

POPULAR MECHANICS

NOV. 1966
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for Popular Mechanics

*2nd board
June*

The Saturday Mechanic—Keeping Filters Filtering
How to Find Sunken Treasure and Hang Onto It

PKMAR69 10001 49 RND3 028191
MRS J RUNDLE
BOX 281

I rode our newest...

Polaris missile sub

The author takes you on a three-day shakedown cruise as a nuclear-powered, missile-launching underwater craft goes through its violent acrobatic paces hundreds of feet below the sea

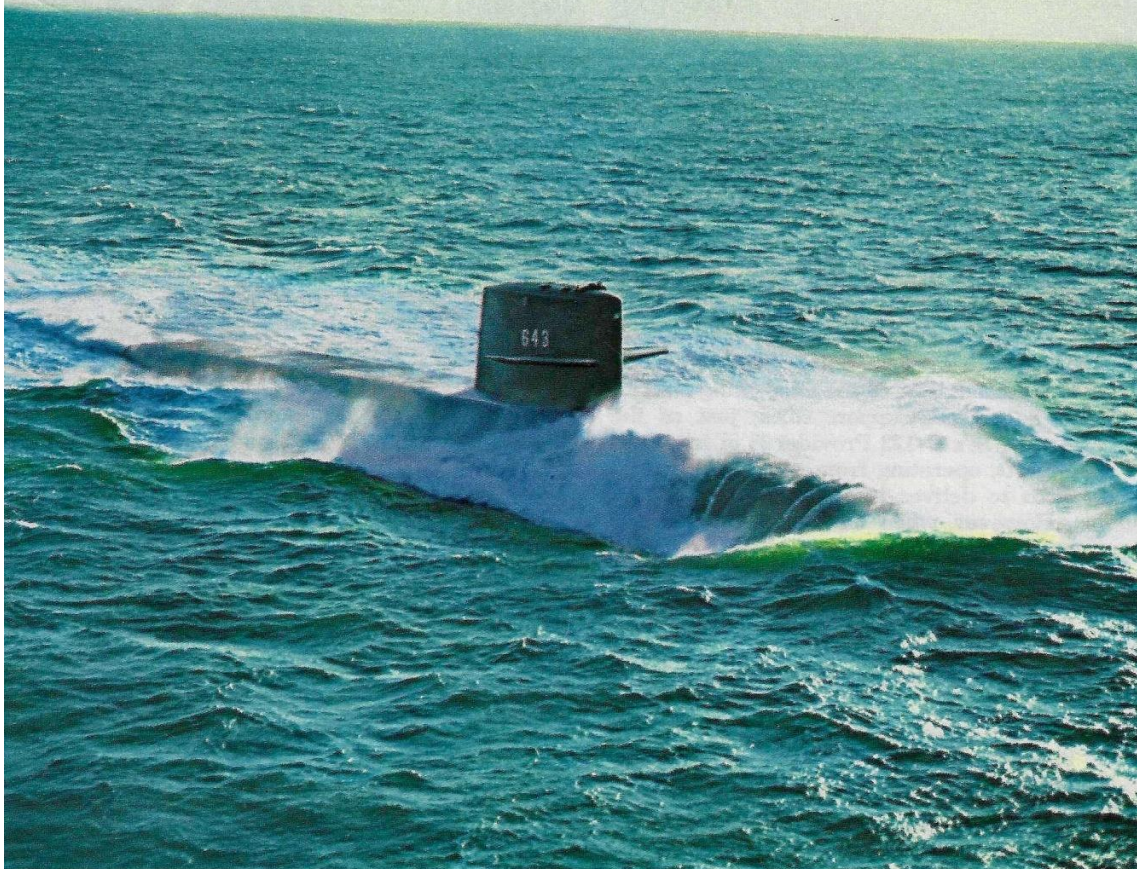
By HANS FANTEL

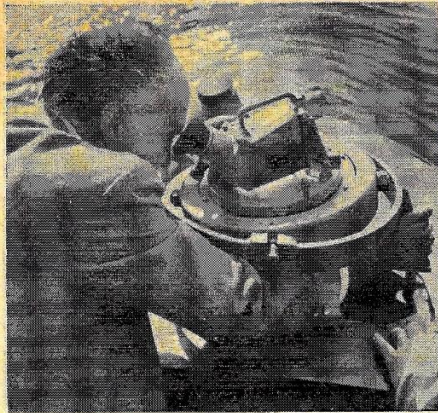
SHEER SIZE STRIKES YOU FIRST. Somehow I had thought of submarines as compact bean pods. But this one, docked at Connecticut's New London naval base, stretched 425 feet—about the length of 1½ football fields. Her 33-foot beam and 42-foot tower confirmed the impression of massive bulk.

She—all ships are still female—was the USS *George Bancroft*, one of the Navy's newest atom-powered, missile-carrying Polaris subs. By special invitation of her skipper, Capt. Joe Williams, *Popular Mechanics* was to share a crucial moment of her career—a predeployment exercise before she joined the other Polaris subs that prowl the ocean depths as America's outermost guard.

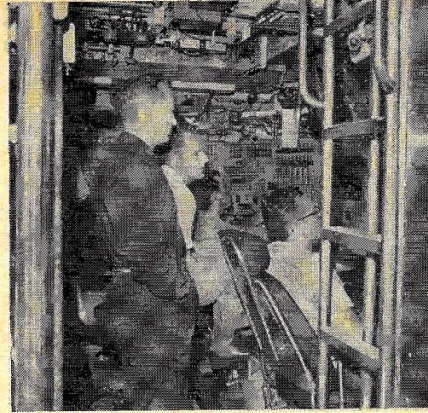
Our mission had three objectives: 1. Fire a dummy missile, simulating an actual Polaris launch; 2. Torpedo a surface ship; 3. Execute deep-submersion maneuvers to elude a make-believe enemy.

The first call for action came after we'd been riding the surface for two hours.





AUTHOR SCANS THE HORIZON from bridge of USS *George Bancroft* before our newest nuclear sub dove on its Atlantic shakedown cruise



CONTROL AREA is enlarged cockpit, holding 12 men or more. Underwater maneuvers are controlled from here as airliner's maneuvers are in air

“RIG FOR DIVE!” the intercom bellowed, starting the diving sequence.

I had been standing on the bridge—the tiny observation platform atop the tower that houses periscope, snorkel and antenna masts. As the ship prepared to dive, the tall masts retracted, gliding noiselessly back into the tower—like the horns of a snail.

