of the hatch door. This is a common *Balao* class feature, regardless of whether the boat is a Government or EB design.

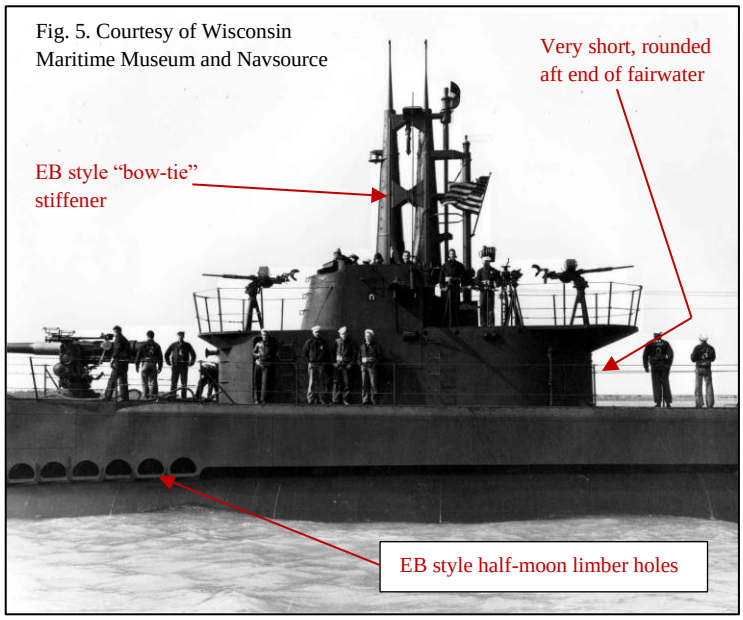


Fig. 5. Courtesy of Wisconsin Maritime Museum and Navsource

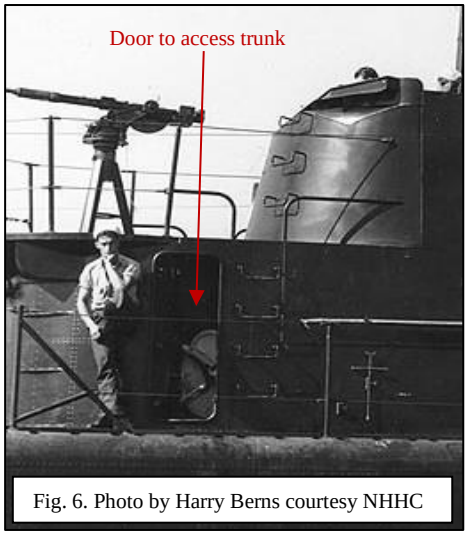


Fig. 6. Photo by Harry Berns courtesy NHHC

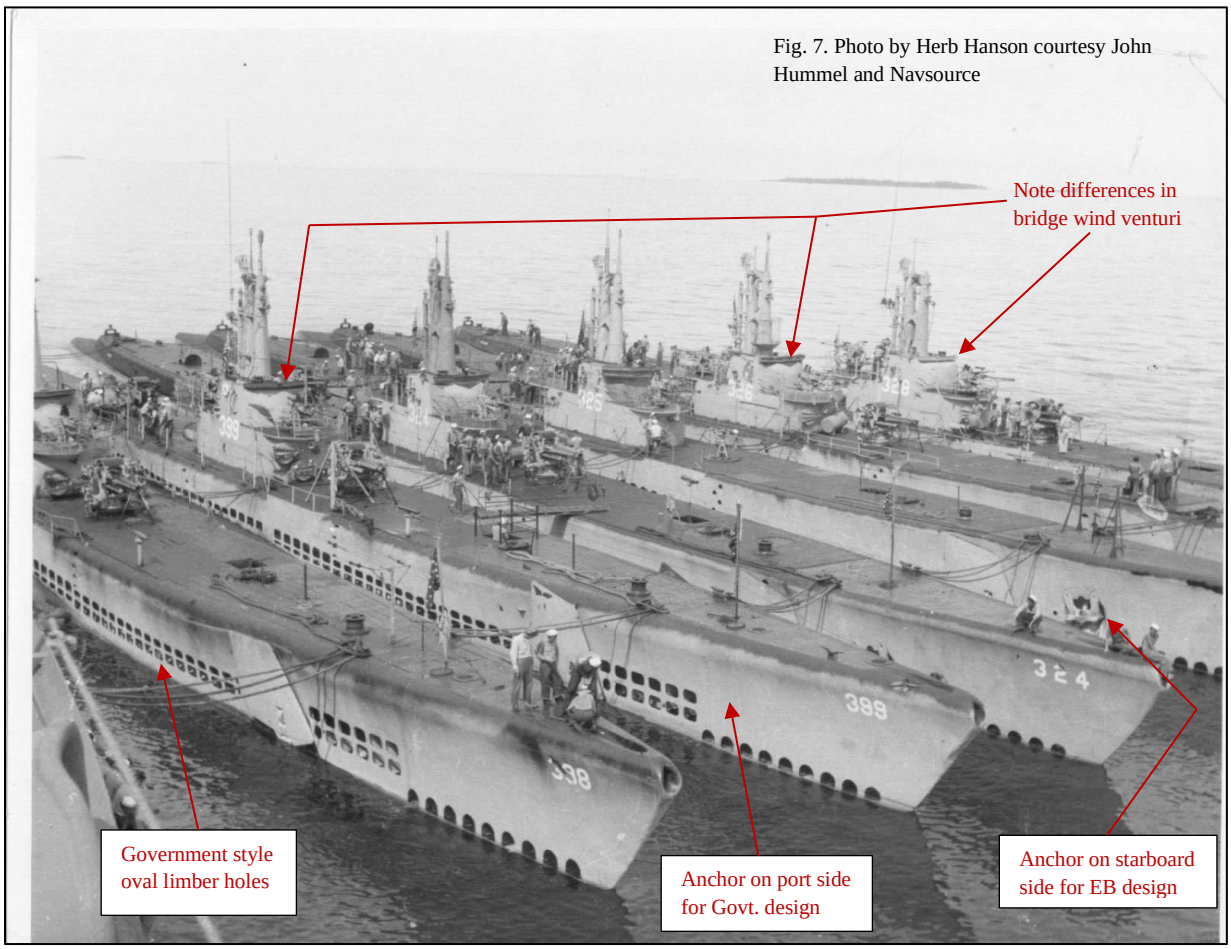


Fig. 7. Photo by Herb Hanson courtesy John Hummel and Navsource

Many *Balao* class boats finished the war with the Type 1 mast configuration, as shown here in this fall 1945 photo of Submarine Squadron 5 at Guam. In Figure 7 are (L to R) *Segundo* (SS-398), *Sea Cat* (SS-399), *Blenny* (SS-324), *Blower* (SS-325), *Blueback* (SS-326), & *Charr* (SS-328). The first two boats are Government design, indicated by the double row of oval limber holes in the superstructure and the flat horizontal stiffeners in the shears. The rest are all EB design, indicated by the bow-tie stiffeners in the shears. Note also the starboard side position of the anchor on *Blower*. EB boats had the anchor on the starboard side, Government boats on the port side. The forward edge of the bridge fairwater has a wind venturi mounted, used to deflect wind up and over the heads of the bridge watchstanders. Note in this photo that no two boats have the exact same venturi design, indicative of the many schools of thought that existed on how to mitigate the bridge wind problem.

One of the other tangible side benefits of the weight fiasco of 1938 was that the weight margin built up in the aftermath of the incident also allowed additional equipment to be added to the boats without having to worry about an adverse stability impact. New radars, communications gear, electronic surveillance antennas, and most importantly guns and ammunition were added as they became available. Gun armament varied wildly from boat to boat, shaped by supply issues, by the desires of the submarine's crew, and by the type of mission the boat was going on. All of the boats in Figure 6 have been refitted with the 5"/25 caliber Mk 17 gun[1], a late war innovation intended to increase firepower as good torpedo targets became scarce. Some of the boats have the gun mounted in the forward position, others in the aft spot. Some even have two of the larger guns. All of the boats have the 40 mm gun on both of the fairwater gun decks, but *Blower* (which has only one 5"/25) has an additional 20 mm Mk 10 mount on the main deck in the forward deck gun spot.

Careful re-arrangement of the ammo magazine below the crew's mess allowed additional rounds to be carried, and watertight ready service ammo lockers were later added topside in several locations, most notably in the forward and aft ends of the fairwater.

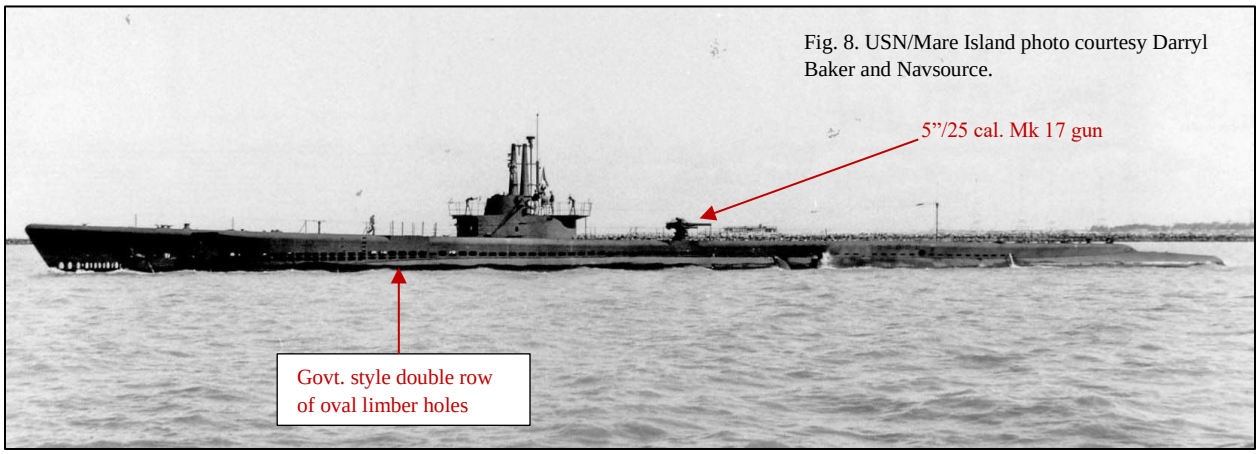


Fig. 8. USN/Mare Island photo courtesy Darryl Baker and Navsource.

