ALL HANDS

THE BUREAU OF NAVAL PERSONNEL INFORMATION BULLETIN

special issue

UNDERSEAS NAVY

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MARCH 1959

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MARCH 1959 Nav-Pers-O NUMBER 506

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• FRONT COVER: BATTEN DOWN—Highly trained hands of fellow divers secure deep sea diving helmet on Alan May, EN1, USN, as he prepares for test in recompression chamber at School for Deep Sea Divers in Washington, D.C.

• AT LEFT: OTHER WORLDS—Resembling men from another planet, Navy underwater demolition men examine Arctic ice in preparation of blasting path for landing craft.

• CREDITS: All photographs published in ALL HANDS are official Department of Defense Photos unless otherwise designated.

DOWN BELOW—Navy underwater men perform many jobs. *Left:* EOD man goes below. *Rt:* PH photographs hull.

Over the Centuries:

MEN HAVE BEEN GOING "down to the sea in ships" foı thousands of years. They have also been going down *in* the sea—in everything from birthday suits to barrels—for a very long time. In the couple of centuries that the U.S. Navy has been sailing the oceans, it has made some notable contributions to underseas knowledge and exploration. But there's still lots to learn—we've, literally, just broken through the surface.

This issue is about the underseas world, and what the Navy has been and is doing to find out more about it. We're starting off with a bit of history, and that, of course, brings up the subject of diving.

The darkness of prehistory obscures the "who, when and where" of man's first venture into the underwater world. Chances are, the first divers used no equipment at all, except perhaps a stone to get them to the bottom more quickly. (Even today, pearl and sponge divers in some parts of the world still use the same technique.)

It is known that there were divers more than 800 years before the beginning of the Christian era, for Homer, the great Greek poet, referred to them in this passage from the *Iliad* describing the fall of a charioteer:

"Ye Gods! With what facility he dives!
Ah! It were well if, in the fishy deep,
The man were occupied—he might no few
With oysters satisfy—although the waves
Were churlish—plunging headlong from his bark
As easily as from his chariot here!
So, then, in Troy, it seems, are divers too!"

Xerxes, who ruled Persia from 486 to 465 B.C., is said to have used combat divers in naval warfare. According to Herodotus, the father of history, the Persian king also ordered some salvage diving to be done.

In about 460 B.C., Herodotus wrote of a famous Greek diver named Scyllis who was hired by Xerxes to recover treasure from some wrecked Persian ships. After Scyllis had finished the job Xerxes tried to keep him around, but Scyllis had other ideas. In the midst of a storm he slipped over the side, cut the anchor cables of Xerxes' ships and, during the confusion which ensued, swam nine miles to freedom.

Another historian, Thucydides, tells of the Athenians using divers in about 415 B.C., during the siege of Syracuse. These early UDT men (perhaps in Greek they'd be Upsilon-Delta-Tau men) sawed down underwater barriers built to obstruct Greek ships.

ABOUT 333 B.C., Alexander the Great also employed the ancient version of frogmen when he sent divers to destroy the boom defenses of the harbor at Tyre. Alexander himself is supposed to have taken a first-hand look at the underwater world when he was lowered into the deep in a glass barrel.

The underwater warriors at Syracuse and Tyre weren't the only ones in the annals of early naval warfare. References to divers who cut (or tried to cut) the anchor cables of enemy ships can be found in accounts of the sieges of Byzantium in 196 A.D.; Les Andelys, France, in 1203; Malta in 1565; and Mayenne, France, in 1793. Until the early 1800s, Spanish warships carried men who dived without breathing appliances to cut cables and perform other underwater tasks for the fleet.

Underwater tactics figured not only in war, but also in love among the ancients, at least according to Plutarch, the famous Greek biographer. As he tells it, when


ALL WET—Underwater Demolition Team member 'takes off.' *Rt:* Deep sea diver makes his way over ocean's bottom.

Men Under the Sea

Anthony couldn't get a bite in a fishing contest held before Cleopatra, Anthony got a diver to keep his hook supplied with fish. Cleopatra soon grew suspicious of Anthony's sudden change of fortune, so she brought in an underwater accomplice of her own. Next thing Anthony knew he was pulling out a fish that had already been dried and salted.

Some of the early Greek divers apparently used crude breathing apparatus. Aristotle, who lived from 384 to 322 B. C., tells of divers who could stay underwater for a long time through the use of instruments which enabled them to draw air from above the surface. He also reports that divers breathed from containers full of air lowered to them.

Pliny the Elder, a Roman naturalist and author, wrote in 77 A. D., of combat divers who got their air from a tube held in the mouth. The other end of the tube floated on the water's surface.

THROUGH THE CENTURIES all sorts of breathing devices, underseas suits, diving bells and you-name-its have appeared, but most of them didn't get beyond the drawing table stage. Here are just a few of them.

• Some time around 1250, Roger Bacon, an English philosopher, wrote of "..... a machine, or reservoir, of air to which labourers upon wrecks might resort whenever they required to take breath." Evidently this was some sort of diving bell (a container which holds air under water in the same way an inverted drinking glass will when pushed below the surface).

• About 1500 Leonardo da Vinci, who seems to have foreseen practically everything that was ever invented, designed a number of diving rigs and gadgets. One of his outfits included sandbags which gave the diver the extra weight needed to take him to the bottom. When he was ready to come back up he simply emptied the bags.

• A 1511 edition of an ancient book on military matters, printed at Erfurt, Germany, contains what is thought to be the first picture of a diving suit ever to appear in a printed volume. The engraving shows the diver with his head enclosed in a tight-fitting leather bag which had no eye-holes. The bag tapered at the top to a long slender tube which extended to the surface. The top of the tube was kept afloat by a bladder.

• In 1524 another picture of a leather diving helmet appeared in print. This time the helmet had eye-ports and the breathing pipe was reinforced with iron rings.

• In 1679, Giovanni Alfonso Borelli, an Italian mathematician and physicist, came up with an ingenious, but impractical, outfit that featured a metal helmet, an attached pipe which was supposed to regenerate exhaled air and a cylinder-and-piston gadget which the diver cranked when he wanted to change his displacement, so that he could go up or down.

• In 1680 William Phips (or Phipps) of the colony of Massachusetts contrived a diving bell which he later used to recover a fortune from a treasure-laden Spanish galleon sunk off the Bahamas. As a result of his find the former ship's carpenter apprentice became a very wealthy man, and was knighted and named sheriff of New England.

• In 1776 David Bushnell completed his famous *Turtle* (see ALL HANDS, April 1958), a primitive submarine which almost succeeded in blowing up a British man-o'-war while the warship was in New York harbor.

MOST UNDERWATER EQUIPMENT designed before 1800 was pretty crude by today's standards. However, by then diving bells and helmets were in use for salvage jobs as deep as 60 feet, and reasonably practical air compressors had been developed.

The advent of the air compressor revolutionized underseas diving as we think of it today, for this made it possible to maintain an air pocket against considerable pressure, and for the diver to go deeper and remain on the job longer.

It also brought up the problem of the bends, or decompression sickness, caused by too sudden a change from high air pressure to ordinary air pressure. Scores of men—most of them construction laborers working in caissons on bridge-building jobs—were killed or maimed by the disease before the French physiologist, Paul Bert, discovered its causes in the 1870s and advocated gradual decompression. Even after that "caisson disease" was responsible for many deaths and much suffering until Professor J. S. Haldane, of England, worked out his stage system of decompression. With this method which came into general use about 1907, a man who had been working under pressure was held at certain depths for set periods of time until it was safe for him to come to the surface.)

In 1819 the diving suit from which the standard diving outfit of today evolved was introduced by Augustus Siebe of England. Called the "open" dress, it consisted of a round metal helmet with a shoulder plate that could be attached to a waterproof leather jacket. The helmet was fitted with an air inlet valve, from which a flexible tube ran up to an air pump on the surface. The outfit worked on the same principle as the diving bell, since the air forced into the helmet kept the water below the diver's chin. The edge of the jacket was unsealed so that "used" air escaped around the bottom of the jacket while fresh air was coming into the helmet.

THE "OPEN" DRESS had one very serious flaw. If the diver stumbled and fell, or bent over too far, water filled his helmet and he had to come up quickly—or else. In spite of this drawback, the suit made it possible for a man to stay underwater for an hour or so.

In 1837 Siebe modified his 1819 suit and came up with a "closed" dress, which was worn with a helmet that had an air inlet and regulating outlet valves. With the various improvements that have been made over the years, this is the type of suit most commonly worn by divers today.