“LAY BELOW, SHUT THE HATCH,” the loudspeaker ordered. I clambered down a long ladder, through a well-like shaft that funneled me into the sub’s control area—a wide, horseshoe-shaped room with walls covered by dials, levers, knobs, switches, signal lights and TV-like display screens. Bathed in the red glow of dial lights, the room resembled a jetliner’s cockpit, magnified to hold 12 men.

From the periscope stand at the center, the ship’s X. O. (executive officer), Lt. Cmdr. David S. Cruden, watched his crew smoothly clicking off a pre-dive routine. Along the left wall, three men checked a blinking monitor board which reported the systems status from various parts of the ship: reactor and propulsion plant, atmosphere control, electric and hydraulic equipment and ballast.

To the right of the periscope, radar and sonar crews were watching multicolored beams trace electronic oscilloscope images of our surroundings. Two men were leaning over a large table on which a spot of light automatically plotted our position on a chart.

But the heart of the whole control area is the helm. Don’t expect to see a traditional brass-trimmed oak wheel with extended spokes for handles. The driver’s seat on a modern sub looks exactly like the seats in an airliner. Small steering wheel-type “stick” controls, just like those on a big jet, work stabilizer and rudder controls, pointing the ship on its course. Push the stick forward and she noses down; pull back and she rears up on her tail. Turn the wheel left or right, and she changes direction accordingly.

Steersmen on surface craft may scan the horizons of the open sea. Sub drivers face a different vista. Compass heading, true course, depth, rate of dive or climb, attitude, rudder angle, trim angle, course and depth error, engine speed, true speed—these are the gauges crowding into the helmsman’s vision. Even if he goes to the autopilot, these instruments never go unwatched.