Spadefish (SS-411) is shown in Figure 8 off Mare Island on 11 May 1944. Even though she is in her as-built Type 1 mast configuration, she is sporting the 5"/25 caliber Mk 17 gun in the aft position. She was the first boat to be built with the heavier gun.

LATER CONFIGURATIONS – TYPE 2

All but the very last of the Government design *Balaos* were built with the Type 1 mast configuration, as were over half of the EB design boats. However, in mid-1943 EB altered their plans with a new mast arrangement that moved the SJ radar mast forward of the periscope shears, leaving the SD mast in its usual position aft (Figure 9). The reason for this change is not entirely clear, and it went against the trend started in the *Tambor/Gar* and *Gato* classes of moving the SJ mast aft of the shears and out of the way on the bridge. However, starting with *Bugara* (SS-331) all subsequent EB boats were built with the SJ sited forward (the sequence may have started with *Brill* (SS-330), but her as-built configuration is not yet clear). Manitowoc made the switch to SJ forward starting with *Lizardfish* (SS-373) in March 1944. This arrangement of the SJ forward, followed by the two scopes, then the SD is called the Type 2 configuration. The SD mast is separated from the shears by a fairly large amount, suggesting that the SJ mast move was a simple expedient, leaving the existing support brackets for the SD mast largely intact.

Fig. 9. USN photo via Navsource

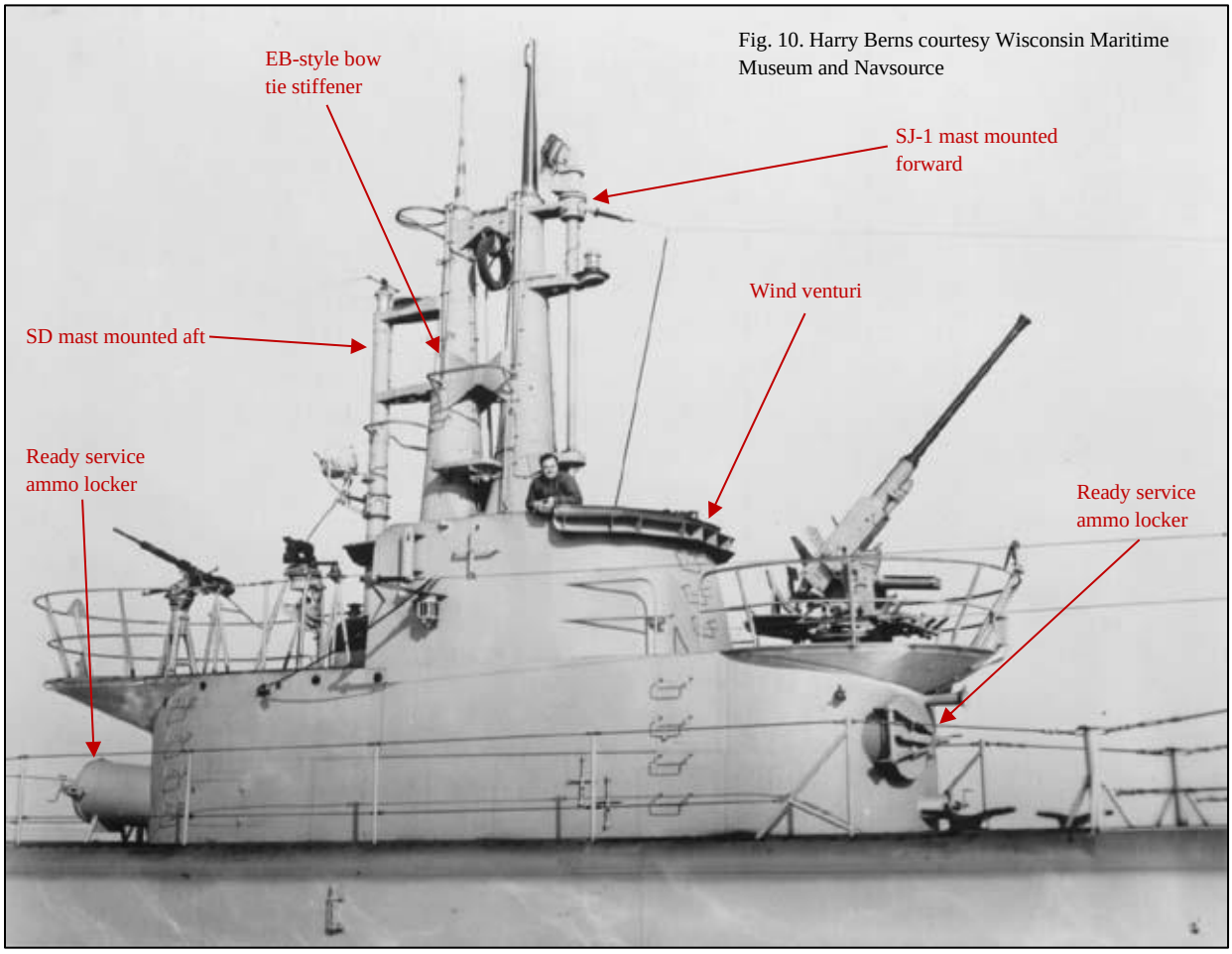


Fig. 10. Harry Berns courtesy Wisconsin Maritime Museum and Navsource

Figure 10 is an excellent August 1944 photo of *Loggerhead* in her Type 2 configuration. Very evident are the typical EB design bow-tie shears stiffeners, two additional ready service ammo gun tubs under the fore and aft fairwater gun decks, and the LF loop antenna between the shears. She has the heavy Mk 3 40 mm forward and a 20 mm Mk 10 gun aft, a typical outfit for Manitowoc boats of this period. Except for the gun armament and the SJ position, notice the overall similarity with the photo of the Type 1 *Hardhead* above. Between EB and Manitowoc only eight boats can be confirmed to have been built with this mast arrangement (with quite possibly three more). Curiously, the overwhelming majority of the Type 2 boats had their surface search set moved to an aft position after the war, with only *Dentuda* (SS-335) retaining her Type 2 (Figure 11).

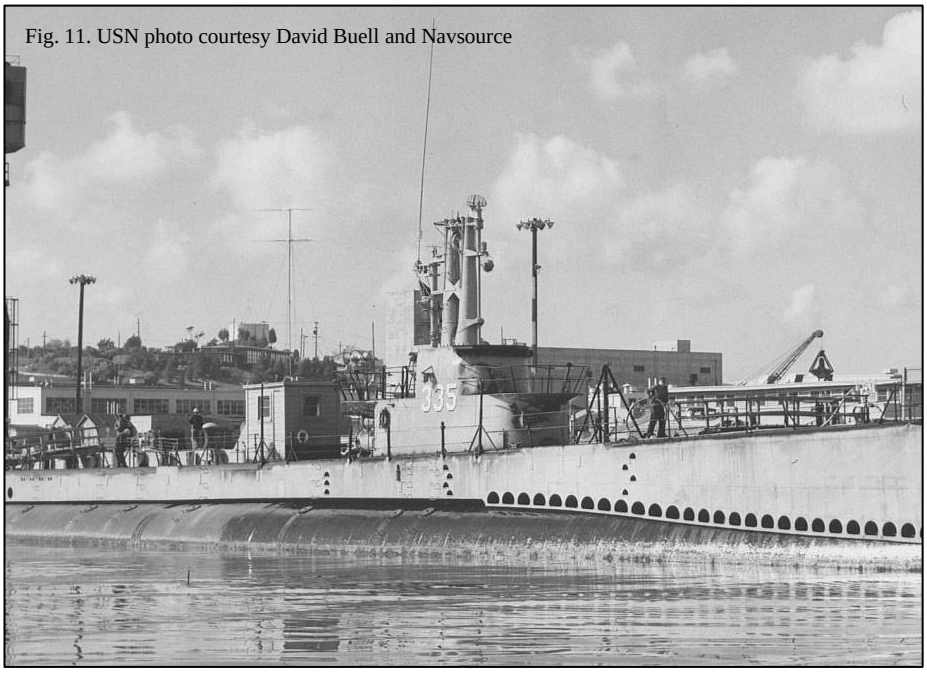


Fig. 11. USN photo courtesy David Buell and Navsource

TYPE 3

Then, with these eight boats still under construction, EB altered the plans again. They completely re-designed the SD air search radar mast, thickening it, using a gradually tapering cone shape very similar to the periscope shears, but slightly shorter. This obvious change to the radar mast distinguishes these boats as the Type 3. *Carbonero* (SS-337) was the first boat with a Type 3 and all subsequent EB boats were built this way. Manitowoc made the shift to the Type 3 with *Macabi* (SS-375) in May 1944. Figure 12 is a September 1945 shot of *Mero* and is a very good representation of a Type 3 boat. The LF loop has been moved aft between the shears and the radar mast (in this case the brand new SV) and she sports two 40 mm gun mounts. A late war addition was a ladder that ran from the aft gun deck to the main deck, just visible in this photo on the right. The opening in the fairwater for the gun access trunk is plainly visible under the forward gun deck. Another feature that varied considerably between boats are the lookout platforms, usually attached to the shears. They were easy to change by yard or tender crews between patrols and the variations reflected the whims and operational practices of the individual crews. Twenty boats were built by EB and Manitowoc as Type 3s and being at the tail end of their production runs most of them were completed too late to make any war patrols. Figure 13 is a fine shot of the