During the interval between the appearance of Siebe's open and closed dresses W. H. James designed an outfit which required no air connection with the surface. In this 1825 version of SCUBA (Self-Contained Underwater Breathing Apparatus) the diver breathed compressed air from a belt around his waist. The trouble with this scheme was that the diver couldn't carry enough air to keep going very long.

The first practical Scuba—one with oxygen rebreathing apparatus—didn't come along until 1878. Another Englishman, Henry A. Fleuss, is credited with this development. Its usefulness was well demonstrated in 1880 by Alexander Lambert, a famous English diver who wore it when he made his way a quarter of a mile through a flooded tunnel, strewn with all sorts of obstacles, to close an iron door and sluice valve so that the tunnel could be pumped out.

MEANWHILE—back in America—these developments had taken place:

- In 1838 W. H. Taylor had come up with a metal diving dress which, according to one authority, "..... has a fair claim to be considered the first design for a completely armoured and articulated diving dress intended to safeguard its wearer against deep-water pressure......" A model of it appears on page 33.

YESTERDAY'S underwater dreams and experiments are recorded far back in the history of man and the sea.

• In 1856 L. D. Philips designed an outfit that anticipated quite a few of the features of the most successful modern armored dress.

• During the Civil War both the Union and Confederate Navies had dabbled in submarines, and one of the Confederate craft managed to blow up and sink USS *Housatonic* off Charleston, S. C., in 1864. (See ALL HANDS, April 1958.)

Chances are there were some divers in the U. S. Navy by the time Lambert pulled off his tunnel exploit. Trying to track them down is like looking for a needle in a stack of seaweed. As early as 1882 there was a diving school at the Torpedo Station, Newport, R. I., run by a retired chief gunner's mate named Jacob Anderson.

Since Anderson presumably learned to dive in the Navy, it seems safe to conclude that there were Navy divers before there was a school for them.

The volunteer students at the school were gunner's mates who learned diving in just two weeks (which was probably more than enough time to teach them all that the Navy knew about diving in those days). Graduates usually wound up searching for practice torpedoes on the firing range off Newport. By regulation, they weren't supposed to go beyond a depth of 60 feet but, since the range was 130 feet deep in spots and the divers were paid under a bonus arrangement, Anderson and others regularly went below the regulation depth.

IN 1898, when USS *Maine* blew up and sank in Havana harbor, the Navy's divers had a chance to prove that they could do a lot more than recover torpedoes.

Following the disaster, one of the big concerns of *Maine's* skipper, CAPT Charles D. Sigsbee, was to get American divers to Havana to recover the ship's cipher code and the keys to her magazines. The code, of course, had to be kept out of foreign hands. The keys, which were hung at the foot of the captain's bunk when not in use, were important to the investigation of the sinking, since their presence in the usual place would be a pretty good indication that *Maine's* magazines had been secured at the time of the explosion.

The divers arrived within a few days and were soon groping their way around in the wreckage. They came up with the cipher code first, but the hunt for the keys took a little longer. One diver reported that he had looked all over the captain's cabin and couldn't find a trace of the keys. W. H. F. Schluter, GM2, of USS *New York* had better luck. He finally located them, hooked to the captain's mattress which was floating against the overhead.

The divers proved helpful not only in finding the keys and the code, but also in trying to track down the causes of the explosion. Several of them, from USS *Iowa* and *New York*, were questioned about the condition of the wreckage by a court of inquiry which met in Havana shortly after the mystery blast.

When the excitement over *Maine* had died down, Navy diving slipped back into obscurity for a while. In 1909 LT Kenneth Whiting made a naked free escape from the torpedo tube of USS *Porpoise*, 26 feet below the surface of Manila Bay, but other than that, not much was doing.

By 1912 divers in England, using Haldane's decompression tables, were reaching depths which made the U. S. Navy's regulation 60 feet look like mere wading. So, Chief Gunner George D. Stillson figured it was high time something was done to modernize the Navy's diving.

He wrote up a report, full of constructive criticism, and requested an assignment in which he could try out the latest methods and equipment. As a result, in 1913 he was ordered to Brooklyn, N. Y., and given an

STRANGE LOOKING designs of the past are shown here with present diver, frogman. For others, see pages 32-35.

SALVAGE of *USS Lafayette* (ex-*Normandie*) in N. Y. harbor provided classroom for Navy salvage divers.

experimental diving team composed of four chief gunner's mates and Surgeon G. R. W. French, who had studied at England's Royal Navy Diving School. In the tanks of a Brooklyn firm (that supplied diving gear to the Navy) the experimenters were soon reaching a simulated depth of 256 feet. They also conducted tests from the destroyer USS *Walke*, in Long Island Sound, where they got down to 274 feet in 1914 to establish a new record for the open sea.

STILLSON'S EXPERIMENTS paid off in several ways—among them, the establishment of a modern Navy Diving School at Newport, the preparation of a Navy diving manual and improvements in gear and technique. In 1915, when the submarine USS *F-4* sank off Honolulu, Navy divers were able to reach her at a depth of 304 feet—probably a record for useful diving in the standard rig with air as a breathing medium.

When the United States entered World War I the diving school at Newport was closed. Its instructors, and some of its graduates, became the nucleus of the overseas salvage division which was part of the United States Naval Forces abroad. Throughout the war these men were engaged in salvage operations along the French coast.

In the mid-1920s two submarine disasters made it plain that despite Stillson's efforts, there was plenty of room for further improvement in Navy diving.

On 25 Sep 1925, USS *S-51*—rammed by a steamship—sank in 132 feet of water off Block Island, R. I. Just three of her crew of 37 survived. At that time only 20 Navy divers were qualified to go below 90 feet, and only six civilian divers on the entire East Coast were willing to chance a depth of 132 feet.

Salvage operations began on 26 Sep 1925, but, because of interruptions by winter storms and because so few divers were trained to work at such depths, it wasn't until 5 Jul 1926 that the sub was finally raised.

On 17 Dec 1927, there was another collision—this time between a Coast Guard cutter and USS *S-4*, which sank, with 40 men on board, to a depth of 102 feet off Cape Cod. USS *Falcon* (then AM 28, but later redesignated ASR 2), a veteran of the *S-51* job, raced to the scene. Her divers reported signs of life in the sub 22 hours after the sinking and managed to ventilate the helpless boat. However, winter storms forced abandonment of the rescue attempt a week after the accident.

On 27 Dec 1927, the salvage-phase of the job began. Once more the shortage of qualified divers—only 24 were available—hampered the operation. It wasn't until 17 Mar 1928 that *S-4* was finally raised by divers working from *Falcon*.

Chief Gunner's Mate Tom Eadie was awarded the Medal of Honor for heroism on the *S-4* job.

EVEN BEFORE the 1925 and 1927 disasters there had been concern that divers might be called upon to do rescue and salvage work in very deep water, where a man, breathing air, couldn't think clearly or work effectively. In 1919 Professor Elihu Thompson, an electrical engineer and inventor, had suggested the use of helium (instead of nitrogen) in the diver's breathing mixture as a solution to this problem. Since the Bureau of Mines was then trying to figure out what to do with helium, Thompson made his suggestion to that agency.

In late 1924 the Navy's Bureau of Construction and Repair (now BuShips) joined the Bureau of Mines in the experimental work on helium-oxygen mixtures which was being conducted at the Bureau of Mines Experimental Station in Pittsburgh, Pa. The experiments indicated that helium-oxygen had a number of advantages over air for deep dives. Besides eliminating undesirable mental effects, the new mixture held promise of cutting down on decompression time.

By early 1927 the work on helium-oxygen mixtures had progressed so well that the Navy decided to transfer the operation from Pittsburgh to what is now the Naval Gun Factory, Washington, D.C., and to make the Experimental Diving Unit a permanent activity. At about the same time the U. S. Naval School, Deep Sea Divers, was also permanently established at the Naval Gun Factory, where proximity to the Experimental Diving Unit would enable students and instructors to apply the findings of the experimenters with a minimum of delay.

In 1937 a diver on helium-oxygen reached a simulated depth of 500 feet in one of the tanks at the Experimental Diving Unit—a feat which made it plain that depth was no longer the obstacle to submarine rescue and salvage work that it once had been.

THE MOMSEN LUNG—a submarine escape appliance—(see page 36), and the submarine rescue chamber designed by CDR Allen R. McCann, also held out hope that tragedies like those of the mid-Twenties could be averted in the future.

