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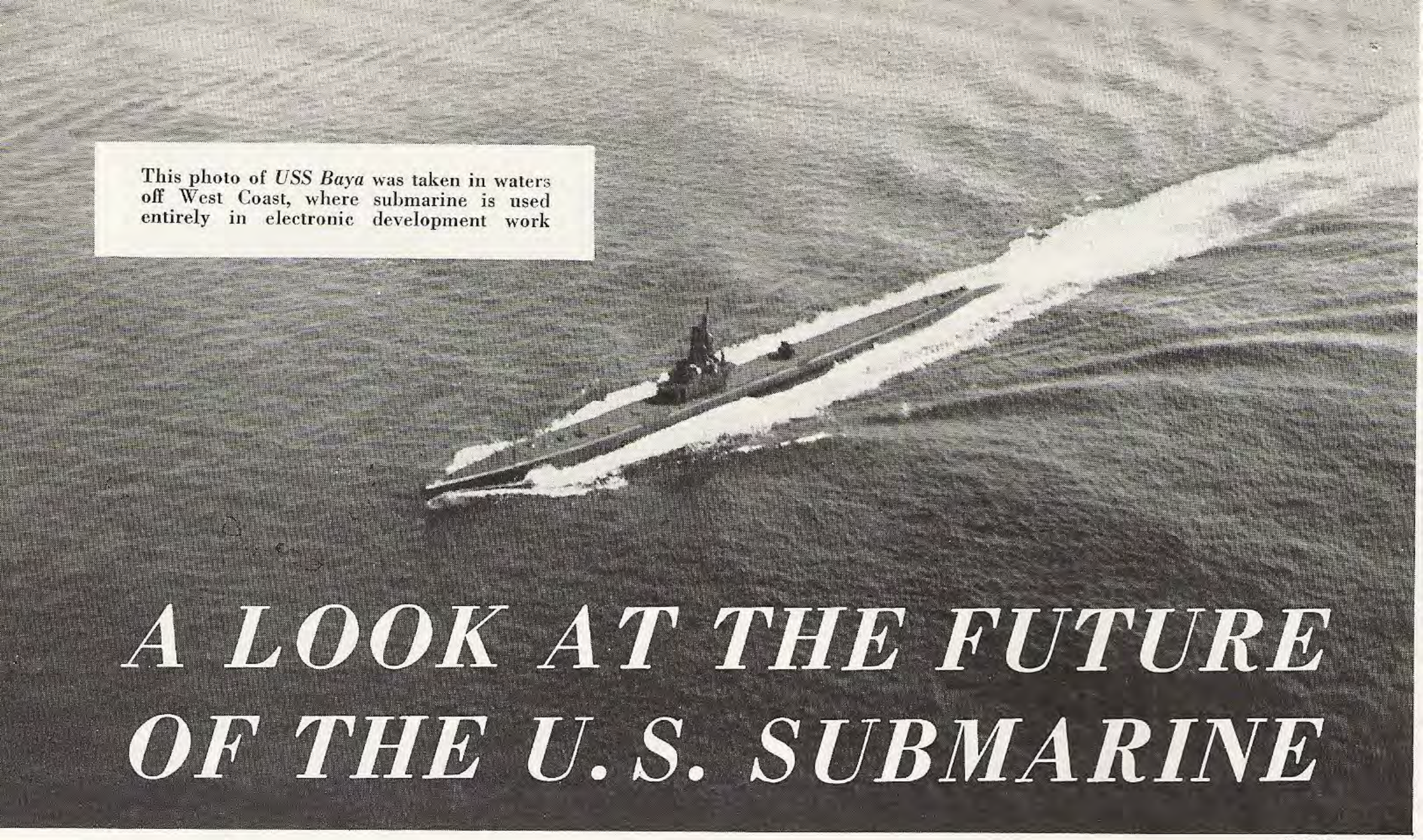


This photo of *USS Baya* was taken in waters off West Coast, where submarine is used entirely in electronic development work

A LOOK AT THE FUTURE OF THE U.S. SUBMARINE

—U. S. Navy photos

BY CAPT. ROY S. BENSON, USN

THERE is hardly anything submarines can do to defeat an enemy which cannot be done better by certain types of surface ships and aircraft. There are, however, important provisos, and in these we have the key to the usefulness of the submarine. First, the ship or aircraft must be able to get to the location where the job needs to be done; second, it must be able to stay there long enough to do the job; and third, it must be able to get home again after the job has been done. If these conditions can be met, the submarine

A native of Concord, N. H., Roy S. Benson was commissioned Ensign upon graduating from the Naval Academy, class of 1929, and assigned to duty aboard the battleship *USS New York*. Instruction at the Submarine Base, New London, Conn., followed in 1934, and after submarine and other sea duty and a period as instructor at the Naval Academy, he was assigned executive officer aboard the submarine *USS Nautilus*. In recognition of meritorious service aboard the *Nautilus*, following the entry of the United States into World War II, he was authorized to wear the Commendation Ribbon from the Commander in Chief, Pacific Fleet, and the Presidential Unit Citation.