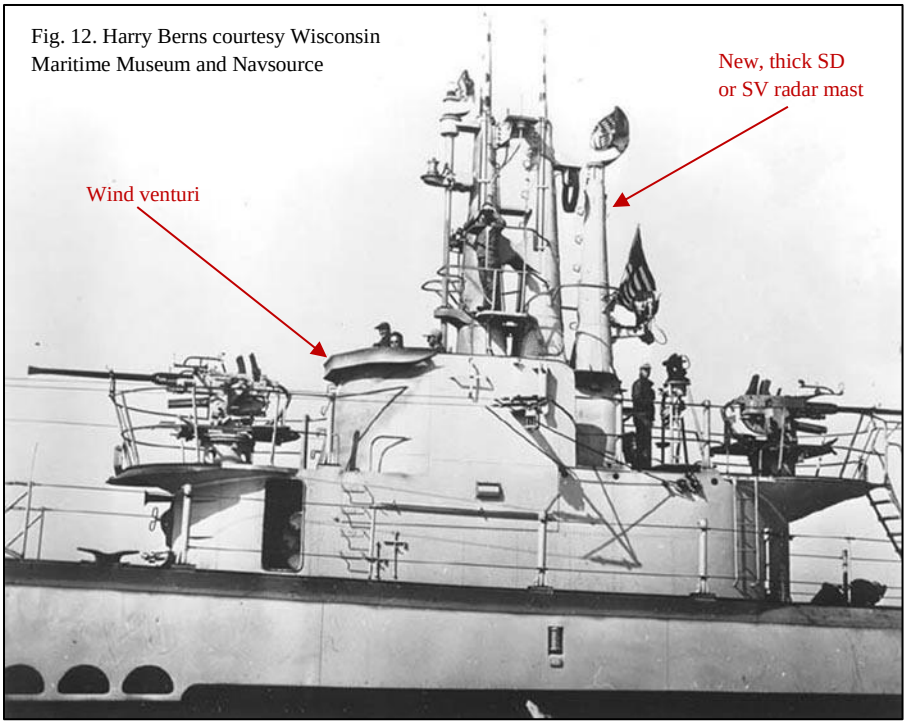


Fig. 12. Harry Berns courtesy Wisconsin Maritime Museum and Navsource

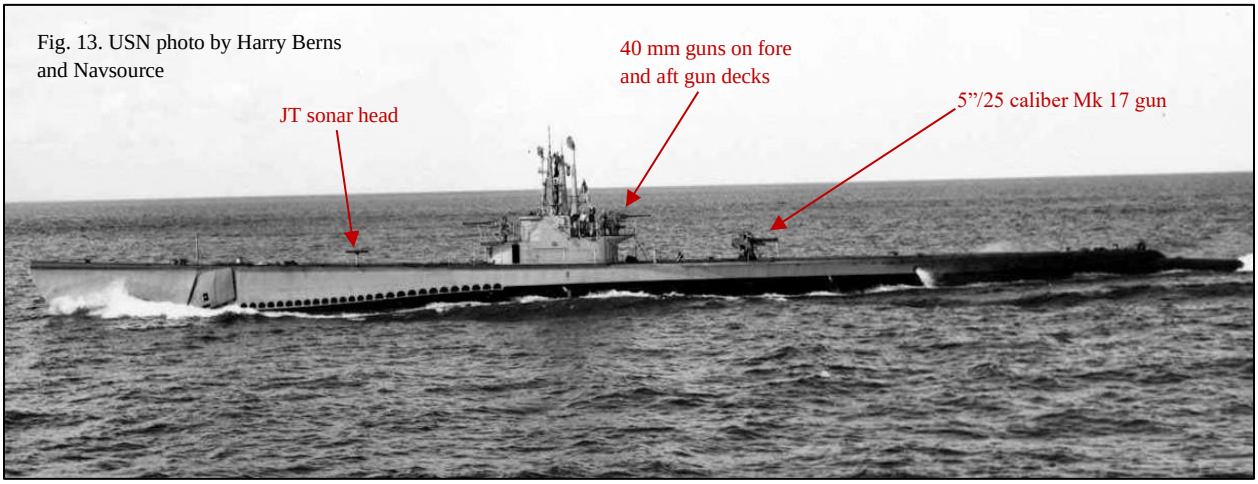


Fig. 13. USN photo by Harry Berns and Navsource

Type 3 configured *Macabi* (SS-375) on trial runs in Lake Michigan in 1944. The T-shaped bar on her forward deck is the rotating head for the JT sonar, a passive listening array meant to supplement the standard QB/QC transducers mounted on retractable posts underneath the forward torpedo room on the keel.

TYPE 1A

By 1944 the conning tower had become badly crowded. This separate horizontal cylinder exterior to the pressure hull and above the control room was home to the boat's attack center. It contained the helm, chart table, both periscopes, radar, sonar, the Torpedo Data Computer (TDC), and torpedo firing controls. At battle stations as many as 12 men crowded into it. A small amount of room was gained in the *Balaos* by having both ends of the conning tower dished outward in a convex arrangement, as opposed to one (sometimes both) ends being concave as on the *Gatos*. This relief was short lived and various methods of relieving the congestion were studied.

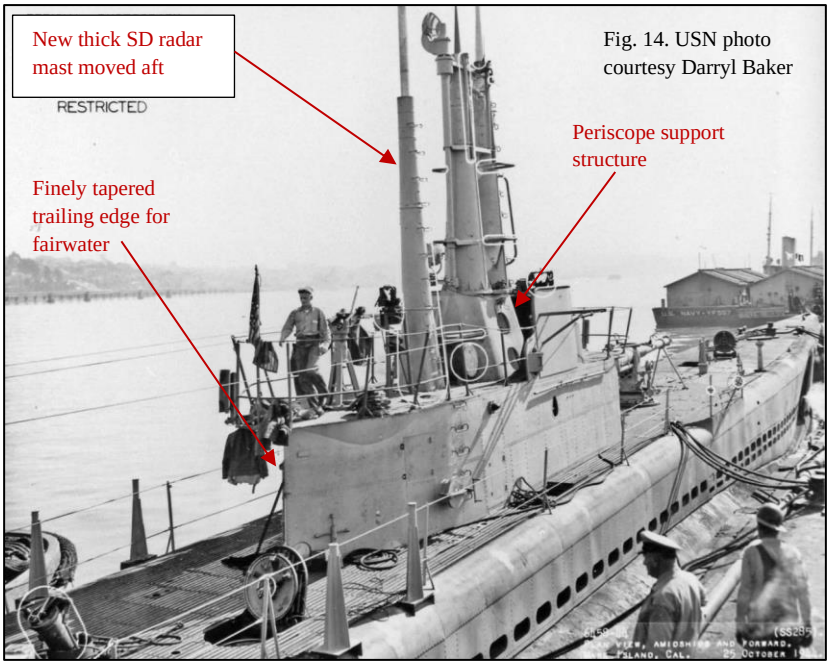


Fig. 14. USN photo courtesy Darryl Baker

The extendable SD radar mast was located aft of the periscopes in the original Type 1 configuration and the mast had to pass through the conning tower. In mid-1944 a new mast arrangement moved the SD mast aft just enough to get it out of the conning tower completely. A whole new thick mast housing was built for it on the forward part of the cigarette deck. Figures 14, 15, and 16 are October 1944 photos of the class boat *Balao.* They highlight the new mast. This configuration is the Type 1A. The surface search SJ mast stayed in its normal spot attached to the aft periscope shear. This photo also shows the tapered support structure for the shears, normally out of view behind the bridge fairwater. *Balao* retains the original shape of the aft end of the fairwater, with it tapering to a fine point with little overhang for the gun deck. Some boats had this modified to a more rounded end, very similar to the EB design, and it was worked into the later Government production runs. *Balao* retains two 20 mm guns and the original 4"/50 caliber Mk 9 deck gun in this photo. The larger guns would come in a later refit. The bulge on the starboard side of the bridge fairwater that provided swing space for the conning tower hatch can be seen. The small stub antennas on the forward edge of the number one periscope shear are the first installations of electronic surveillance gear. The APR stub at the top could detect low frequency signals and the AS-44 antenna below it was used for microwave (S-band) detection. They had no jamming capabilities and were only for detection and classification. A circular ready service ammunition locker can be seen below the forward gun deck, right next to the twin horns of

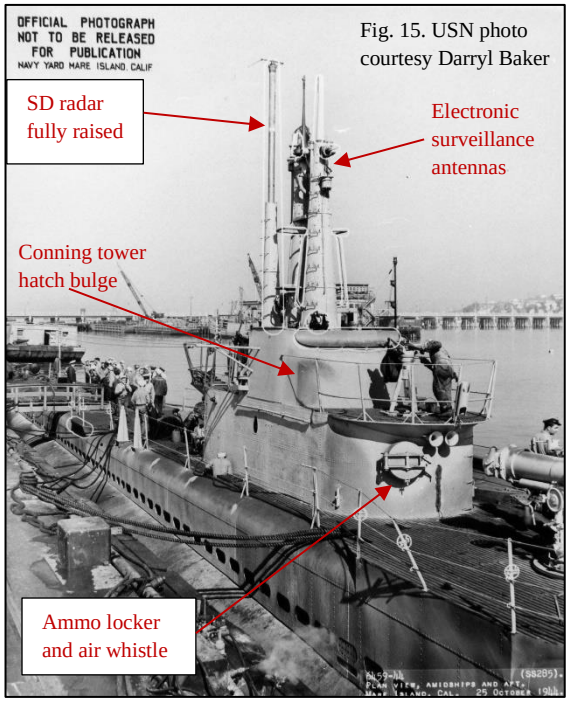


Fig. 15. USN photo courtesy Darryl Baker

the boat's air whistle. *Balao* has also been refitted with a new number one periscope which in addition to the optics had a small range only radar transmitter/receiver built into the head. This ST radar eliminated the guess work involved in getting an accurate range to a target while making a submerged approach. It was a modification that was highly coveted by the boat commanding officers, but its initial availability was somewhat limited.