The pre-dive sequence is now complete. The ship is ready. “DIVE, DIVE,” commands the intercom. The alarm horn howls in frantic whoops. Ballast valves

cracked like 40-mm cannon shots. Oddly, you feel almost nothing. No dramatic plunge—no crash dive as in the days of World War II. Gently, as helmsman Barry Doe nudges his control stick forward, the ship nods down beneath the surface. The shallow dive angle keeps the propeller from sticking out of the water during the first nose-down.

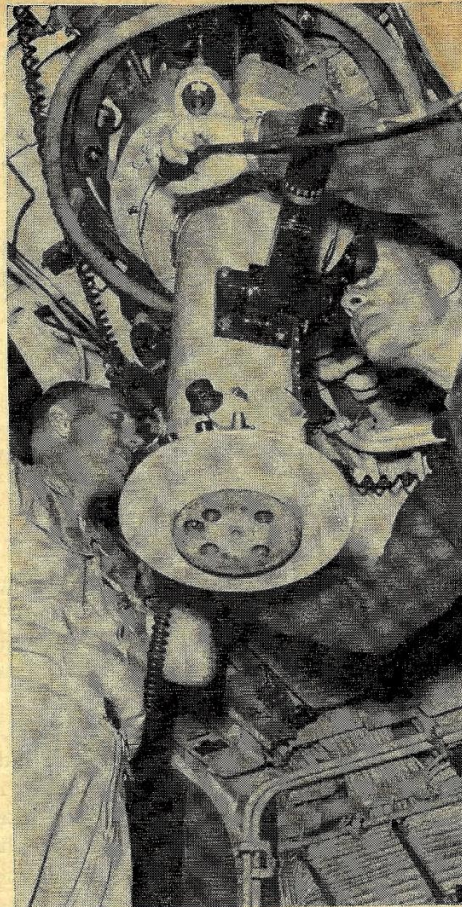
Suddenly the ship seems motionless. Surface waves no longer rock the keelless hull. An eerie sense of stillness is the first sign that you are now submerged.

But all the instruments and electronic displays have come alive. Their pointers and beams swing off, trembling slightly as the ship—like a living organism—adjusts itself to the mounting pressure of its new environment.

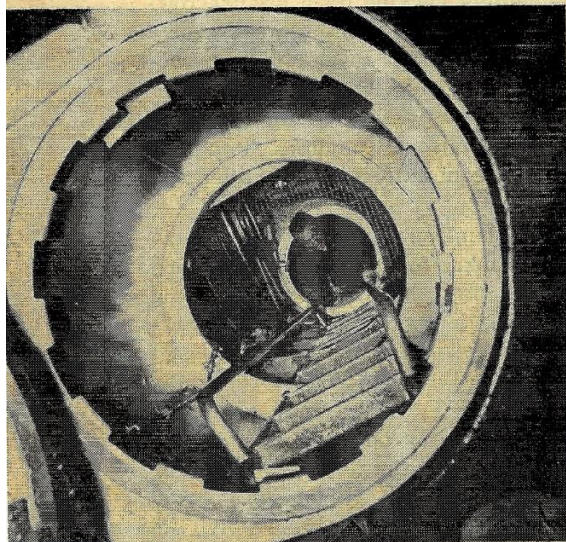
The next scheduled operation—as soon as we reached deep water off the continental shelf—was a series of violent maneuvers to test the ship's handling.

Again the X.O., who acts as a sort of deputy captain, commands from the periscope stand. Despite his studiously nonchalant attitude, you see the tension in his face.