As Lieutenant Commander Benson, he was placed in command of the submarine *USS Trigger*, and for extraordinary heroism and distinguished service aboard this vessel during operations in the Pacific, was awarded the Navy Cross, a Gold Star in lieu of a second Navy

CAPT. ROY S. BENSON, USN

Cross, a Silver Star Medal, a Gold Star in lieu of a second Silver Star Medal, and a Presidential Unit Citation.

Relieved of command of the *Trigger*, he was in charge of the Prospective Submarine Commanding Officers' School, Submarine Base, New London, for a year, following which assignment, came further submarine duty, in recognition of which he received the Legion of Merit.

Detached from sea duty in July, 1945, and now having the rank of Captain, Benson saw service in important assignments in various offices of the Navy Department, Washington, D. C. In March, 1947, he was ordered to duty on the staff of the Commander, Submarines, Atlantic Fleet, as New Developments Officer. In 1948, he became War Plans and Intelligence Officer on the staff of Commander Submarine Force, U. S. Atlantic Fleet, and one year later was made the first Commander of Submarine Development Group 2 when that unit was commissioned. Following a period of duty as the Navy's Director of Public Information in the Pentagon, Captain Benson, during the summer of 1952, was assigned to study at the National War College.

should not be called upon. If they cannot, and if suicide attacks are not to be engaged in, then the submarine can be extremely useful.

Submarines have in their short life sunk a greater tonnage of ships in wartime than have all other agents of destruction put together. The Allies came perilously close to losing both World War I and World War II as a consequence of German U-boat attacks. In World War II, American submarines sank a greater tonnage of Japanese shipping than all branches of all other services combined. As indication of their decisiveness, Mr. Shun Nomura, one of the leading oil authorities in Japan, said, during postwar interrogation, "Japan's chief supplies of oil came from America in the years prior to the war. Therefore, since the war started, our wartime requirements, which amounted to about 5 million tons per year, had to be supplied mostly from the Dutch East Indies. One of the decisive factors in our defeat was the activity of American submarines which cut off the supplies from that source entirely. As a consequence, our petroleum supplies were so reduced that, at critical times, our planes could not take to the air because of lack of gasoline."

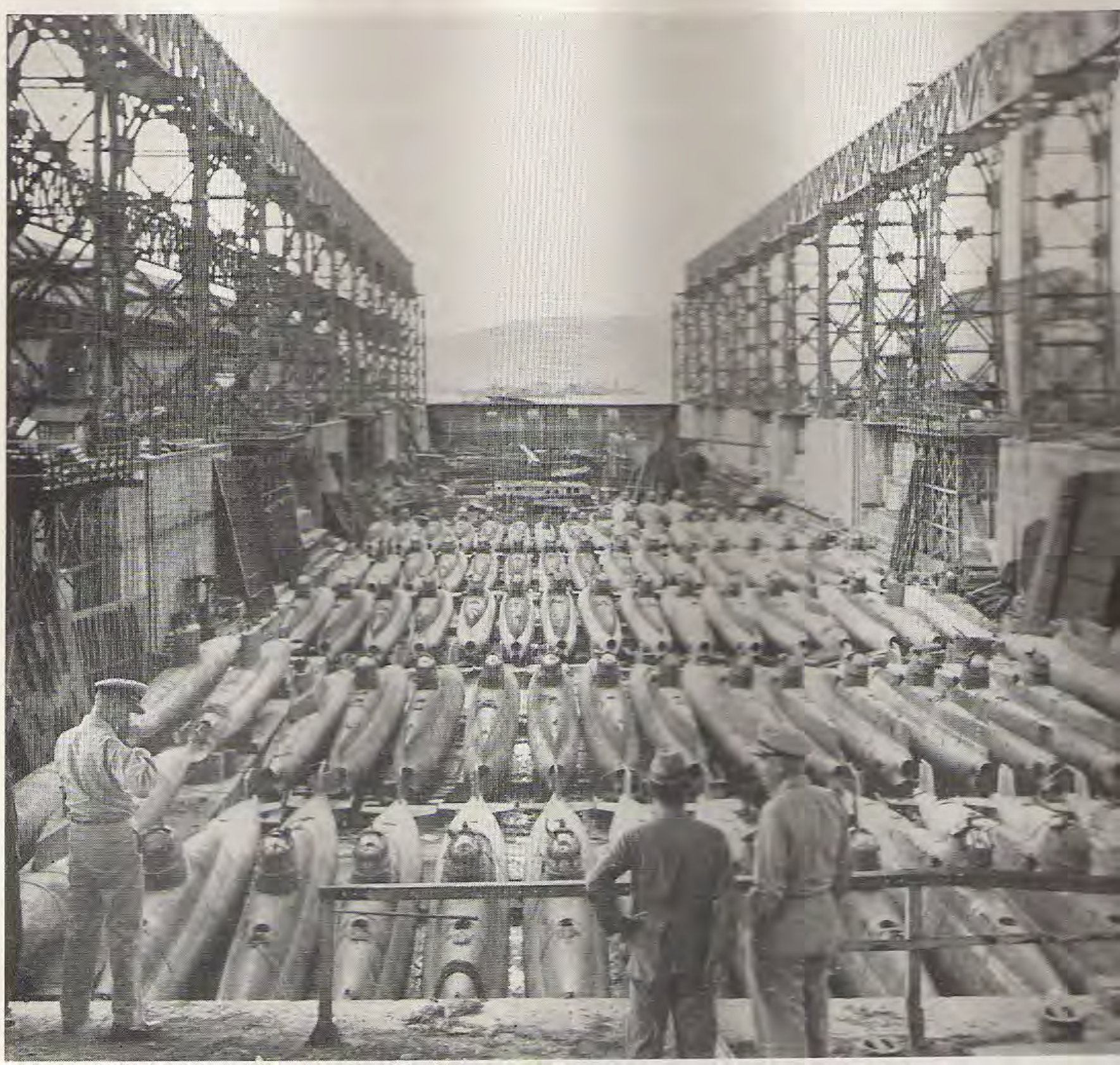
The fundamental of Japan's defeat was that she lost command of the seas. On the other hand, the United States retained command of the seas, and everything we were able to do to Japan stemmed from our ability to use them as a highway. Likewise, because of the excellence of the Anglo-American Anti-Submarine Warfare forces, we kept command of the waters in other parts of the world, and our landings in Africa and Europe were thereby made feasible. If the German U-boats had succeeded in turning the seas into a barrier we would have lost the war.