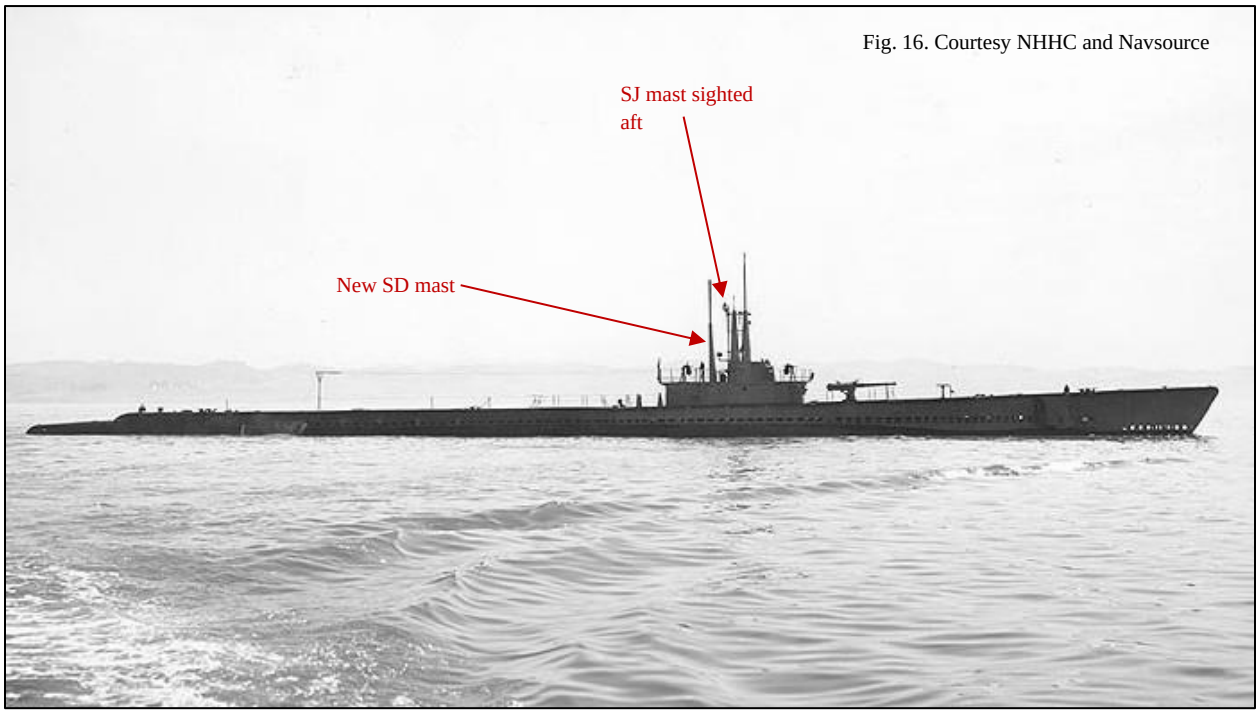


Fig. 16. Courtesy NHHC and Navsource

The space gained in the conning tower by moving the SD mast aft was highly desirable, and this Type 1A configuration became the preferred version. It became the as-built configuration for the last of the *Balaos* at Mare Island and Cramp, and possibly at Portsmouth as well. Many of the in-service boats received this modification before the end of the war, and most of those that didn't received it in their first post-war overhauls. Even some of the boats with the SJ radar forward of the shears (Type 2 configuration) were eventually modified to the Type 1A, as shown by this December 1946 photo of *Capitaine* (SS-336) below (Figure 17).

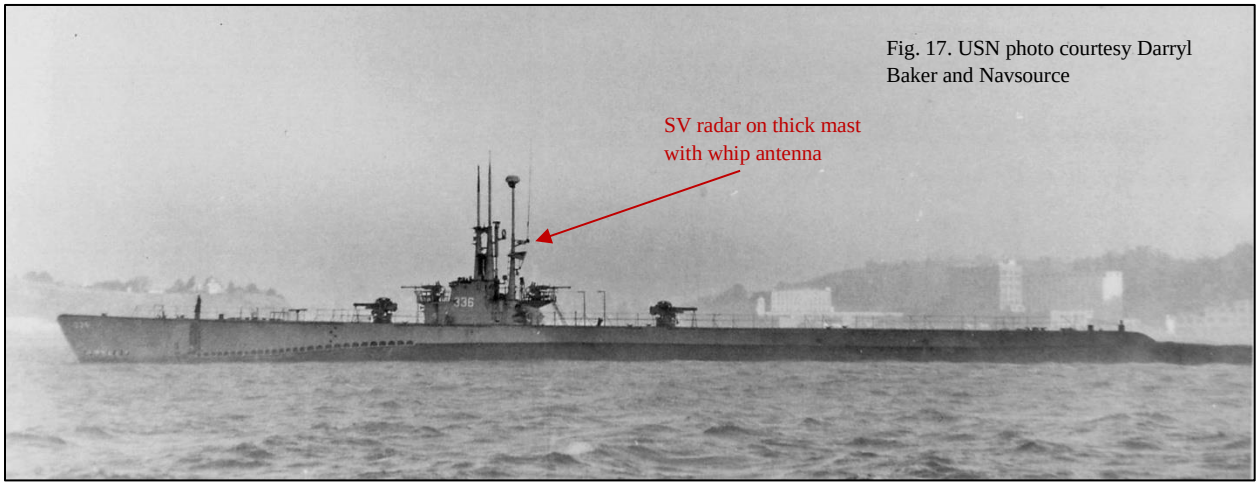


Fig. 17. USN photo courtesy Darryl Baker and Navsource

Her wartime SD radar has been replaced with the new and much more capable SV with its large screen dish. The SJ mast has been moved aft of the shears, and a whip style radio antenna has been

attached to the SV mast. Another note of interest is the heavy gun armament. She carries two 5"/25 caliber Mk 17 guns and two 40 mm Mk 3 guns. Some boats were even fitted with a rudimentary gun control system to coordinate and aim the fire of the 5" guns.

TENCH CLASS

Although construction of the *Balao* class began after the war started, it was essentially still a pre-war design, basically a *Gato* class with the heavy hull and the cut down fairwater. Although an excellent design in most respects, extensive war patrol experience had turned up several issues that needed to be addressed.

One vulnerability that was revealed was in the propulsion train. With the diesel engines acting only as generators providing electricity, two high speed electric motors were coupled to each of the propeller shafts via reduction gear boxes, which slowed the high speed of the motors down to useable output for the shafts. The gears were, by necessity, machined to extremely fine tolerances and very carefully aligned. Thus they were very intolerant of shock damage or misalignment caused by depth charge attack. Even a minor problem could shut down propulsion completely. The gear boxes were so complex that they could only be worked on by a major shipyard, requiring a trip all the way back to the west coast for repair. The gears also produced a fairly loud characteristic whine which made the boat vulnerable to detection by passive sonar systems.

Another problem area revealed during depth charge attack were the vent riser pipes that passed through the single hull sections of the boat inside the forward and aft torpedo rooms. These risers allowed main ballast tanks #1 & 7 to vent properly when diving and contained full sea water pressure when at depth. Depth charge shock damage could cause these risers to fail, allowing catastrophic flooding in the torpedo rooms.

The submarine crews also desperately wanted to be able to carry more reload torpedoes. Stowage tubes mounted topside in the superstructure had been tried on the *Salmon/Sargo* class boats, but the concept had proven to be impractical due to the difficulties and dangers in getting these extra weapons struck below at sea in enemy held waters. The only real answer was to keep them below in the torpedo rooms, but structural limitations of the current *Gato* and *Balao* class designs prevented this and kept the capacity fixed at 24.

The reduction gear issue was solved by a brilliant but somewhat eccentric engineer at the Bureau of Ships by the name of Capt. Hyman Rickover (later to become the "father" of the nuclear submarine). Dedicated development work by Rickover and his staff led to a large, low speed double armature motor, powerful enough that only one per shaft was needed. Their slower operating speed and higher torque allowed the elimination of the reduction gears altogether. They were actually ready by the spring of 1944 and the first set was installed on *Sea Owl* (SS-405) at Portsmouth. Completely successful, these motors were installed as original equipment on most of the following boats, and some others had them retro-fitted during late war overhauls.