The McCann chamber and helium-oxygen diving were put to a real test in 1939. On May 23 of that year USS *Squalus* (SS 192) submerged with her main induction valve open and sank in 243 feet of water off the Isle of Shoals in the North Atlantic (see page 59). *Falcon*, the same ASR which had been in on the *S-51* and *S-4* jobs, was on hand the next morning with the rescue chamber. CDR Charles B. Momsen, a pioneer in the field of submarine escape, was in charge of diving.

At 1014 on 24 May, M. C. Sibitsky, BM2, attached the rescue chamber's down-haul cable to the forward hatch of *Squalus*. At 1130 the chamber was lowered over *Falcon's* side and, during the next 12 hours, the chamber made four round trips to bring up all 33 survivors from the forward part of the sub. The rescue chamber was then attached to the after hatch of *Squalus*.

Up came the word that there were no signs of life. The after part of the sub had been flooded when *Squalus* went down.

Now the rescue effort became a salvage job, which resulted in the first field application of helium-oxygen diving. With the new mixture men were able to think clearly and work efficiently despite the 243-foot depth. Surface decompression with oxygen was also used successfully on this operation.

On 13 Sep 1939, after months of effort, *Squalus* was towed into port. Rechristened *Sailfish* (SS 192), she went on to fight in World War II.

If it hadn't been for the experiments in helium-oxygen she'd probably still be on the bottom. Yet, even with the new breathing mixture and rescue chamber, the *Squalus* job had been far from a cinch. Four divers —William Badders, MMC; Orson L. Crandall, BMC; James H. McDonald, MEC; and John Mihalowski, TM1 —got the Medal of Honor for extraordinary heroism during the operation.

AT THE TIME of the *Squalus* disaster the number of divers in the Navy was still quite small and restricted to just a few ratings. World War II changed that. New ships, especially designed for ship salvage work and service under wartime diving conditions, made their appearance. And, training facilities had to be expanded to turn out the divers in a variety of ratings who were to work from these ships.

About the time this expansion was under consideration, a fire broke out in USS *Lafayette* (APV 4), the former French liner *Normandie*, moored at Pier 88, North River, New York, N. Y. While the fire was being put out, the ship capsized.

This misfortune put an end to the problem of deciding where to train our wartime salvage divers. A school was set up on Pier 88, so that student divers could get valuable practical experience in ship salvage.

Established on a permanent basis in September 1942, the Naval Training School (Salvage) remained at Pier 88 until 1946. Then, as the U. S. Naval School, Salvage, it was moved to Bayonne, N. J. It stayed there until the summer of 1957, when the courses for salvage divers and salvage diving officers were both moved to Washington, D. C.

The salvage training programs weren't the only diving developments to come out of the war. In 1943 the Navy began to organize the Underwater Demolition Teams which took part in amphibious operations in both the European and Pacific theatres. Most of the men in the first UDT units were Seabees, who worked without much more equipment than face-masks and swim fins. However, self-contained underwater breathing apparatus was soon to enter the frogman picture.

The military potential of Scuba diving was most effectively demonstrated during the war by the Italian and British navies. Operational swimmers of the Office of Strategic Services also used this type of equipment. In the U. S. Navy the first submersible operations platoon was organized in 1947 for the purpose of applying Scuba to UDT operations. Nowadays Scuba is used not only by the UDTs, but also by members of Explosive Ordnance Disposal Units and men working on a variety of underwater tasks. In 1954, because of the growing need for Scuba divers, the Navy set up a special school for them—the Naval School, Underwater Swimmers, at Key West, Fla.

IN THE POST-WORLD WAR II years the Experimental Diving Unit has developed and tested many types of Scuba equipment and made numerous studies of the physiological problems involved in Scuba diving. At the same time, it has continued its work on helium-oxygen equipment and techniques, and it has worked out tables for surface decompression after air dives, using oxygen to shorten decompression time. On 3 Mar 1949, as part of the unit's work in helium-oxygen diving, Boatswain's Mate Harold Weisbrod made a simulated dive to 561 feet, while breathing that mixture, the first of a series of such dives. By 18 May 1949 ten other divers had made the same dive.

The post-war period has also seen improvements in submarine escape techniques. In 1956, after thorough studies, the Navy adopted "buoyant free ascent" as the recommended method of individual escape from a disabled submarine when there is no chamber available for group rescue. (In the simple technique, which is considered quite an improvement over older individual escape procedures, the submariner is propelled to the surface by the buoyancy of his inflated life jacket. To keep his lungs from bursting on the way up, he exhales vigorously as he leaves the sub.)

Thanks to modern experimentation and an increasing interest in the underwater world, man has learned more about diving in the past century and a half than he did in all the thousands of years before it put together.

But he still has a lot more to learn. —Jerry Wolff

TOUCH AND GO—Navy underwater explosive experts cleared harbors in WW II. Here, charge is placed.

smoothly-sanded round pegs in round holes, and there's not a jagged edge in the pack."

Although it's easy to make mistakes when you generalize about people, chances are you won't go too far wrong applying this description to the crew of just about any submarine, whether it's a brand-new nuclear type or the oldest World War II ship in the Fleet. In fact, the picture is a pretty good likeness of the biggest group of men in the whole underwater Navy — the submariners.

THE GUYS who wear dolphins are no supermen. They have no monopoly on courage, intelligence, "team spirit" or any of the other characteristics that most Navymen have. But somehow, somewhere along the line, they become as distinct a breed of Navyman as the true "tin can sailor," the "airdale" or anyone else who believes his own particular part of the Navy is something special.

Sailing with the Silent

WHEN USS *Nautilus*, SS(N) 571, arrived in England after her journey under the North Pole, just about every reporter who talked to her crew commented on the fact that the nuclear submariners viewed their history-making voyage as little more than a strictly routine trip.

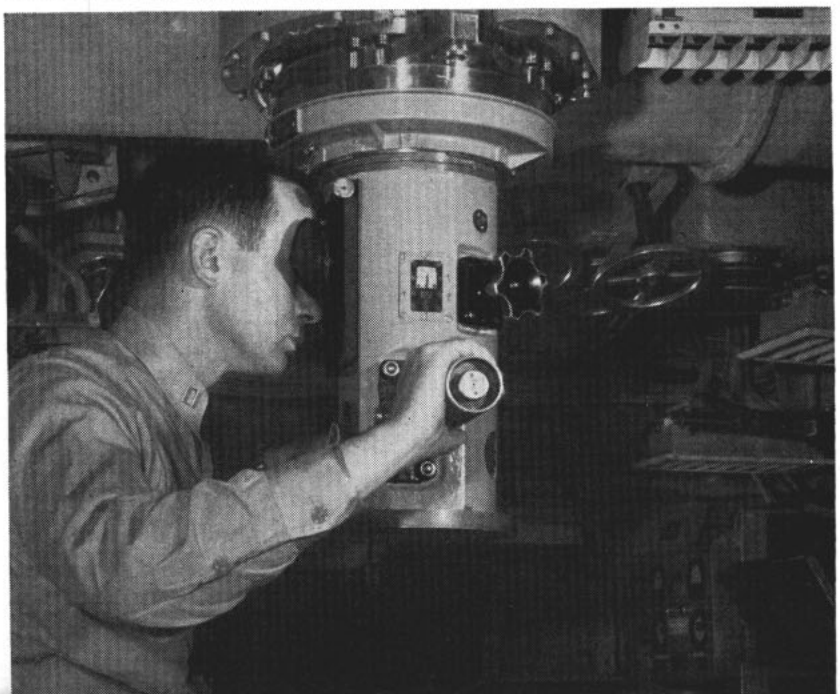
There was no phony modesty.

The submariners knew they had done something important, but they were genuinely convinced their feat was a perfectly natural thing to expect of a good ship and well-trained officers and enlisted men. Everyone on board had his job to do. He had done it—and success was almost a foregone conclusion.

The kind of men who hold that attitude were pretty well described by a British observer who said:

"One would think Washington built them to specification. They seem to be a group of men less likely than any other group in the world to get on each other's nerves, panic in fear, crack under pressure or let each other down. They are all

UNDERWATER SAILORS—An officer on board *USS Albacore* (AGSS 569) takes a look through the scope at things topside while cruising below surface.



Those qualities which transform a plain Joe Doakes into a submariner are sometimes hard for the outsider to understand. Among them are such factors as "motivation," selection, training, the submariner's way of life and that important intangible called *esprit de corps*.

Motivation is reflected in the fact that all submariners are volunteers. The reasons behind their volunteering fit no standard patterns.

Says R. E. Korn, LCDR, USN, who saw a lot of World War II action in USS *Trigger* (SS 237):

"I got into submarines back in 1930, when I was a yeoman striker in a submarine tender. One of the subs in the squadron needed a yeoman, so I just volunteered."