American submarines also carried out many other vital tasks during World War II. Among them were rescuing downed aviators close to the Japanese coast, transporting Carlson's Raiders to the Makin Raid, conducting reconnaissance photography of landing beaches to supplement the photography taken from the air prior to amphibious assault, and carrying supplies to guerillas in the southern Philippines. Submarines were not acting in competition with certain types of surface ships and aircraft in accomplishing these auxiliary, though important, tasks. The locations were in enemy hands, and therefore the jobs either had to be done by submarines or they could not have been done at all. And they were not done easily. The writer recalls the considerable number of headaches incident to getting the submarines NAUTILUS and ARGONAUT ready to transport Carlson's Raiders. They had been admirably designed for their primary task of torpedoing enemy ships and had to be given hurried, make-shift alterations for this special assignment.

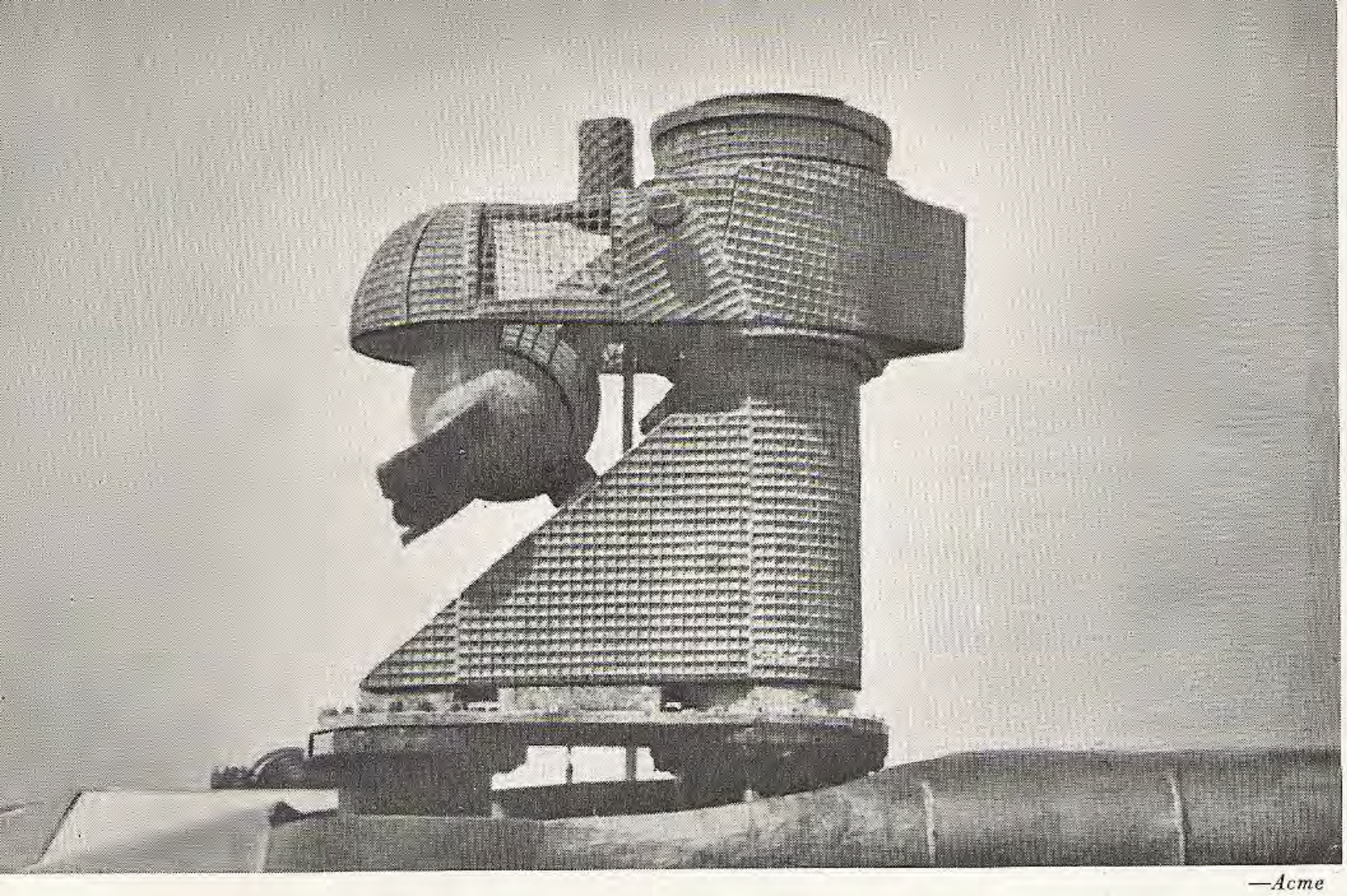
After World War II, a group of submarine officers in the Navy Department in Washington undertook a study of what the future role of the submarine should be. Experience had already demonstrated to them that these craft, in the event of need, could do a little of many jobs in which surface ships and aircraft were expert. These officers wanted, however, to avoid as much as possible a repetition of the hurried, make-shift conversions of the past. They also wanted to increase the submarine's usefulness in the total assemblage of weapons. They discussed various tasks with the experts in those tasks. For example, they held discussions with the world's experts in amphibious warfare, the United States Marine Corps and Navy amphibious forces, to decide on the desirable and feasible characteristics of submarine transport to take care of the transportation of any future Carlson's Raiders.