The designers and engineers at Portsmouth worked diligently to find solutions to the other issues. By the spring of 1944 they had prepared a new design which had solved them all. The ballast tank riser issue proved quite vexing and it required the complete rearrangement of the tankage. #1 main ballast tank (MBT) was moved to a position forward of where the pressure hull normally ended. This allowed the tank to vent directly into the superstructure just like the other MBT's, eliminating the risers from the forward torpedo room. #7 MBT, normally sited underneath the aft torpedo room (the top of the tank formed the deck of the torpedo room) was found to be redundant and was converted into a variable fuel oil tank or, in some cases, a storage room. This new arrangement of

these tanks forced a complete redesign of the rest of the tankage and the associated piping runs. This effort, also allowed a careful revamping of the torpedo rooms, resulting in space for four additional torpedoes being found, for a total of 28.

Remarkably, all of these changes resulted in a boat that was virtually indistinguishable from the

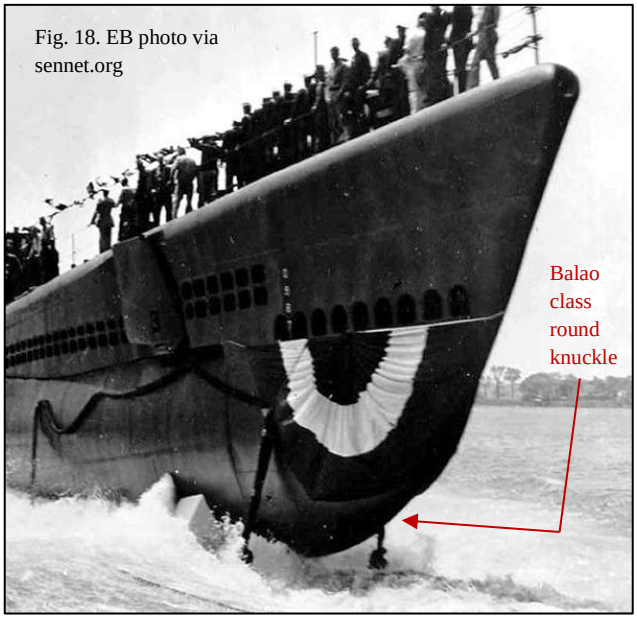


Fig. 18. EB photo via sennet.org

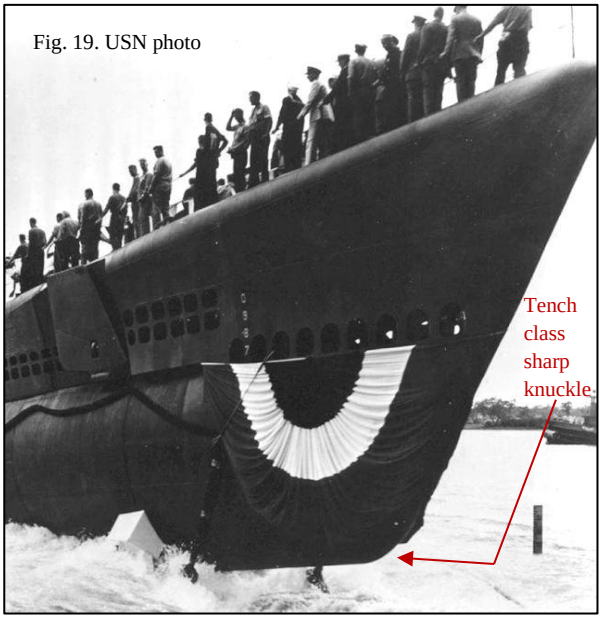


Fig. 19. USN photo

late war *Balaos*, with two small exceptions being a sharper "knuckle" on the lower corner of the bow (Figures 18 & 19), and the elimination of a small bulge on either side of the pressure hull around the motor room. This bulge had accommodated the reduction gear boxes in the *Balaos*, but the use of the new motors in the *Tench* class allowed these bulges to be smoothed out. Neither of these two features were visible when the boat was surfaced. The lead boat was *Tench* (SS-417), laid down by Portsmouth in April 1944 and commissioned that October. Ultimately, many of the *Tench* boats were completed too late to make any war patrols, with some not completed until after the war had ended.

Figure 20 shows *Sirago* (SS-485) in October 1945, and her appearance is typical for the *Tench* class. These boats incorporated all the improvements and lessons learned from the war. All but two (of those completed to the original wartime design) were completed to the optimum Type 1A mast configuration.

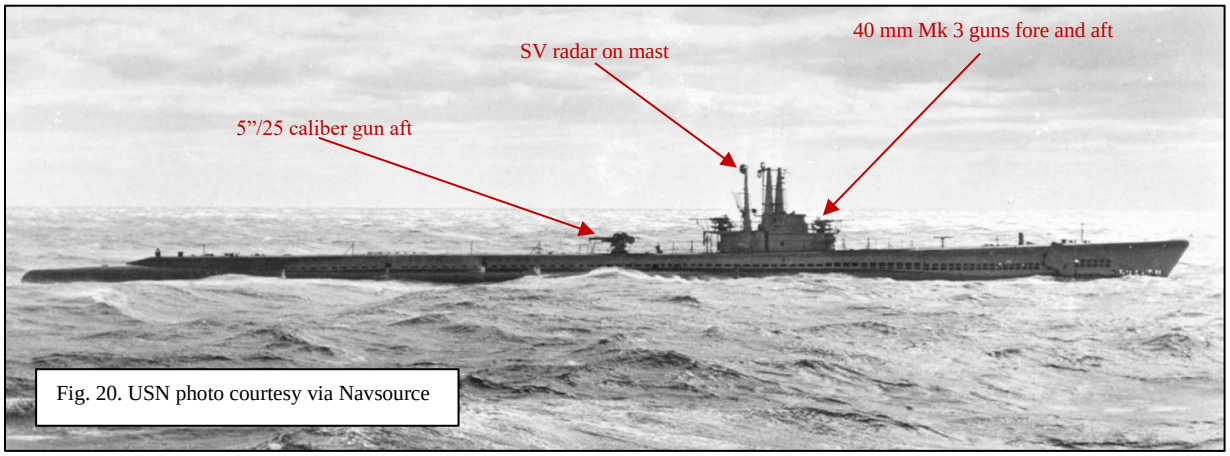


Fig. 20. USN photo courtesy via Navsource

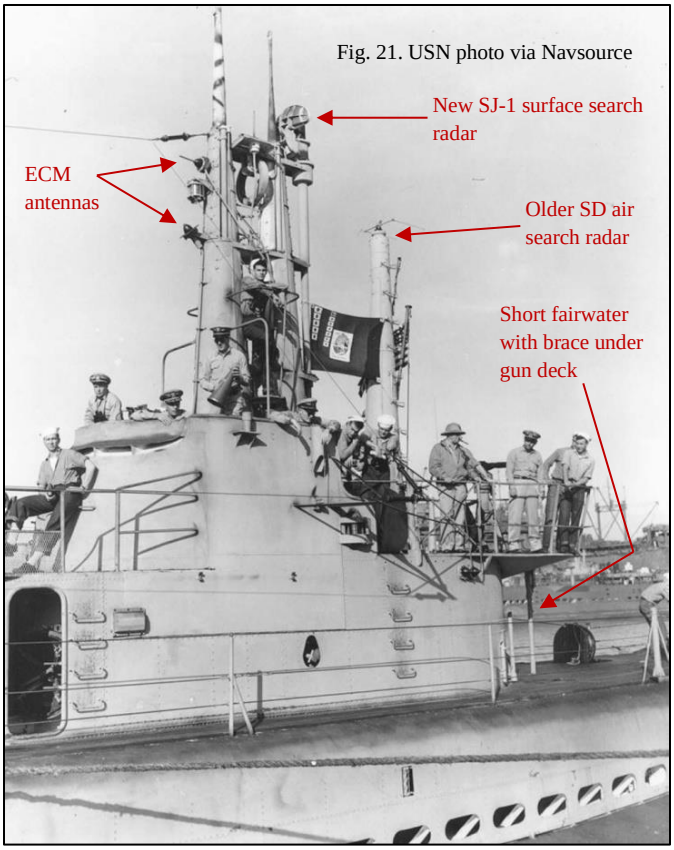


Fig. 21. USN photo via Navsource

A single 5"/25 caliber gun in the aft spot along with two 40 mm's on the fairwater gun decks were the as-designed armament although some boats received a second 5"/25 between patrols or post-war. Figure 21 shows the class boat *Tench* in 1945, returning from a patrol. Unlike the *Sirago* above, she still carries the SD air search radar. The LF loop antenna is mounted between the scopes; many of her sister boats would have it moved to a position on a bracket aft of the SJ mast. The ECM antennas are prominent on the forward periscope shear and the SJ radar is the later, more capable SJ-1 type. The fairwater itself had been shortened as much as possible. Notice how much of an overhang the aft gun deck now has. Many of these boats had a brace stanchion added underneath the deck to help support it, and it can be seen here, between the open hatch on the deck and the end of the fairwater.