Joseph E. Marion, YNC (SS), USN, a veteran of five war patrols in USS *Bluegill* (SSK 242), explains his motives this way:

"I was a battleship sailor from 1940 to '42. In those days battleships were so regulation that when we ate we sat at the table according to seniority, and we had to get permission to talk to an ensign. Being a seaman, I was low man on the totem pole.

"Then, I saw how the submariners lived — better chow and all you wanted of it, better liberty, higher pay and not so much formality as we had on our ship. I decided then and there that submarines were the thing for me."

A. A. Burki, LCDR, USN, now in his 11th year as a submarine officer, gives these as two of his main reasons:

"While I was First Classman (senior) at the Naval Academy during World War II, I spent a week of my summer leave riding subs out of New London, Conn. I liked them from the start.

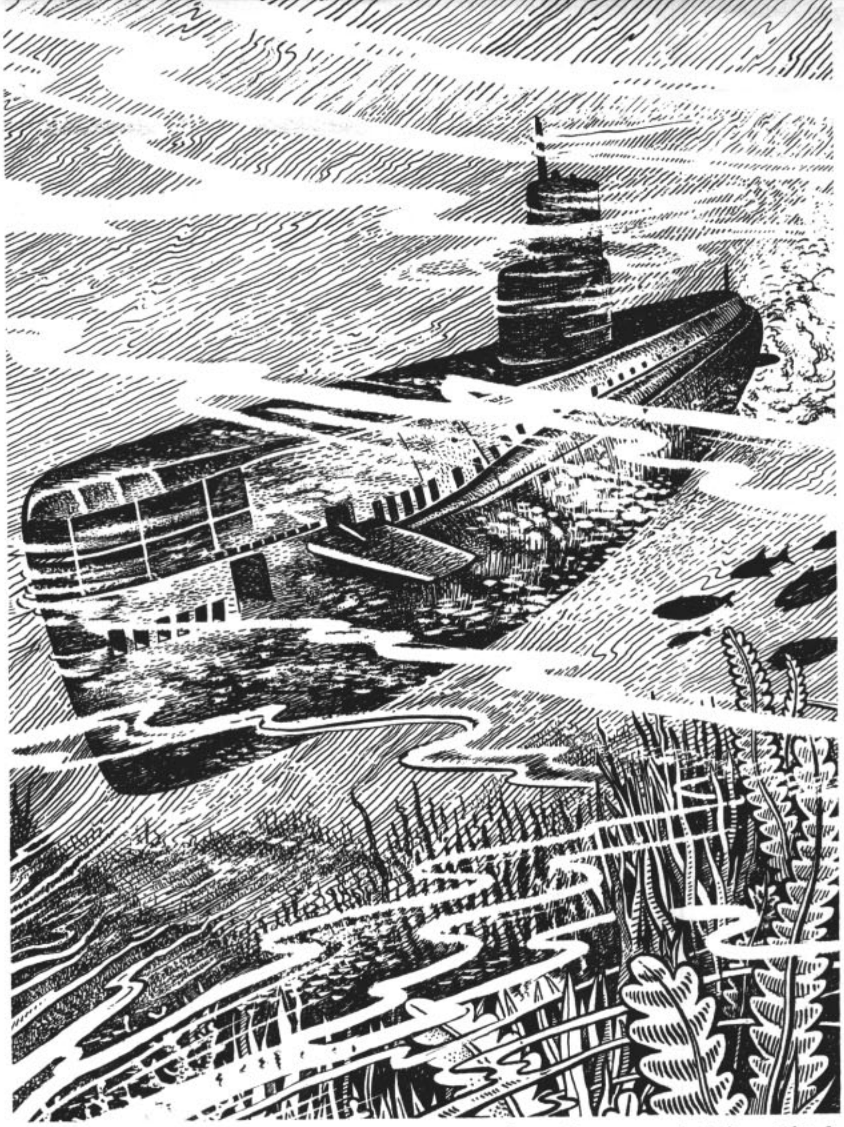
"Another thing that made me want submarine duty was a talk that CAPT Slade Cutter (now the Academy's athletic director) gave about the job submarines were doing in the war. It made quite an impression on me."

Service

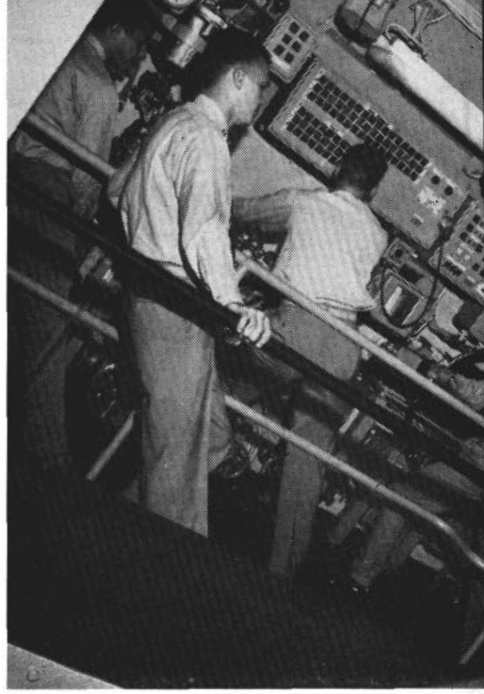
As you can see, there is no set pattern to the submariner's motivation. No matter what his reasons for volunteering are, nor how much he wants to become a submariner, it takes more than motivation to make him a good one.

The eligibility requirements for initial enlisted submarine training reflect some of the traits the Navy looks for in would-be undersea sailor.

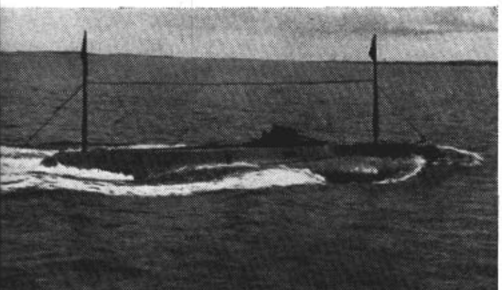
- He doesn't have to be a mental giant, but he has to be on the ball. He should have a minimum combined ARI and MAT, ARI and MECH or GCT and ARI score of 100. However, waivers of this requirement are granted if the man is a good prospect otherwise.
- He must be in good physical shape.
- He must be mature and mentally and emotionally stable. One of the main points in the judgment of these traits is the man's service record, since a poor record often indicates that he lacks these qualities.
- He should have stamina and flexibility. Although these characteristics are usually associated with youth, youth alone doesn't indicate that a man possesses them. But if a man over 30 puts in a request for initial submarine training, his CO's endorsement must include comment as to the way the man stacks up in respect to stamina and flexibility.



PICTURE THIS—Artist's drawing shows present-day sub on patrol. *Below:* Chief-of-the-Boat mans diving controls to take *USS Sea Owl* (SS 405) down under.



SUB HERITAGE—*USS Redfish* (SS 395), Fleet-type sub of WW II is still in service. *Rt:* Simulator trains sub men.



USS Holland **(Navy's first sub) and *below***

USS Salmon**, later renamed D-3, are shown.**

MANY NAVYMEN can meet these requirements, but it takes training, along with the right characteristics, to make submariners of them.

They get that at the Naval Submarine School in New London, where both officers and enlisted men really get started on the way to becoming submariners.

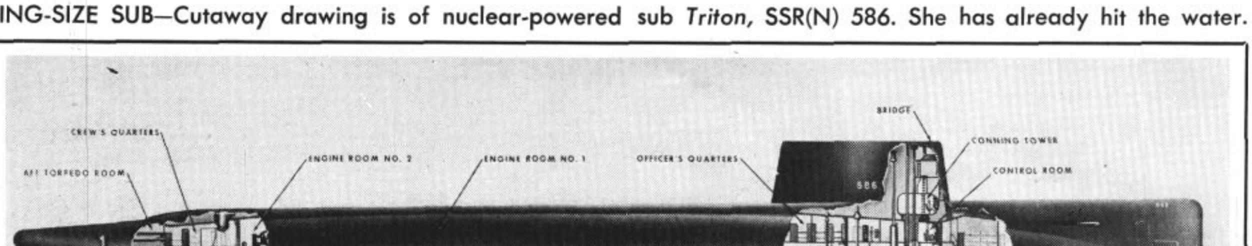
The basic course for enlisted men lasts eight weeks. During that time the embryo submariner gets his general indoctrination. This covers such subjects as submarine history; torpedoes; methods of escape from a disabled submarine; ballast, trim, air, hydraulic and other systems of a typical submarine; and various emergency procedures. Mock-ups (including a full-size "control room" set up on gimbals so that it goes through all the motions of a real sub) and practice runs in Long Isand Sound help give the student "the feel of things" so that he'll be no stranger to a sub when he first reports to one.