It was decided to make a trial conversion of one or two submarines for each of the special functions discussed. These converted craft would be useful as prototypes for more conversions should necessity arise. They would also serve as development vehicles through which characteristics could be studied, and, with the assistance of the lessons learned from them, one or more of the special types could be built from the keel on up as a new ship with greater chance for success.

Two submarines were converted into troop transports; another was



Like fish in a market, 5-man Japanese submarines were captured at Kure Naval Base.



—*Acme*

View of snorkel, the device which enabled German subs to "breathe" without surfacing.

made into an oiler; one more was turned into a radar picket; and still another became a guided missile launcher. A great deal has been learned from these vessels. This knowledge has prepared us for more conversions and, in the event of need, new construction of special types. Blueprints and know-how are on hand.

Anti-Submarine Warfare is an extremely important subject to America. No guarantee can be given that a future war can be won solely because an enemy's submarine force was defeated, but we can be certain of our own defeat if we do not cope decisively with that enemy submarine force. Because of the necessity for excellence in Anti-Submarine Warfare, our submariners have greatly interested themselves in this type of effort. They have been aided by scientists from various organizations, both governmental and civilian. Three anti-submarine submarines have been built from the keel up. One conversion has been completed and six others are under way. And in the best tradition of setting a thief to catch a thief, all our submarines can be used to detect and destroy enemy submarines.

As noted, the German submarine force sank many ships belonging to the Allies during World War II. The menace was beaten down only after the loss of many lives, the cost of many millions of tons of ships, the expenditure of about 100 billion dollars, and the utilization of the undivided efforts of one-fourth of the scientific talent of both Britain and the United States. The defeat of the German U-boat took all of this tremendous effort. The highest talents of scientists and engineers and the practical sea-going experience of many excellent men went into it. It was a dirty, tedious job calling for the hardest exertion.

Among the most decisive combinations of vehicles and weapons devised, and those which also pointed to the future in anti-submarine development, were aircraft, both land- and carrier-based; aircraft radar; and acoustic homing torpedoes. Submarines had to surface in order to charge their batteries. Our planes would catch the Germans on the surface at night by means of radar and, using the illumination of searchlights, would dive at them with all weapons firing. If the submarine submerged, the aircraft would release an acoustic, homing torpedo which, attracted by the submarine's noise, would follow it down and detonate on contact. Aircraft, particularly those which were carrier-based, would also surprise the U-boats on the surface in the daytime, when the submarine captain considered that he was so far at sea that land-based aircraft would not be able to cover that part of the ocean.