Although the gun armament now pretty well satisfied the crews, some experimentation continued. *Thornback* is shown in Figure 22 just returned from a late war patrol with a twin 20 mm mount sited on the forward deck gun position. The scarcity of good targets as the war drew to a close by necessity turned the submarines into gunboats, hunting junks and fishing sampans and even bombarding shore targets. The boats were also performing an increasing number of life guard missions for aircraft raids on the home islands, sometimes preventing the boat from submerging while the recovery of the downed aircrew was going on. The added rapid fire guns helped protect the boat from enemy aircraft. Several .50 caliber machine guns could also be brought topside and mounted on spindle mounts on the bridge and alongside the fairwater. She also has the larger head on #1 periscope for the ST radar.

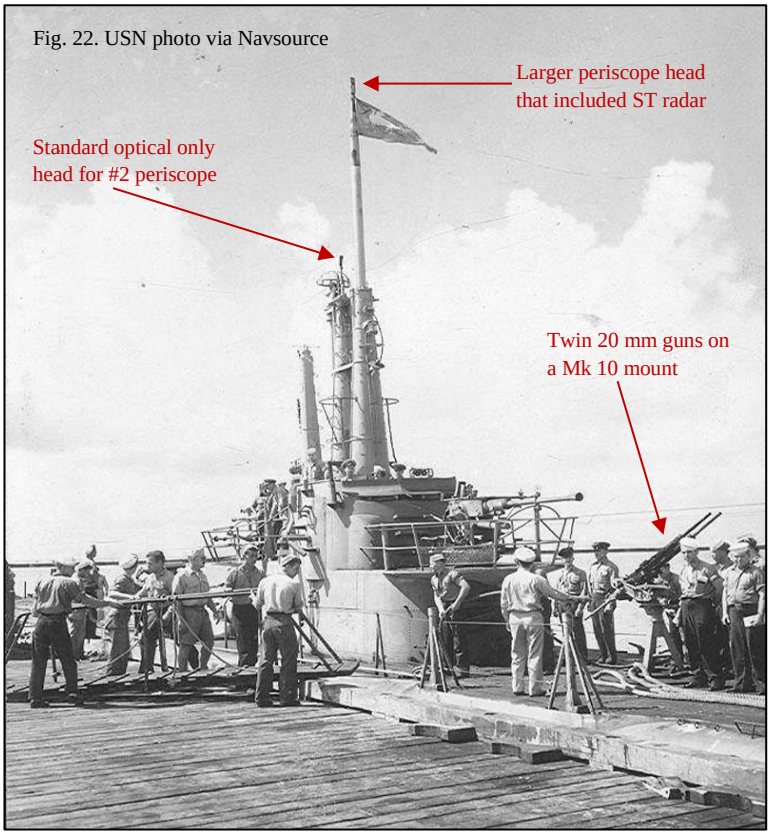


Fig. 22. USN photo via Navsource

As usual, Electric Boat developed its own version of the *Tench* design, although it could not incorporate it into their production schedule until

quite late due to its backlog of *Balaos* still under construction. In the end, with the war obviously drawing to a close, EB was awarded contracts for only three *Tench* class boats, only one of which,

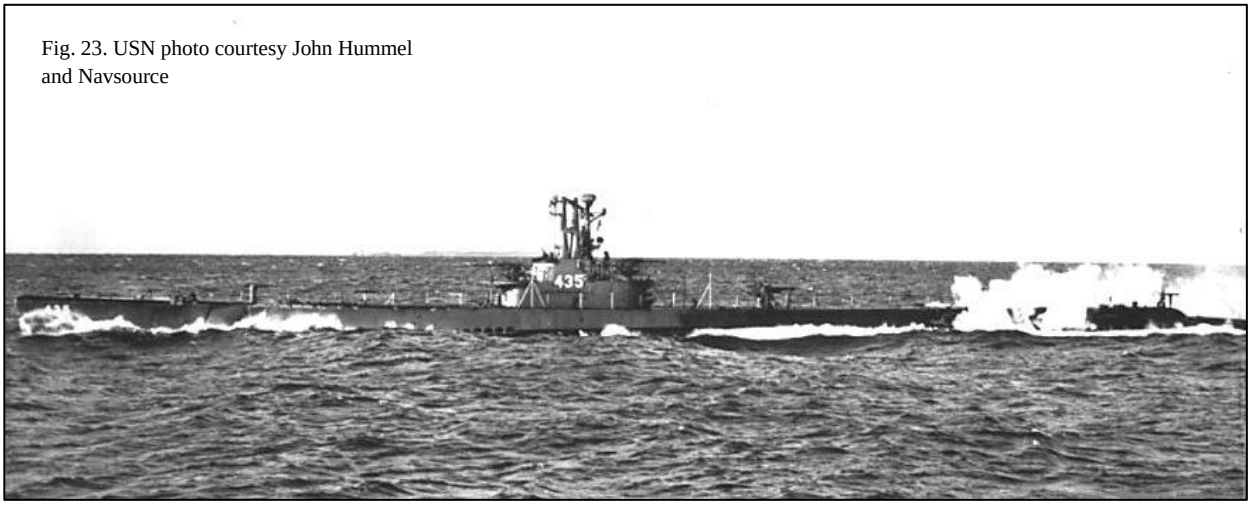


Fig. 23. USN photo courtesy John Hummel and Navsource

Corsair (SS-435) was completed (Figure 23). Built to their typical late-war EB Type 3 configuration, *Corsair* was not commissioned until November 1946. The other two EB boats, *Unicorn* and *Walrus,* were never completed and were launched and delivered to the Navy as incomplete hulks. Manitowoc finished their production run of the *Balao* class and were not awarded any further boats. The Boston Navy Yard was brought into the submarine construction plan late in the war, mostly to help the struggling Cramp yard to complete its boats. Boston was then awarded 16 *Tench* class new construction submarines, 12 of which were cancelled before the keels were laid. Only one of the remaining four was completed to the original wartime *Tench* design, *Amberjack* (SS-522), but not until 1946.[2]

One visual clue that can be used to date a submarine photo are the hull numbers. With the exception of a handful of the older fleet boats that were used in stateside waters for training purposes (*Cuttlefish*, *Cachalot*, *Porpoise*, and a few others) no U.S. submarine carried her hull number during the war. They were painted out immediately after the war started, but reappeared as soon as hostilities ceased in most cases. So if you see a hull number, the photo was not taken during the war years.

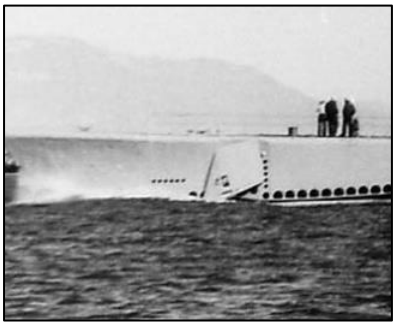
OTHER VARIATIONS

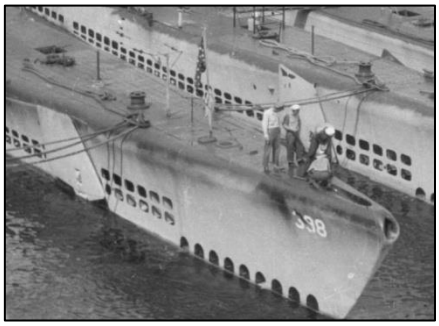
It is quite safe to say that at any given time, no two U.S. submarines were exactly alike. An astounding number of minor variations appear, such as the lookout platforms, wind venturi deflectors, and ready service ammo tubs mentioned above. The yard and tender crews were quite liberal with changes requested by the boat's crew between patrols and would usually accommodate any reasonable request.

These boats were large submarines when compared to those in other navies, and thus tended to have a slower diving time. This was an operating characteristic that was obviously very important to the survival of the boat, and the crews and designers constantly tinkered with ways to shorten dive times. In the earlier boats, one method that was used was cutting additional limber holes in the superstructure in an attempt to get that free flooding space to fill faster. This resulted in a huge variety of limber hole patterns, some of which changed from one patrol to the next. The *Gato* class standardized on a specific pattern, with the EB design having a single row of half-moon shaped holes along the bottom edge, and the Government design having a double row of oval shaped holes that transitioned to a single row as they moved aft. However, additional holes were added and by

the end of the war a large variety of patterns appeared. The *Balao* and *Tench* class boats continued with the two standard patterns, but mania over adding additional holes seems to have abated somewhat and the patterns remained fairly constant.

Another method of shortening dive times involved a minor change to the bow planes. The original design had the planes' outer edge parallel to the top edge of the superstructure when rigged in. When the planes were rigged out prior to diving they were roughly parallel to the water's surface. One brilliant idea involved making a slight alteration to the rigging mechanism that resulted in the planes being stowed tilted in a dive position. When rigged out they would already be tilted downward in the dive position and would take an immediate bite in the water, pushing the bow downward. The pictures below[3] show several variations in how the bow planes were stowed in





the rigged in position. There was quite a variance in the angle that was used, reflecting how fast the crew felt they wanted to dive. This feature was done during refits between patrols or in post commissioning overhauls. New boats coming off the ways had the planes in the non-tilted parallel position. All the efforts at reducing dive times were quite successful, with dives to periscope depth taking only 30-40 seconds by the end of the war, a very fast time for such a large boat and acceptable to the crews.