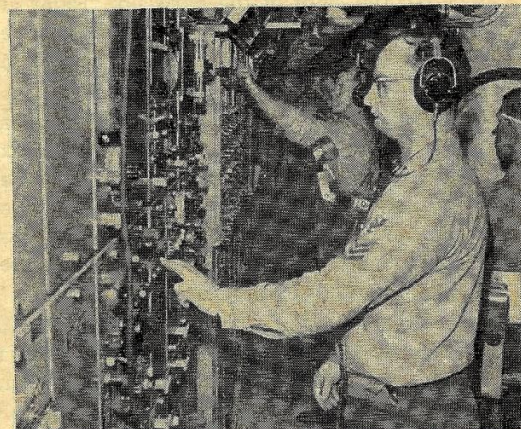
In the back of his mind, every submarine navigator lives with two private horrors—he may joke about them, but the fear remains: running the ship aground during a deep dive and surfacing under



OBSERVATION OFFICER mans periscope as sub skims just below surface of ocean. With modern sonar, sightings can also be made easily without 'scope



STAIRWELL from bridge leads below to control area. Before dives, bridge is cleared of personnel, all masts are retracted into tower and hatch closed



BATTLE STATIONS are manned during tense moments of Polaris launchings. Automation and double checking makes accidental launch of missiles impossible

the hull of another ship. A quick glance at the fathometer reassured Cmdr. Cruden: 1500 feet from keel to sea bottom—plenty of room for acrobatics.

Our world tilted. Grabbing the nearest handhold—there's always one within reach—I hung on as if I were on the slopes of the Matterhorn. The floor tipped forward 30° as the sub burrowed down into its element. Spinning like the counter of a filling-station pump, the digital depth gauge raced to keep up with our plunge. All the Navy will let me say is that the sub goes down "more than 400 feet." Chalk it up as the understatement of the year. Even the X.O. admits, "That's just getting our ankles wet."

"RUDDER 25° LEFT, DEPTH 350," the next command rang out. Like a fighter plane in an air duel, the massive ship zoomed upward in a steeply banked turn. With engine at "Full," thousands of horses churned the water, pushing her up a steep slope to the ordered depth. Moments later, another command sent her plunging down again, this time twisting to the right.

My feet had lost confidence in the heaving floor. My hands clung to their holds; my eyes unbelievably followed the swinging instrument and screen displays as they registered the ship's extravagant motion. My head was busy, too, trying to conceive the vast power and magnificent engineering that let us "fly" an 8000-ton ship at crushing depth like a Piper Cub in the hands of an exuberant weekend pilot.

Normally, the ship would never have to perform such acrobatics. Its main job, in fact, is to provide a rock-steady undersea platform for missile launching. "But it's nice to know," says Capt. Williams leaning back in his chair and clasping his hands behind his head, "that you can twist your way out of trouble if an enemy trails you."

Solid comfort

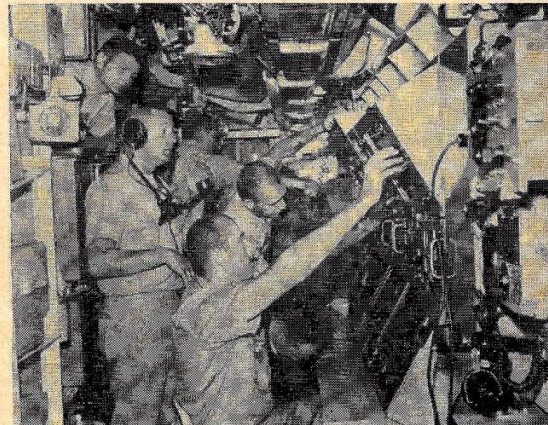
I had expected life on a sub to be about as comfortable as a ride on a rush-hour bus. To my surprise I found it no more cramped than tourist class on some airliners. Sure, three layers of bunks were stacked under a 7-foot overhead. So you couldn't sit up in bed. You went sideways through hatchways, and companionways were a collision course when a well-fed sailor came the other way. But aside from that, you had nearly all the comforts of home: Stereo music—just plug in your earphones, or, as an alternate program, you could listen to a recorded course in Russian. (You never know whom you might meet in international waters!) Feature movies twice a day in the crew's mess and a library of 1500 books (anything from Victorian novels to higher mathematics) let you forget you're isolated from the rest of humanity—that you're living in a tiny air capsule in the depths of a hostile sea.