The inability to use the surface of the sea as they had was a shock to the German submarine command. They immediately undertook development of the snorkel, a tube which a submerged submarine can raise and through which it can draw air to support the combustion in the engines and also expel exhaust gases. It now became possible for a submarine to remain submerged and charge its batteries with only the snorkel tube showing, and this greatly decreased the possibility of detection. A World War II submarine is a little longer than the playing area of a football field, while a snorkel tube is only about the size of a barrel.

Another German development went hand-in-hand with the snorkel installation. When it was no longer feasible to remain on the surface for any period of time, the Germans undertook to make their submarines more nearly true submarines, rather than surface craft capable of submergence. If the ship could not be on the

—*Acme*

Anzio: G.I.'s view with interest Nazi one-man submarine (right) and torpedo (left).

Remarkable photo of *USS Pickerel* emerging at 48-deg. angle from depth of 150 ft.

surface much, why bother with guns or surface-keeping contours and other qualities not primarily useful for submerged operations? The German command decided to go all the way. They took off the guns and other top-side appurtenances, streamlined the ship as best they could, and installed improved storage batteries. The result was greatly increased submerged speed and endurance.

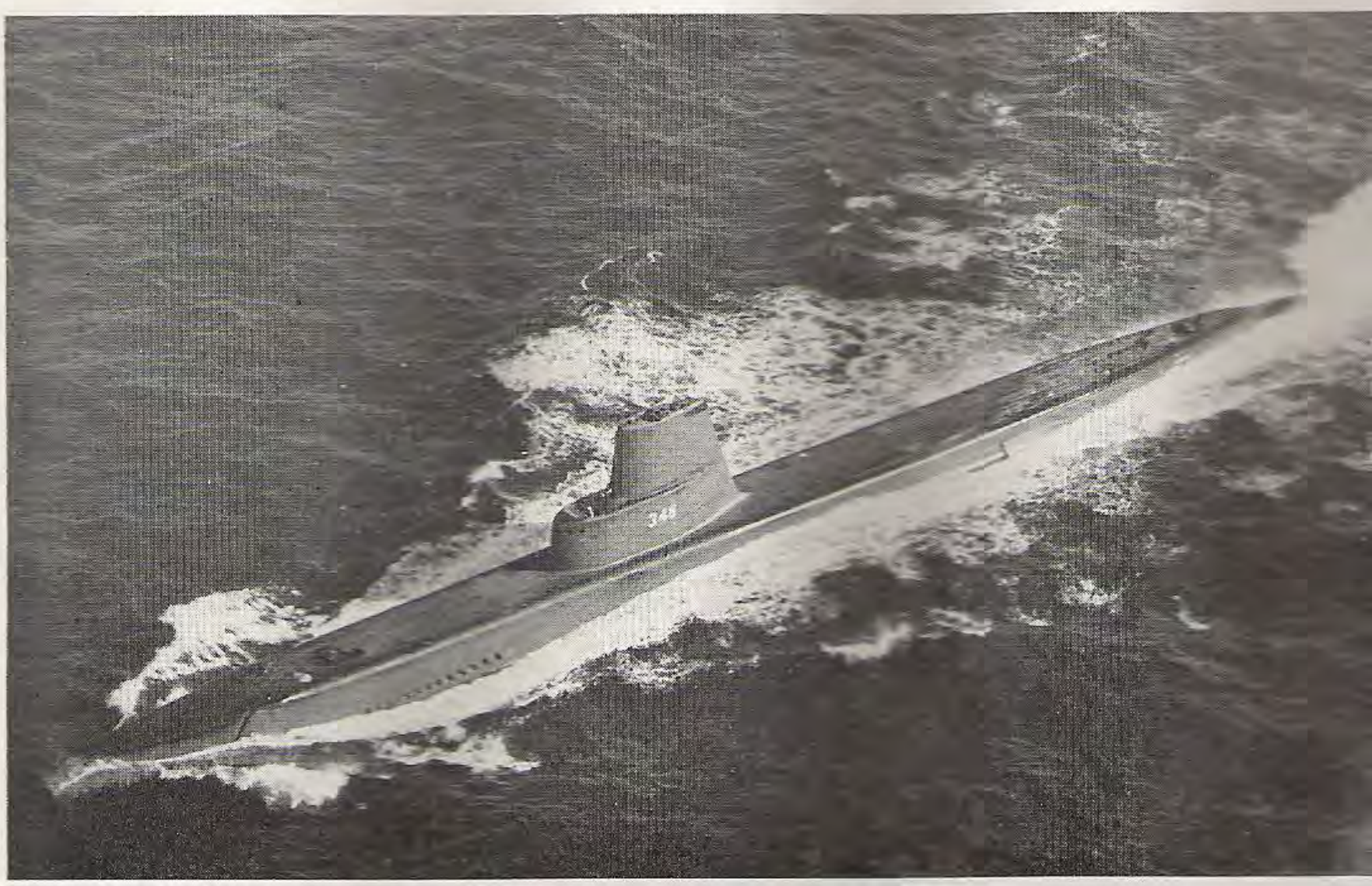
The snorkel, coupled with increased submerged speed and endurance, made a formidable combination. But it came too late. The War was over. And this was most fortunate for the Allies, for postwar tests have proved that their Anti-Submarine Warfare techniques would have been totally inadequate against the new-type German U-boats.