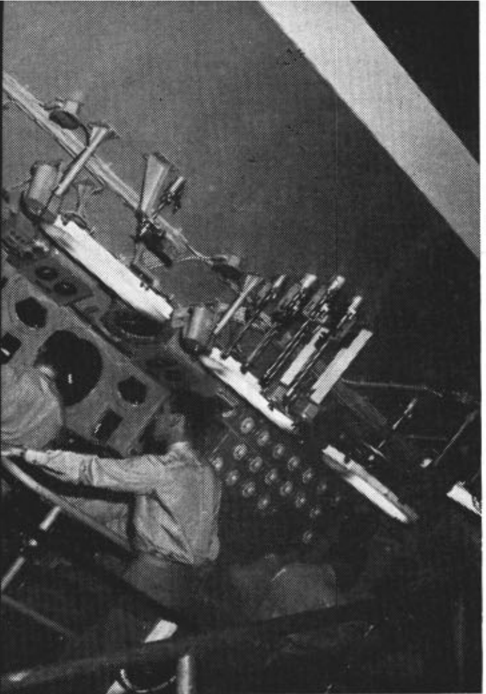
The officer's basic course is longer and even more complicated. It lasts six months and includes diving and surfacing, attack procedures, tactics, shiphandling, electronics, escape procedures, engineering electricity, fire control, sonar and everything else a submarine officer has to know just to get started.

While they are undergoing initial training, the students — whether they're officers or enlisted men — are also being observed for danger signs which might indicate that they aren't quite suitable for submarining.

GRADUATION from the basic course is only the beginning of the submariner's education. Before some

KING-SIZE SUB—Cutaway drawing is of nuclear-powered sub *Triton,* SSR(N) 586. She has already hit the water.





AFTER WW II Fleet-type subs were given new streamlined guppy look. Here, *USS Pickerel* (SS 524) makes way at sea.

of the enlisted students can be assigned to a sub, they need more detailed instruction in the submarine aspects of their ratings. For instance, an electrician's mate who's had all his previous experience in surface ships, requires special training in the workings of a sub's electricial system. (In addition, some of the students go directly from initial training into the nuclear-power school.)

Later, perhaps after the individual has been a qualified submariner for several years, he may go back to school at New London for training designed to keep him abreast of submarine progress. This "post-graduate" training can range from the well known nuclear submarine program to short courses on the intricacies and peculiarities of the latest IC system or torpedo. Or, if he has been away from subs for a while, he may need refresher training.

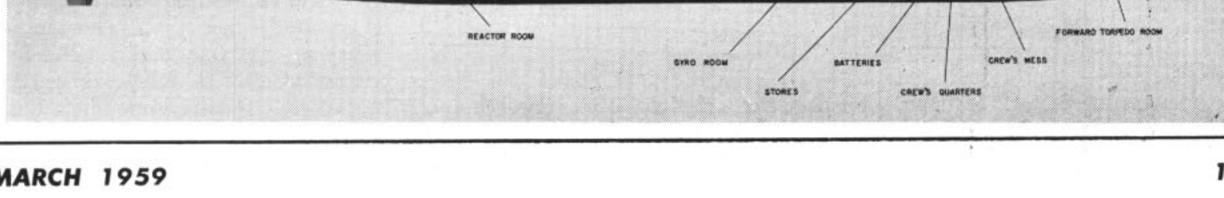
Even after he reports to his first submarine, an officer or enlisted man still has a long way to go before he qualifies as a genuine submariner.

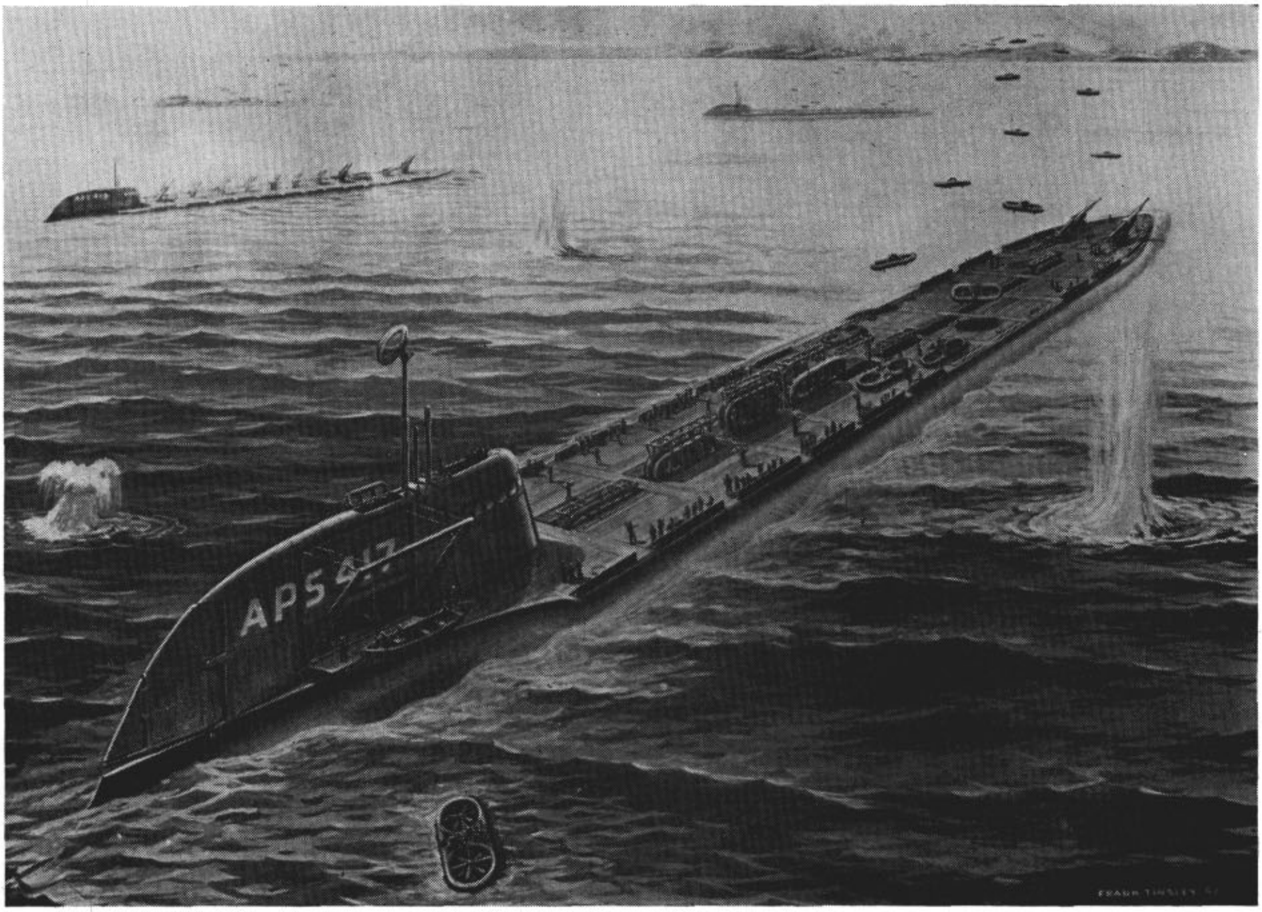
Normally, for the first six or seven months an enlisted man is on board, he's busy studying a variety of manuals and instruction books; sketching the layouts of all the important systems and the locations of valve, gages, switches and the like; taking notes; boning up for monthly examinations; and, generally speaking, learning all he can about the submarine.

At the end of the seven months he is given a final examination by the Qualification Officer. If he passes that, he finally earns the right to wear dolphins and put an "(SS)" after his name. Usually, he also gets

LATEST style is worn by *USS Skipjack.* *Below:* A-powered *USS Seawolf,* poses.

ON THE WAY—Fleet Ballistic Missile submarine George *Washington,* SSB(N) 598, is designed to fire *Polaris.*





***ARTIST'S CONCEPTION**—The Secretary of the Navy was recently presented with the original of this painting which appeared not too long ago in* Mechanix Illustrated. *Conceived by Frank Tinsley, it illustrated an article concerning the potentialities of a 10,000-ton submarine 720 feet long with a beam of 124 feet. It would abandon the traditional shape of present-day subs in favor of five cigar-shaped hulls—a sort of underwater-catamaran.*

Combined, they would form a 48-by-300-foot flight deck from which 20 "air rafts" could be launched at one time. It would carry 2240 Marines in addition to the crew, as well as 40 air rafts. These would be twin-engined, "airphibious" flying platforms with a speed of 100 mph.