Another variation was related to the two different designs and appeared on the boats during construction. The architects at Portsmouth looked for ways of expediting construction and one method they came up with concerned the teak wood slats in the main deck topside. It was decided that having a long wooden deck was unnecessary and they greatly shortened it. Figure 24 at the right shows the Government design *Pilotfish* and the EB design *Loggerhead* alongside immediately after the war. The teak slat deck on *Pilotfish* stops just aft of the forward torpedo room hatch and ends between the aft end of the fairwater and the deck gun. *Loggerhead*'s deck ends approximately seven feet forward of the forward hatch and runs all the way to the after torpedo room hatch. The deck not covered by the teak slats on both boats is steel, with numerous holes drilled into it to allow air to escape. One common feature

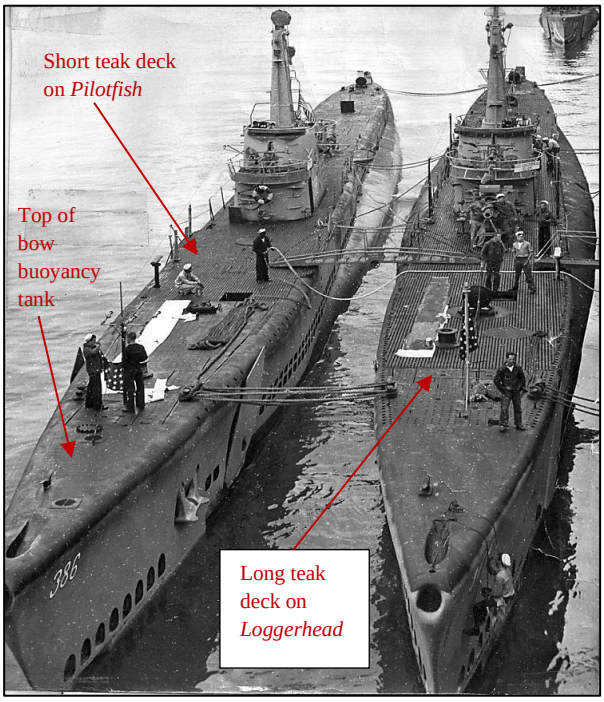


Fig. 24. Photo courtesy Navsource

between the two designs is at the very forward end of the deck, from the jackstaff forward. The drilled steel decking stops here and is replaced by a solid surface. This area is actually the top of the bow buoyancy tank, a tank kept dry on the surface to prevent the bow from burrowing into a head-on sea. Figure 25 is a 1944 shot of *Blower*, showing the length of the EB design slat deck. It is also interesting to note the damage to her forward deck. While enroute to the Pacific in the fall

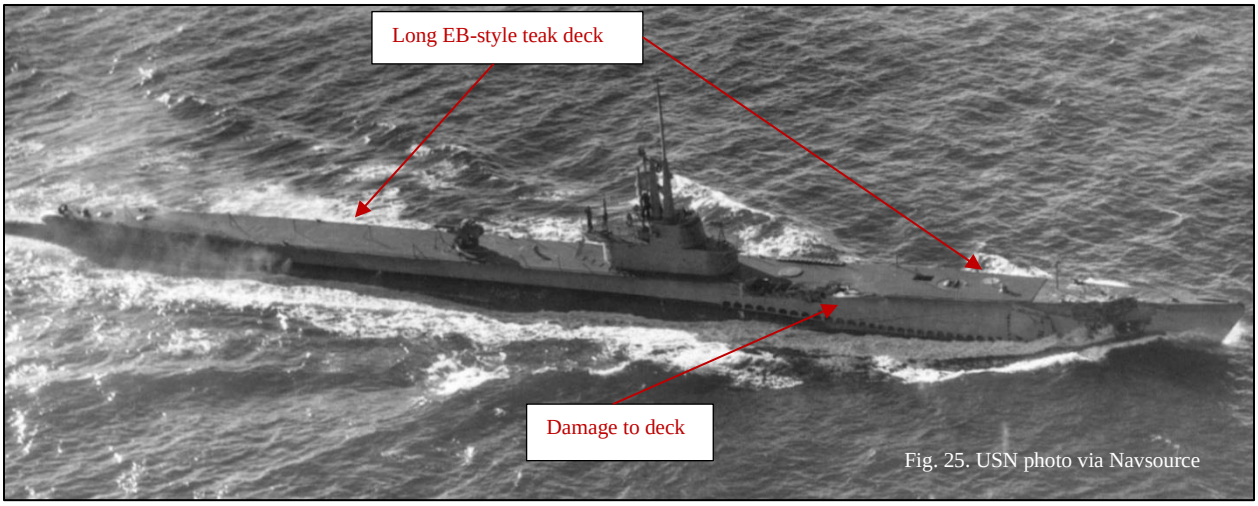


Fig. 25. USN photo via Navsource

of 1944 she conducted sonar training exercises in Caribbean with a patrol boat. At night during poor visibility she collided with the patrol boat and her deck was banged up as shown here. The damage was only cosmetic in nature and she proceeded on to Pearl Harbor where she was repaired prior to departure on her first patrol.

As noted above, the increasing amount of equipment being placed in the conning tower had led to an overcrowded situation late in the war. With new electronics coming on line it was felt that in the post-war period the integration of these new systems into a useable format for the crew would be a major problem. One solution was to create a Combat Information Center similar in nature to what surface ships already had. However, space in the conning tower was already at a premium. *Sarda* (SS-488), a Portsmouth built *Tench* class boat, was chosen to receive a new, longer conning tower to test the concept[4] (Figure 26). Five feet longer than normal, the new conning tower was installed while still on the ways and a modified fairwater was built around it. She is shown here late in her career with all of her guns removed. Of particular interest is the shears and mast

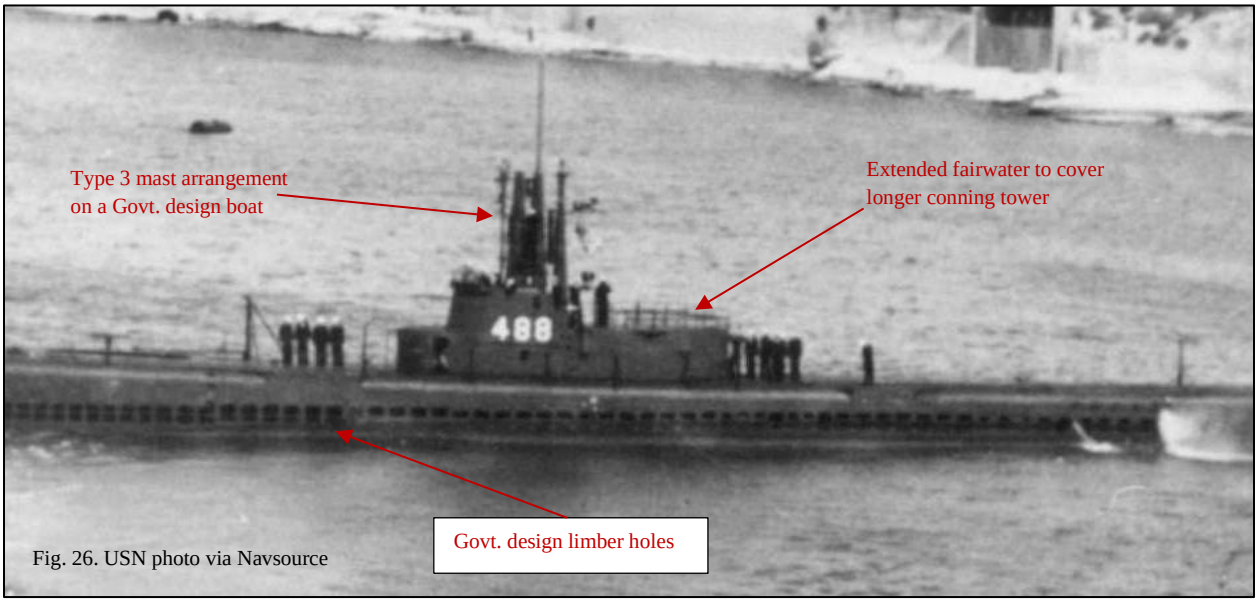


Fig. 26. USN photo via Navsource

arrangement. *Sarda*, commissioned in 1946, is the only Government design boat with an EB style Type 3 mast configuration. The longer conning tower, while seemingly a good idea, was not repeated due to new post-war thinking that led to the integration of the attack center into the control room. This idea first showed up in practice in the new fast attack boats of the *Tang* and *Darter* classes in the early 1950's, which did away with a conning tower for the first time.

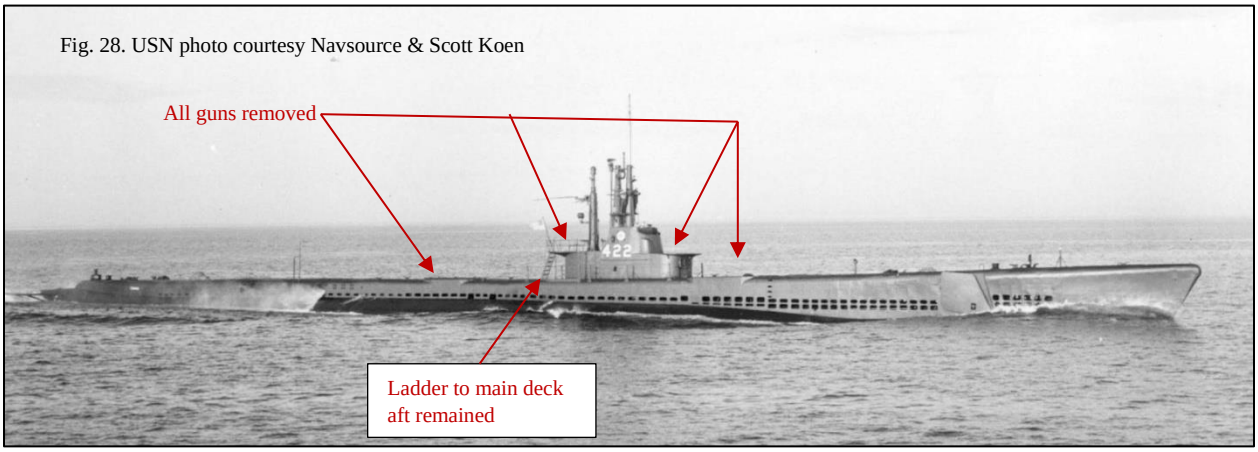
A justified criticism of all of the fleet boats was underwater maneuverability. Several submarine officers had proposed adding a topside rudder during the war, but the modification was never carried out. In the post-war period a few boats had an additional rudder added topside. It was attached to the top of the existing rudder operating mechanism and moved in conjunction with the

Fig. 27. Photo by Ralph Morse courtesy of time.com and Navsource

below water rudder. Not as successful as first hoped, it was not a widespread modification. The Type 3 *Cobbler* is shown in Figure 27 in 1948 with this rare modification; the additional topside rudder is just visible on the far left.