Another submarine development of the Germans which startled our people after the war was hydrogen peroxide propulsion. Through the use of hydrogen peroxide as the oxygen-furnishing agent, the Germans had achieved submarine propulsion which they calculated would give 25 knots for a period of 6 hours. Again we were fortunate that this development came too late. We simply could not have coped with it.

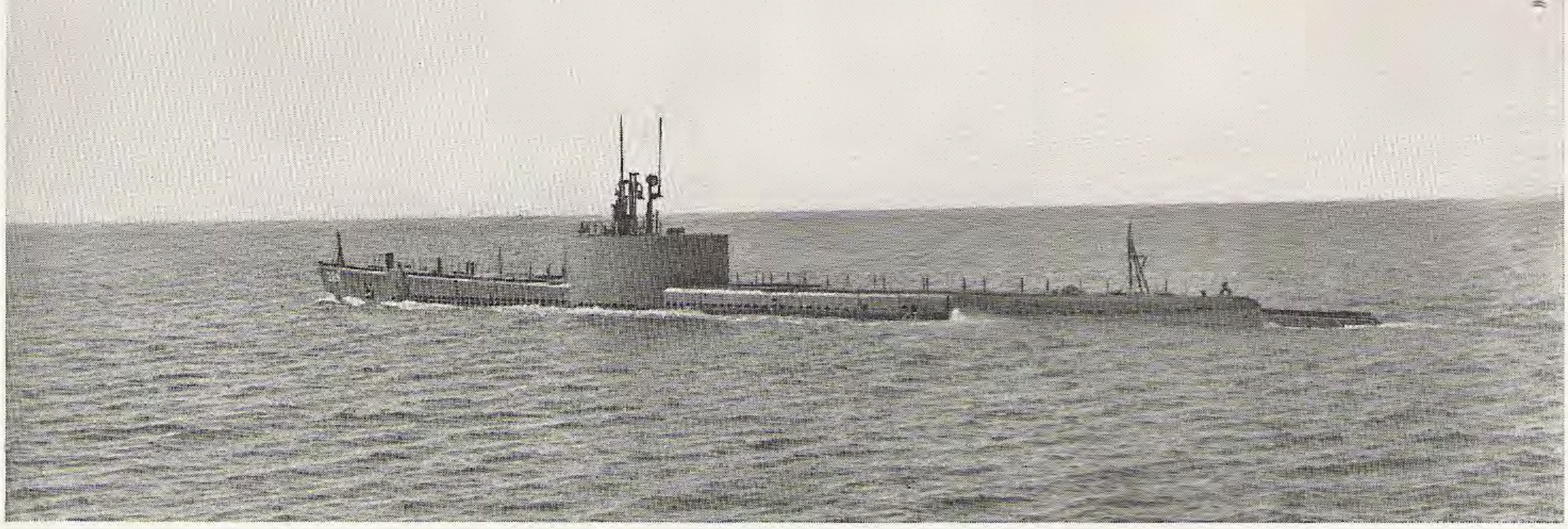
One might wonder why it was that the Germans were so far advanced beyond ourselves. The fact is we did improve our submarines during World War II, but such improvements were not fundamental because we were not forced by circumstances to do better. Had the Japanese anti-submarine techniques been as successful as the Anglo-American efforts became, we would either have had to develop better submarines as the Germans did, or we would have been defeated. Another reason why the Germans came forward with the best ideas on submarines was that they considered their U-boats as their most important warships. We have never done this. The interest shown in the submarine by this country and Great Britain has primarily taken the form of devising methods of defeating this type of craft. We are taking a new kind of interest now, however, for we have come to realize how useful the submarine can be for many tasks, and we have also grown alert to the fact that an enemy of the future might surprise us with developments with which we might not be familiar. The latter happened at the beginning of World War I and World War II.

Since the war, we have converted certain of our submarines—those of the Guppy class—to utilize the snorkel as well as increased submerged speed and endurance, and we have found that these ships are generally better than the German craft from which they were copied. This achievement can be considered rather remarkable, in view of the fact that we made our conversion of a vessel designed and built for something else, while the Germans built theirs for snorkel and greater submerged speed and endurance from the keel up. We have also undertaken a new construction program of six submarines of that general type, called the fast-attack type, of which three are now in commission. And so, for the first time in our history, we have submarines capable of greater speed submerged than on the surface.

Why greater submerged speed represents an advance can be understood if we recall the tactics of the slower submarine. Because of their low submerged speed and endurance, it was customary for these craft to adopt the role of "intelligent mine-fields" and place themselves in a position where their targets could be attacked as they went by. During World War II, many submarines did what was called an "end run," that is, they ran



USS Corporal, one of Guppy class subs, shows speed and sleek lines in maneuver.