During an assault the air rafts would rise in a vertical position to the flight deck on their elevators, set down horizontally. As the first rafts take off, each loaded with assault personnel, other would follow. They could land the Marines in seven trips.

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thrown over the side as part of the ceremony that goes along with qualification.

THE OFFICER'S INTERNSHIP normally takes a year. During that time he's rotated from department to department; he qualifies for OOD watches in port and underway; he learns how to dive and surface, how to direct an anchoring, what to do as OOD, Diving Officer or Senior Officer Present during an emergency or casualty; he practices shiphandling, navigation, approaches, attacks, landings and the like; and in between he's learning how everything on the sub operates—from the main engines to the trash ejector. In short, he learns everything there is to know.

At the end of that year the officer is examined by a board, composed of one division commander and the skippers of two submarines other than his own. The exam has three parts. One is an oral or written test. Another is given while underway. And the third part is given in port and on board.

When the officer gets through all this successfully, he is recommended for qualification in submarines and, upon approval by the Chief of Naval Personnel, is finally designated as "Qualified in Submarines."

By the time a man has qualified, he knows not only his own job, but also a great deal about the duties that go along with every billet on board. He's ready to stand any watch that comes his way, and in a pinch, he can fill in just about anywhere. As LCDR Korn puts it:

"In a submarine you hang your specialty mark outside when you come aboard."

ALSO BY THE TIME he's qualified, the individual has become accustomed to the submariner's way of life.

He's gotten used to the idea of seeing nothing but the inside of the ship for days or weeks at a time; he's learned to get along with his shipmates; he's had considerable practice at acey-deucy, checkers, chess, reading or whatever pastime occupies his spare time; he's found room for his gear; he's come to regard a big, perfectly prepared steak dinner as just another meal; he knows exactly where to find the dividing line between grim, business-like efficiency and the spot for a bit of relaxing banter; and he's amused at the outsider's notion that submarine life is like living in a telephone booth with 10 or 12 other people and a St. Bernard dog.

Of course, in the newer subs—and especially the SS(N)s—things aren't quite that crowded. But, as one submariner said:

"They'll come up with something that'll take up all that living space."

Even the oldest sub now in commission is practically a floating palace compared to those the real old-timers knew. Here's how VADM C. B. Momsen, USN (Ret.), described those days at the recent commissioning of USS *Barbel* (SS 580):

"IT WAS NEARLY 38 years ago that I volunteered for submarine duty.

"The captain of USS *Maryland* informed me that 'only the scum of the Navy go to submarines.' I soon found out that there was plenty of scum all right, but it was not in the hearts of those stout submariners that I found in New London.

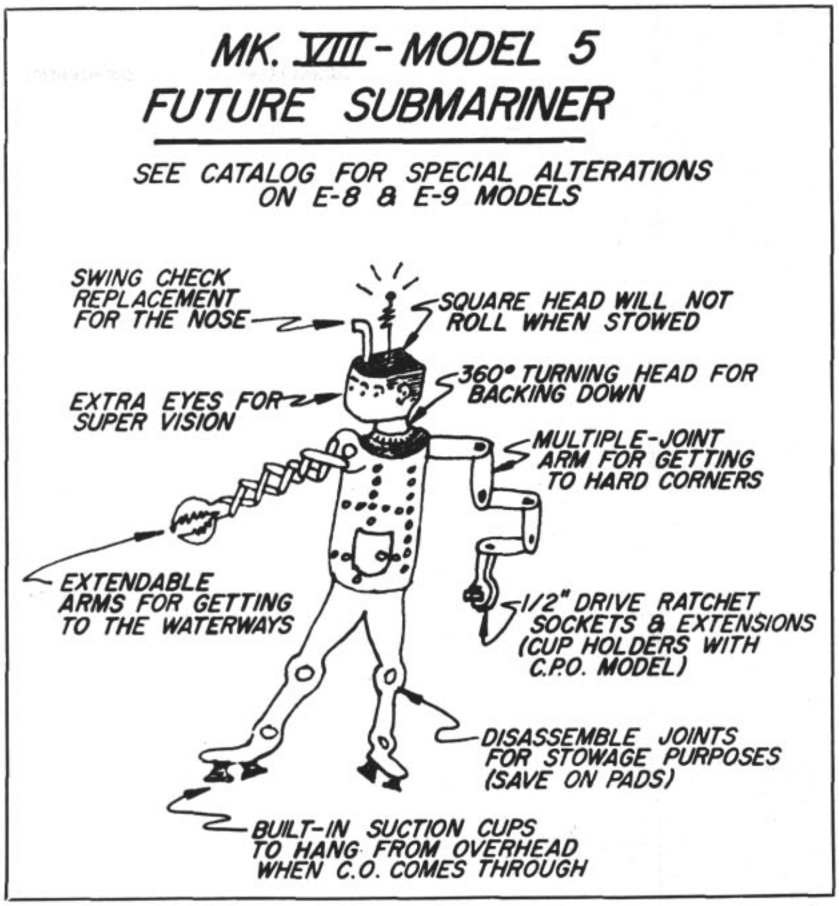
"Words fail me when I try to give a true picture of those early submarines.

"They were slow. They were clammy. They smelled. The engines were rickety. The batteries looked like a Fourth of July sparkler. There was no refrigeration, no bathing facilities, no toilets. Torpedo fire control methods were primitive and navigation facilities were almost nil.

"We submariners started a long hard fight to improve our material. It took seven years to get electric ice boxes . . . It took eight years before we got an angle solver with which to aim torpedoes. It took 14 years to get air-conditioning and 18 years to get a diesel engine that could operate reliably—and 32 years to get a true submarine."

One thing that the modern submariner has in common with the old-timer is esprit de corps. From the time a submariner starts his initial training until his retirement, this rubs off on him.

Despite the fact that the Navy's underwater arm is fairly young, the submariners have a lot of tradition and a fine record—and they make sure the newcomer knows it.



SHADES OF TOMORROW—Crew members of *USS Diodon* (SS 349) have this conception of future submariner. Drawing is by David R. Whalen, EN2(SS).

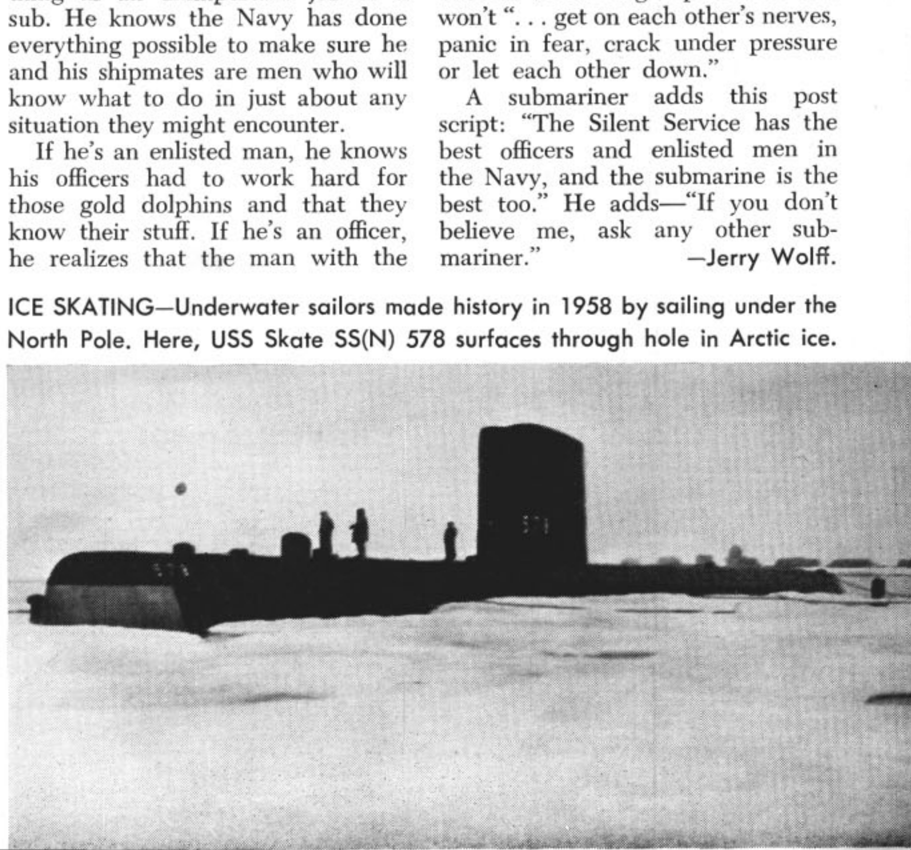
THROUGH TRAINING and life on board his sub, the submariner comes to realize that there's no such thing as an unimportant job in a sub. He knows the Navy has done everything possible to make sure he and his shipmates are men who will know what to do in just about any situation they might encounter.