Starting in about 1947, a movement started within the submarine force to remove the guns from the boats. This was prompted by the belief that in the new post-war environment submarines would rarely encounter situations in which the guns would be useful. The guns and ammo were heavy and they caused a lot of drag underwater. The former ammo magazine under the crew's mess could be used for other equipment as the boats were overhauled or converted. The GUPPY and Fleet Snorkel conversions eliminated the guns entirely and the rest eventually followed suit.

Fig. 28. USN photo courtesy Navsource & Scott Koen



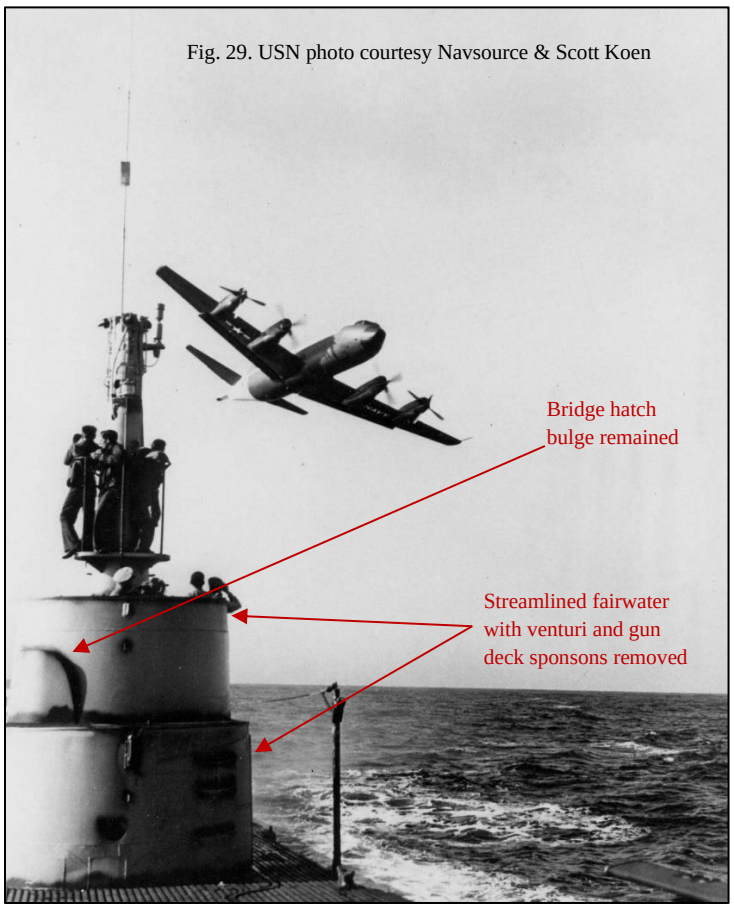


Fig. 29. USN photo courtesy Navsource & Scott Koen

The first step was the simple removal of the guns and in most cases the associated ready service ammunition tubs, and Figure 28 of *Toro* above in 1947 shows her new cleaner look. Notice that the late war addition of a ladder down from the aft gun deck remained in place. The next step involved reducing the size of the fairwater even further, a minimalist approach to streamlining. The sponson overhangs on the gun decks were cut away, and in some cases even the wind venturi was removed from the bridge, with the top edge rebuilt and smoothed out, as shown in Figure 29 on *Capitaine* operating with a P-3 in 1960. This early attempt at partial streamlining was euphemistically called the "*Queenfish* Mod" in the force, apparently named after the first boat to receive it. In some cases this mod was the final configuration for the boat and it carried it to the end of its service life. For others (*Charr*, *Ronquil*, etc.) it was an interim step until the boat could receive further modifications, usually a Fleet Snorkel conversion. *Sea Dog* is shown in Figure 30 with the *Queenfish* Mod in the early 1950's.

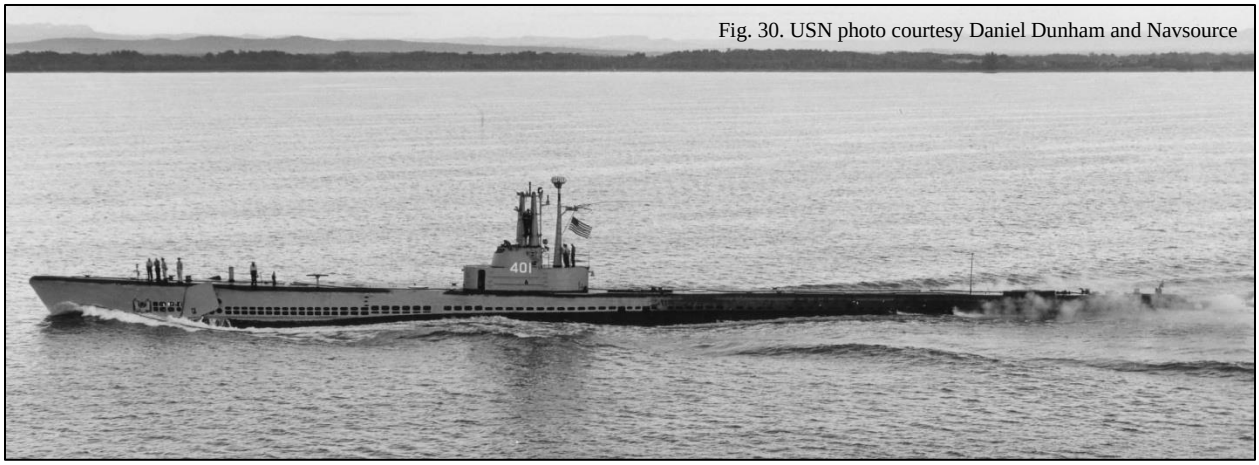


Fig. 30. USN photo courtesy Daniel Dunham and Navsource

A fair number of the *Balao/Tench* class boats served their entire service lives (some into the late 1960's) never straying far from their WWII appearance. Most of the boats however, were taken in hand and received various major modifications such as radar pickets, amphibious transports, guided missile launchers, target boats, sonar test platforms, Fleet Snorkel, and the extensive GUPPY conversions. These modifications have been covered extensively in other works and are beyond the scope of this article.

ACKNOWLEDGEMENTS

Special thanks go to Michael Mohl, the webmaster of the Navsource.org submarine photo archives. Michael and his associates at Navsource have put together the finest photographic repository of U.S. Navy images on the web and all of the pictures contained in this article came from there. This article simply would not have been possible without them. www.navsource.org

In addition, my personal friend and fellow historian Ric Hedman provided much needed encouragement and a keen editorial eye.

The government organization that had been called the U.S. Naval Historical Center was reorganized and made an official U.S. Navy command. Based at the Washington Navy Yard, it is now called the Naval History and Heritage Command. It is referred to in this article as NHHC.

REFERENCES

The Fleet Submarine in the U.S. Navy, John D. Alden, Arms and Armour Press, 1979

U.S. Submarines Through 1945: An Illustrated Design History, Norman Friedman, Naval Institute Press, 1995

Ship's Data 5: USS Bowfin (SS287), Arnold S. Lott and Robert F. Sumrall, Leeward Publications, 1975

The Floating Drydock Series: Fleet Submarines of World War Two, Thomas F. Walkowiak, Pictorial Histories Publishing, 1988

U.S. Subs in Action, Robert C. Stern, Squadron/Signal Publications, 1979

Dictionary of American Naval Fighting Ships, DANFS Online via Hazegray.org

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[1] There is frequent confusion here on this gun, with some references listing it as a Mk 17 and some as a Mk 40. Per official Navy convention, the *gun* is designated as a Mk 17, the *mount* (the mechanism that attaches it to the deck and allows the gun to rotate and elevate) is designated Mk 40.

[2] Construction was suspended on five submarines in early 1946, but these boats were later completed as GUPPY II's between 1948 and 1951. These boats were Mare Island's *Balao* class *Tiru* (SS-416), Portsmouth's *Tench* class *Volador* (SS-490), and Boston's *Grampus* (SS-523), *Pickerel* (SS-524), and *Grenadier* (SS-525). *Pickerel* was actually towed up the coast to Portsmouth for completion.

[3] The four pictures in this section are as follows L to R: *Balao* (USN photo courtesy NHHC), *Blower* (USN photo courtesy Darryl Baker, multi boats (photo by Herb Hanson courtesy John Hummel), & *Devilfish* (USN photo courtesy David Buell)

[4] Curiously, Norman Friedman listed this boat as the *Corsair* (SS-435), but several photos show her has having a normal length fairwater.