On the East Coast, research and development in underwater sound is being carried out aboard the submarine *Flying Fish.*

around a ship or group of ships to get ahead of them and dive to become intelligent mine-fields. With this tactic in mind, it becomes obvious that a submarine having sufficient submerged speed and endurance actually to chase down a target or outrun under water any surface ship trying to counterattack would have a greatly increased potential for destroying the enemy. The future holds this possibility. Right now, the latest submarines we have, the fast-attack type like the TANG and TRIGGER, which can go faster submerged than they can on the surface, can outrun a destroyer in anything over a moderate sea by heading into the sea submerged. But their endurance at those speeds is of the order of an hour or so. One might say, "But that is not much, and so what good is it?" The answer is that, at the end of the hour, the destroyer does not know where to look for the submarine.

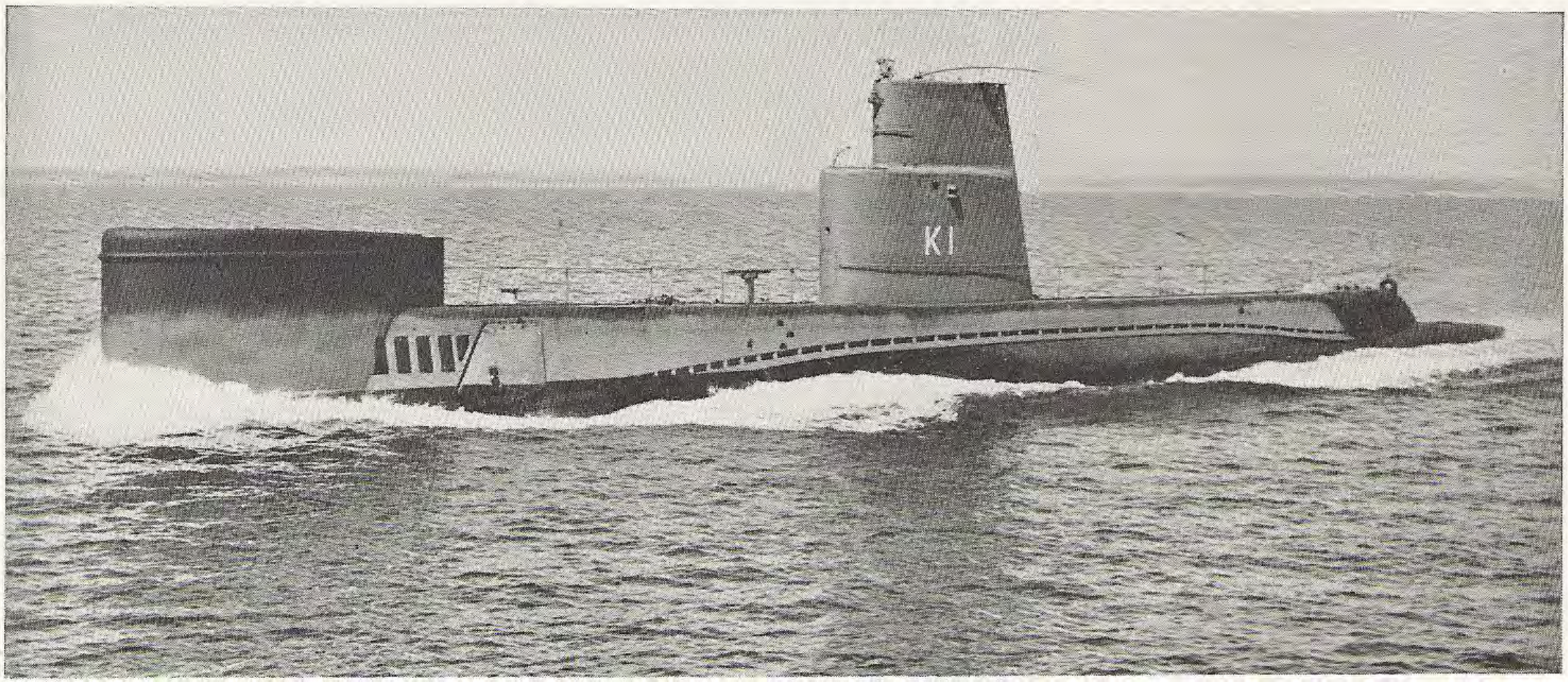
If we are to have more submerged speed, we shall have to study the subject. We need to get the engine power and to ascertain enough about hydrodynamics to be able to utilize the greater propulsion power.

A great deal can be learned from a model basin, and has been. This kind of knowledge corresponds to that which can be found out about aerodynamics through tests carried out in a wind tunnel. Knowing, however, the value of such airplanes as the Douglas Skyrocket to experimentation in aerodynamics, ship contractors have long wanted a submarine built for the express purpose of carrying out experimentation in hydrodynamics. Such a ship is now being built. She is to be of 1,000 tons and will be called the ALBACORE. Her importance will be immense, for progress in submarine development is as impossible to make without the type of study which she will supply as it was in the field of aircraft until experimental planes were provided. The fact is that, right now, we are at approximately the stage of development regarding what the shape of the submarine and the nature of its control surfaces should be as were the aircraft designers around 1912. We have just started. What we did until very recently was simply to build a surface vessel which could be made watertight and then push it around under water by might and main. That era is over.