If he's an enlisted man, he knows his officers had to work hard for those gold dolphins and that they know their stuff. If he's an officer, he realizes that the man with the silver dolphins is someone he can count on to do a good job.

In other words, the subman has become one of a group of men that won't ". . . get on each other's nerves, panic in fear, crack under pressure or let each other down."

A submariner adds this post script: "The Silent Service has the best officers and enlisted men in the Navy, and the submarine is the best too." He adds—"If you don't believe me, ask any other submariner." —Jerry Wolff.

ICE SKATING—Underwater sailors made history in 1958 by sailing under the North Pole. Here, USS Skate SS(N) 578 surfaces through hole in Arctic ice.



WHEN A GUST OF WIND caught the aircraft carrier USS *Franklin D. Roosevelt* (CVA 42), it shoved her seaward from her dockside moorings. The gap that widened between the ship and the pier was just enough to dislodge the after brow and send it toppling into 55 feet of water.

Two men from *FDR*, Ensign Paul Powers and GM2 William Cavanaugh, quietly donned aqualungs and face masks and entered the water. Within 90 minutes the brow was located, lines were secured and cranes had hauled it to the surface. The locators of the elusive brow were Scuba divers.

Scuba diving is the art of swimming under water with the aid of a breathing device. The letters SCUBA stand for Self-Contained Underwater Breathing Appartus. According to undersea explorers, this sport is the most.

The popularity of sport diving continues to grow in almost all parts of the United States and the world. Although many sport divers confine themselves to "skin diving" (without breathing apparatus), additional thousands have acquired self-contained gear and are able to make dives which only professional divers could even consider a few years ago. The Navy's interest is not concerned with the sporting aspect of Scuba diving. It is interested in the mobility factor in that a man can get into this gear, inspect the bottom of a ship and be out of the water faster than a deep sea diver can get into his outfit to do the same job.

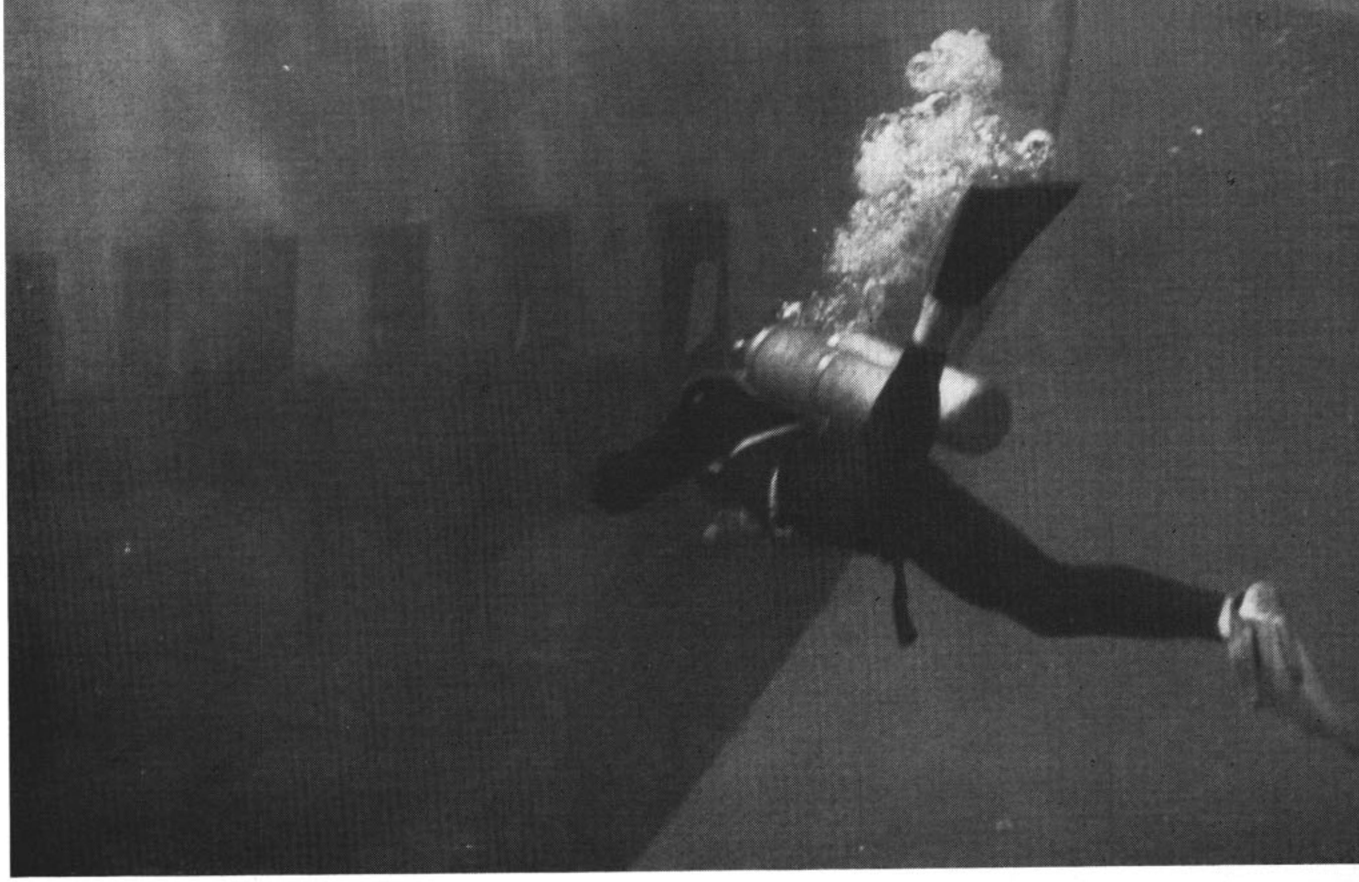
THE NAVY TEACHES initial Scuba diving at the Underwater Swimmers School in Key West, Fla. The course is five weeks long, based on a minimum of 30 instructional hours a week. The training includes diving physics, the primary and secondary effects of pressure on the body, accident prevention, safety precautions and first aid. Instruction is provided in the characteristics, maintenance and use of open-circuit, closed-circuit, and semi-closed circuit types of Scuba. Sufficient Scuba diving experience is provided to enable the student to perform safely underwater while going down to a depth of 100 feet or swimming underwater to distances of 1000 yards.

The five-week Scuba diving course is open to officers and warrant officers who are under 40. The age limit for enlisted is 31 and they may be of any rating or pay grade, but should be ratings closely allied to EOD, UDT, or deep sea diving allowance structures. All must be male and volunteers. They must meet the physical and psychological standards outlined in Art. 15-30 of the *BuMed Manual;* must be at least second class swimmers; and must comply with BuPers Inst. 1500.15.

Officer quotas are controlled by BuPers and requests should be submitted to the Chief of Naval Per-

USN Frogmen &

SPLASHY—Frogmen 'drop off' to check harbor in Korea. *Left:* UDT sets blast.



Underseas Disposaleers

sonnel (Pers-B11) via the chain of command. Enlisted quotas for Fleet activities are obtained from COMSERVLANT or Commanding Officer, EPDOPAC; for shore activities, from the Chief of Naval Personnel.

The equipment used in the Scuba training is the open-circuit air demand type. The Aqua-Lung, Scott Hydro-Pak, and Northill Air Lung are used.

THE TERM "SELF-CONTAINED" indicates that the diver carries his breathing medium with him in cylinders and needn't have the worries of becoming entangled with hose connections to the surface. The three types of self-contained apparatus listed above are in present use. Each type of Scuba may include more than one make or model of unit, but the basic principles and characteristics are essentially the same for all units within the type.

• ***Open-circuit Scuba*** is the simplest type and the one most frequently used. The diver has, strapped to his back, cylinders of medium weight which are normally charged with compressed air. A special type of regulator supplies air on demand when he inhales. No rebreathing takes place. The fact that air flows only in response to inhalation requirements helps conserve the supply. Depth limitations and air bottle capacities are the principal drawbacks of open-circuit gear.