Isolation is heightened by strict radio rules. For 60 days of unbroken submerison during patrol, the sub remains in radio silence. Any signal sent out might



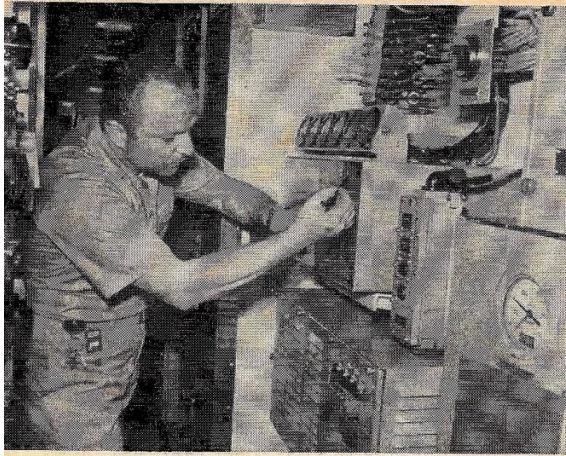
TORPEDO CREW readies "fish" for mock attack on enemy. High-pressure water ram pushes torpedo from tube, catapulting it out for run on target

NOVEMBER 1966



TORPEDO LAUNCHES, directed from control area, are much more tense than missile launchings because target is near and action can be watched on screens

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NUCLEAR SUBS can stay at, or under, sea almost indefinitely. Chief limiting factor is amount of food on board. *USS Bancroft* has excellent galley

SUB'S ATMOSPHERE, checked here by officer, can be replenished with enough oxygen for crew by electrolysis of seawater, so breathing is no problem

betray the sub's presence to an enemy.

Yet even underwater, the sub almost constantly receives coded radio signals through a special Navy network serving the Polaris fleet on a worldwide basis. Personal messages, however, are held to a minimum; one 15-word "familygram" per month for each crew member is the official limit. If a crew member becomes a father while submerged, shore command allows an extra message to get the news to the sub. Other emergency messages are permitted, but not encouraged.

"It doesn't help a man on duty to know of a family crisis," says Lt. Joel Nobel, ship's surgeon doubling as psychiatrist to deal with the crew's emotional problems during their long spells of separation. "No matter what the home situation, down here he can't do anything about it." A by-standing sailor agrees: "If someone's sick or dead topside, I'd rather not hear about it till I get back."

Day and night all the same

We weren't due to reach our target until the next morning. But day and night have little meaning aboard a sub. The handpicked, volunteer crew (14 officers and 124 men—many of them highly trained technical specialists) work a 24-hour schedule: four hours on watch, eight hours off, twice a day; with the maintenance, repair and housekeeping to do in the "off" period.

The fluorescent glare always remains the same, except in certain areas where red lights at night give the crew instant dark adaptation in case of nighttime sur-

facing. In the absence of morning and evening, mealtime is the mark that divides the dayless-nightless flow of time. Chow is served every six hours: midnight, 0600, noon and 1800.

Between meals, heaping platters of cold cuts, assorted sandwich fixings, and a 24-hour coffee urn tempt crew members to take on extra ballast. The mess, always filled with off-watch sailors, resembles one of those all-night cafeterias, except when it doubles as an operating room in medical emergencies.

Since eating is the favorite pastime, the cook ranks next to the captain in importance. Aboard the *Bancroft*, Mess Chief Sadler (nobody knows his first name) is as much appreciated for his flavorful cooking as for his spicy (and highly unprintable) banter. "He gives us a mouthful and an earful," observes an admiring shipmate. "I'm best before mixed audiences," quips Sadler, "soldiers and sailors."

I had my first sampling of Sadler's cuisine—superb chicken Cacciatore—at the captain's table in the wardroom, where the atmosphere is one of cordial formality and the service as elegant as in a first-rank hotel. In a long after-dinner chat, Capt. Williams filled me in on the basic facts about his ship and its weapons.