The reasons can also be made clear why a submarine needs to be able to stay submerged indefinitely.

First, one must remember that the real secret of the submarine's usefulness and the only reason for utilizing this type of craft lies in its ability to remain undetected. Originally, this was easy. All the submarine had to do was to submerge for a while. But today, with modern detection devices in the hands of the enemy, remaining undetected is complicated. To show anything above the surface can be dangerous. Consequently, it has long been the dream of submariners to have true submarines—ships which

Bubble nose of the latest type submarine killer houses SONAR (sound navigation and ranging) equipment, which makes it possible for men aboard submerged vessel to listen for enemy underwater craft, track them down, and torpedo them.



would not be forced to surface or even to put up anything at all unless they wanted to. When a submarine propelled by nuclear power becomes a reality in the near future, this dream promises to be fulfilled. Like Jules Verne's ship in *Twenty Thousand Leagues under the Sea,* our first nuclear-powered submarine will be named the NAUTILUS.

When the first atomic bombs were detonated, it was already obvious that a nuclear reactor capable of furnishing power could be built. In fact, design and operation of such a controlled reactor had been basic in the bomb's design, for that was the way in which the feasibility of a chain reaction was ascertained. The nuclear reactor was controlled by the movement of so-called "control-rods," and that is just the way it is to be done in the nuclear-powered submarine.

The general principle of using heat from a nuclear reactor to propel a submarine does not sound very revolutionary, and it is not. Heat has been a well-known method of creating energy for propulsion for a long time. But every factor in building a nuclear engine for a submarine constituted a new problem, and a very great deal of work had to be done. Since the nuclear reactor is merely the source of heat, it was, for example, necessary to find a method of utilizing that heat so that it would finally result in propelling the submarine through the water. Metals with ability to withstand the heat and pressure had to be found; how to protect personnel against radioactivity brought up shielding problems. A great amount of experimentation took place. Just how much and the full story of the behind-the-scenes effort involved in planning the nuclear submarine will probably not be known for years, if ever. Everything having to do with atomic matters is closely guarded, and the Atomic Energy Commission has cognizance over it for this nation.

There was, however, more to this achievement than solving the problems created by the ship's source of power. A submarine's hull, her contour surfaces, her propellers do not care where the horse-power comes from. As far as they are concerned, it could just as well be derived from rows of oarsmen or an old tea-kettle. Therefore, the study of hull contour and other factors has been of the greatest urgency in planning the NAUTILUS, for, thinking of it in terms of aircraft, there would be small use in trying to put the latest turbo-jet engine into a plane of the vintage of 1910. To the writer, the fact that we have been able to make sufficient advance in hydrodynamics to design this ship is at least as remarkable as is our success in building the nuclear propulsion unit.

Other problems concerned methods of providing fresh air for the personnel during the weeks and months a nuclear submarine might remain submerged. All that can be revealed on this subject is contained in a Navy Department fact-sheet on the NAUTILUS which said: "Because the USS NAUTILUS will be capable of prolonged submerged operation, special provisions for conditioning and revitalizing the atmosphere inside the submarine are being incorporated in its design. This is being done in order that the endurance of the crew will also be greatly extended." Perhaps this brief announcement does not make the problem sound like very much; it was, however, one which took special effort to solve.

The nuclear-powered submarine has unique potentialities. It is a submarine capable of traveling across an entire ocean, not only without surfacing—we can do this now with a snorkel—but also without putting anything above the surface. Therefore, what we normally think of as devices for detecting submarines will be of doubtful value. If a nuclear submarine is detected it will be a stroke of good luck. Should this happen, such a submarine would be able to run away and with no limit as to how far and how long.

Admittedly, a nuclear submarine in the hands of an enemy would be a great menace to us, and we must learn ways of coping with this type of enemy craft. Not to do so might mean that, in the event of a future war, we would be compelled to carry all our necessities overseas by submarine and would also have to bring into this country, by the same under-water method, all imports arriving by sea. Perhaps some day we shall have to do exactly that, and not by nuclear submarine, but by ordinary submarine. Perhaps the submarine cargo-carrier will be the only answer to keeping control of the seas after our enemy gets nuclear submarines himself. And perhaps our own nuclear-powered submarines will then have to be used as anti-submarine submarines against the enemy's nuclear-powered ships.

Navy Secretary Dan Kimball examines atomic power plant in model of *USS Nautilus.* With him is Capt. H. G. Rickover, who had just been awarded Gold Star in lieu of a second Legion of Merit in recognition of his work on design and development of the submarine.