Atomic subs are the first true under-seas craft, the captain explained. The older Diesel-electric subs he regards as "basically surface ships capable of submerging for relatively brief periods." Then they must surface or snorkel to

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POLARIS MISSILE SUB

(Continued from page 116)

recharge their batteries and refresh their breathing atmosphere. By contrast, the atom sub can stay down practically forever. Its powerplant runs without air and generates enough electricity to manufacture breathing oxygen by electrolysis of seawater. What then is the limiting factor? "The stomach," quipped Lt. Nobel, munching on freshly baked sponge cake. "We can stay down till the food runs out."

Even as atom subs go, the *George Bancroft* is something special. Newest of its kind to enter service, it belongs to the latest type of SSBN (Submarine Ship Ballistic Nuclear) that differs from earlier atom subs somewhat the way a Thunderbird differs from the Model A.

Unlike older subs, the *Bancroft* carries Polaris A-3 missiles, whose 2500-mile range beats earlier types by 1000 miles. Since no place on dry land is more than 1500 miles from shore, this puts every city on earth within the sub's firing range, with room to spare.

Another innovation is the *Bancroft's* whale-shaped hull—a kind of underwater fastback with tapered tail—which ups her top speed to . . . well, forget it.

Her navigation system is a scientific marvel. SINS (Ship Inertial Navigation System) automatically keeps track of her every move—tells you instantly where you are anywhere in the world. To double check SINS, she has a special periscope that sees stars from underwater, to provide a stellar fix. And to top it off, there are several other secret backup systems which I suspected but could only guess at.

Within her thick-steel pressure hull, built to withstand 80,000 pounds per square inch, everything floats on sound-deadening material so that almost no external noise betrays the sub to harking enemies.

Her striking power is incomprehensible, at least in human terms. She can send off all her 16 missiles toward 16 different targets in an unbelievably short time. Imagine a shower of death falling on an area larger than half the United States—all from a single ship invisibly nested in the depth of the sea!

Torpedo attack

Walking back to my bunk, past rows of magnificent machinery arrayed in flawless functional logic, I couldn't help thinking: "What a beautiful thing she is!" But I could take no joy in her beauty, remembering those 16 horrendous missiles. "BATTLE STATIONS—TORPEDO!"

A blood-curdling horn woke me at 0530. Sonar had located our target—a seagoing Navy tug. The torpedo we planned to fire was unarmed and it was set to pass harmlessly beneath the target ship's keel. Had the "fish" been aimed higher and armed with a warhead, it wouldn't just sink a ship; it would shred it to shrapnel.

Everything else was real enough. "DEPTH 61," commanded the X.O. The sub quickly soared up to a level that permitted the periscope to peer above the surface.

"LOOK AROUND," the next command rang out. Like a dancer waltzing with a girl, the observation officer grabbed the two arms of the periscope and swung it through a complete circle—making sure no surface vessels were near enough to spot us.

"RANGE 7100, BEARING 125," announced the observation officer at the scope, which has a built-in ranging radar for measuring target distance. Another reading, moments later, established the target's own speed and direction of travel.

"DOWN 'SCOPE." As quickly as it had been raised, the long tube slithered back down into the hull. Nothing now showed above the surface. Not even a keen-eyed enemy would have spotted the tiny periscope tip miles away amidst the waves during its brief moment of exposure.

"Besides," explains navigation officer Lt. Frank Shaughnessy, "the whole job could have been done without sticking up the periscope. Sonar alone can usually spot and range the target. But," he adds wistfully, "sometimes we have a problem with fish. They're too noisy. Their mating calls throw off the sonar."

Two men in the central control area were cranking target data into a dial-studded computer, which now locked the sub's nose on the moving target. Up front in the torpedo room, the crew readied the high-pressure water ram that pushes the torpedo from its launch tube. Back at control, a light flashed on the console: "TORPEDO NO. 1 READY." The computer reported: "TARGET IN RANGE/LAUNCH FEASIBLE."

"FIRE!" the X.O. orders calmly.

The ship humps a little from the recoil. Then silence.

The drama now is on the sonar. Two blips light the tube screen. One is the enemy. The other, creeping slowly toward him on the tube, is our own torpedo. The suspense lasts nearly half a minute. Then the two blips on the sonar screen meet and blend—our "fish" had found its mark.

The phone doesn't just ring; it yelps

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POLARIS MISSILE SUB

(Continued from page 242)

like an excited pup. The captain lifts the receiver, then flips a switch that lets everyone hear on the intercom.

The enemy is calling on the radiophone. "Congratulations," snarls the tug captain. "Torpedo MOT (Middle of Target). You hit us amidship. We could see her swim right under us."

Missile loft safeguarded

Compared to the excitement of the mock torpedo attack, the launching of the city-crushing Polaris—the ship's main weapon—seemed almost tame. The whole sequence, nearly fully automated, struck me as eerie and somehow unreal.

Our dummy missile was a SABOT, a water-filled cylinder of better than 17 tons, equal in weight to a Polaris A-3. It was to be launched from deep submergence. But unlike an actual missile, it had no rocket engine to carry it to a distant target. It would just plop into the sea.

In an actual launch, the target is identified only in multiple codes that must be cross-checked by several officers for verification. This guards against possible error. None of these men know which city is their mark. None can change the target.

Nobody aboard can start a personal war by pushing a button. Before any missile is lofted, the captain must turn an "enabling key"—like the ignition switch on a car. But that alone does not complete the launch circuit. Two other officers, in different parts of the ship, must confirm the launch order with their own keys. Being positioned far apart, none of these three men can force the others to loft a missile, as might happen if one of them goes insane.

"BATTLE STATIONS — MISSILE." Back in the missile room, the 16 launch tubes stood like gigantic tree trunks. The launch computer had digested the coded target information, checked the ship's own position and depth with the inertial navigation system. A signal light confirmed that the heavy steel hatch covering No. 8 tube had swung open.

Only one factor remained to be checked: surface waves. For, to avoid a sideways kick from rough seas, the missile must pass the surface exactly in the middle of a trough between two waves. A special sonar device analyzed the wave patterns above us. At last, it spotted just the right moment of calm. Automatically a blast of compressed gas drove the missile upward.

The recoil slammed the ship downward, shuddering in the water. The steel

groaned. But moments later, the tension relaxed, both in the hull and in the crew's faces. All had gone well. The bird was on its way.

'Hope we never use it'

What if the bird had been real? What if it were now homing in on a great city populated by millions of noncombatants? What would it be like at the other end of the journey?

I asked the captain how he felt about carrying a cargo of unimaginable horror. "No one likes it," he answered somberly. "But I am convinced it is necessary. I hope to God we never use this ship."

Most of the crew feel the same way. In fact, trigger-happy types are screened out. "I believe in our mission because it keeps global war from happening," says Lt. Tom Priest, an earnest, mild-spoken young man serving as the ship's reactor-control officer. "To keep war from happening," he repeated as if to himself. "That's the meaning of a deterrent. If I thought we'd ever fire those missiles, I wouldn't be on this ship."

One man had a different slant. He was a leathery sailor with a rough Irish eloquence and a hankering for the livelier action he remembers from wartime service on a destroyer. "Here I can blow up a city without getting out of my chair," he grumbled. "Everything's turned around. Women and children are on target. We, the fighting men, are safe. The sea is our ambush. We're hidden. Personal courage and valor have no place. No need for gallantry or daring. Where does that leave the traditional virtues of the warrior?" He looked glum.

No more glory, I thought. Perhaps that's good. Weapons like Polaris are now teaching us to see war as it really is—without glamor. After all, the Russians have missiles, too. ★★★

Tasty toothpaste

An edible toothpaste has been developed by an Air Force dental research team. They call the digestible discovery Astro-9. Although it looks like ordinary toothpaste and is packaged in the familiar squeeze tube, Astro-9 contains neither the detergents nor the volatile oils often found in the commercial variety. It does, however, have an abrasive that is free of calcium.

While Astro-9 may be just the thing for our present astronauts, the military dentist say it would not be the solution for longer flights. Their goal is to develop a paint-on dentifrice that leaves a protective coating on teeth, eliminating the need for brushing.