• ***Closed-circuit*** units employ pure oxygen as the breathing medium. The diver breathes this gas to and from a rebreathing bag through a canister which contains a carbon dioxide absorbent. No gas is normally exhausted to the surrounding water. Since the body consumes only a small amount of oxygen compared to the total volume of breathing, a relatively small gas supply suffices. Closed-circuit Scuba also has the advantage of freedom from bubbles and noise, important in some tactical applications. The main drawback is the severe safety limitations imposed by the possibility of oxygen poisoning.

• ***Semi-closed-circuit*** Scuba was developed to permit conservation of gas by rebreathing without the necessity of using pure oxygen. The apparatus is along the same lines as closed-circuit Scuba, but a continuous flow of a gas mixture is provided to assure that the oxygen level remains constant. The diver rebreathes the major portion of the gas, but a certain amount is continually exhausted from the system. Much greater durations can be achieved than with open-circuit Scuba, without the danger of oxygen poisoning associated with closed-circuit Scuba. Generally, mixtures of nitrogen and oxygen are used. This can sometimes provide an added advantage by shortening the decompression time required.

ACTIVITIES OTHER THAN the school in Florida have been authorized to conduct limited Scuba training on a "not to interfere" basis. These include: Underwater Demolition Units One and Two, Explosive Ordnance Disposal Units One and Two, U. S. Navy Mine Defense Laboratory; U. S. Naval Submarine Base, New London, Conn.; U. S. Naval Submarine Base, Pearl Harbor; U. S. Naval School, Deep Sea Divers, Washington, D. C., and U. S. Naval School, Explosive Ordnance Disposal, Indian Head, Md.

Ships that have allowances for Scuba and swim suits are AN, ARS, ARSD, ASR, AD, AS, AR, ARG, AV, AM, AMS, AVP, and all types of CVs.

Since the Underwater Swimmer School was commissioned in 1954 it has graduated 200 students a year in the art of Scuba diving. Some end their schooling at this point and return to their ships or stations with increased skills. All are encouraged to enter training for Underwater Demolition Units (UDU) and become frogmen, or join Explosive Ordnance Disposal (EOD) units and become disposal technicians, or specialize within the deep sea diving programs.

Explosive Ordnance Disposal

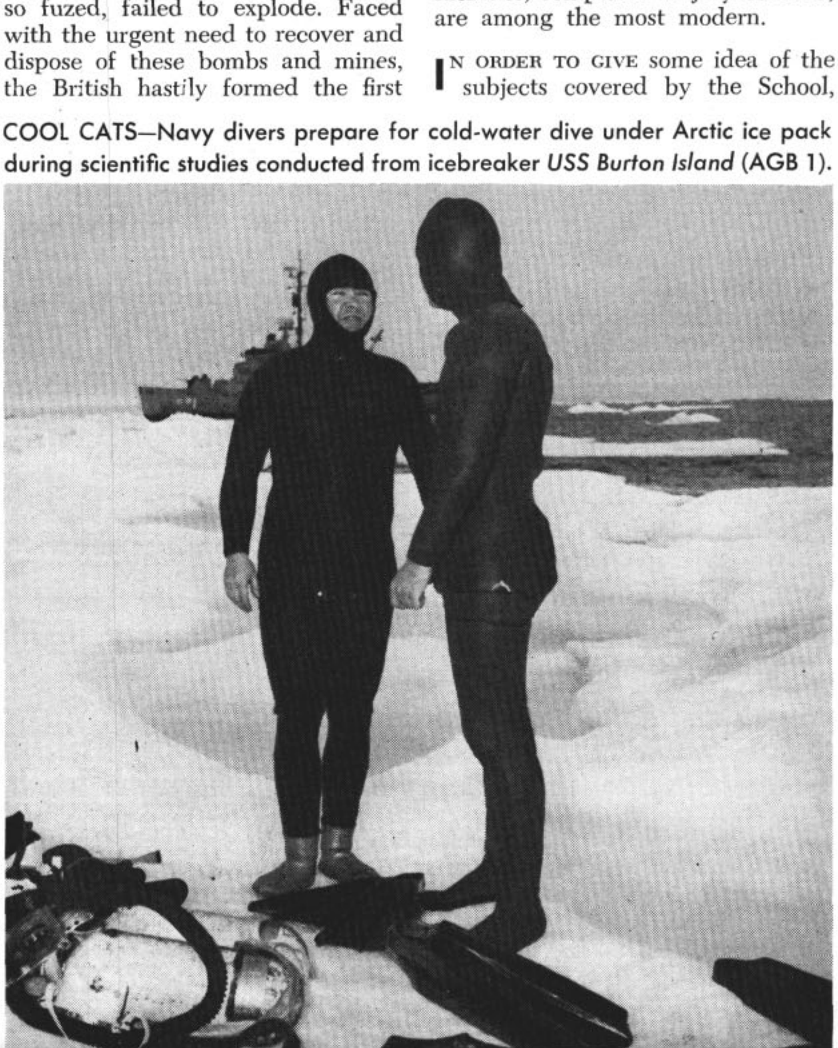
THE NAVY'S Explosive Ordnance Disposal School at Indian Head, Md., is an outgrowth of the bitter experience of the British at the beginning of World War II, when the Germans, with their huge airpower, began a demoralizing campaign against the British Isles. Many tons of complex mines and bombs were purposely fused to detonate from one to 80 hours after the drop. About five per cent of those not so fuzed, failed to explode. Faced with the urgent need to recover and dispose of these bombs and mines, the British hastily formed the first bomb and Mine Disposal Squads.

American naval officers, attaches in London during the blitz, recognized the pressing need for a similar program in this country. Upon their return they established the Mine Disposal School at the Naval Gun Factory in May of 1941. A Bomb Disposal School, established in December 1941, was next on the agenda. This was moved to the campus of American University in Washington, D. C., in the Fall of 1943. Graduates of these schools ranged over most of the globe, providing detailed information on enemy ordnance and on clearing channels, harbors and captured air fields of mines, dud bombs, and booby traps. In November 1945, the two schools were combined and established at the U. S. Naval Powder Factory, Indian Head, Md.

In 1947, responsibility for EOD training for all services was given to the Navy, and officers and enlisted personnel of all services were added to the staff. Today the U. S. Naval School, Explosive Ordnance Disposal, is located on the grounds of the renamed Naval Propellant Plant at Indian Head, Md. Its new facilities, completed in July of 1958, are among the most modern.

IN ORDER TO GIVE some idea of the subjects covered by the School, let's trace a typical Navy section during its seven-and-a-half month course. The courses taken by the other services are identical, except that the naval EOD trainees are required to study underwater ordnance and diving. As a prerequisite they must be graduates of Scuba training at the Underwater Swimmers School, Key West, Fla.

COOL CATS—Navy divers prepare for cold-water dive under Arctic ice pack during scientific studies conducted from icebreaker *USS Burton Island* (AGB 1).



The first phase of instruction is in the use of conventional diving equipment. This leads to qualification of the trainee as a diver second class. Since the warm, crystal clear waters of Key West are a far cry from conditions which exist in most harbors, diving training is conducted in the muddy Potomac, where visibility is strongly similar to that found on the inside of a cow. Here the student is taught to work without seeing, by the sense of touch alone, while wearing clumsy three-fingered gloves.

After completion of six-week diving phase, there is instruction in certain "basics" which apply to ordnance. This covers the various principles that are used to arm and fire electrical, mechanical and chemical ordnance and many explosive fillers used by other countries. Information is picked up on chemical and bacteriological fillers and the best methods for rendering them harmless.

Next comes practical training at the demolition firing area of Stump Neck Annex, Naval Propellant Plant. Here the student is given a thorough course in demolition with special emphasis placed on safety precautions. This is followed by a course in EOD tools and methods. Then he goes to a study of the three categories of underwater ordnance: influence mines, contact mines, and torpedoes.

After this, he is required to prove his disposal ability on actual items of ordnance. If the problem is handled improperly, harmless but noisy charges are detonated at a safe distance from the student to let him know that something went wrong.

Upon successful completion of this phase, the trainee combines his diving and underwater ordnance skills and spends the next few days working on mines at the bottom of the Potomac, rendering them safe, floating them, bringing them ashore, and completely stripping them.

AT THIS POINT, he has completed the strictly "Navy" portion of the course. But training doesn't stop. The remainder of the course is the same for all the other services.

His next step is a study of various-type ordnance which includes land mines and booby traps, projectiles of all sizes and shapes such as rockets, and grenades. The diversity and complexity is almost beyond belief. A single subject of the several taught under surface-type ordnance covers everything from Civil War cannonballs to the latest artillery projectile of all the services, in addition to all similar ordnance of foreign nations.

The EOD student next studies "dropped" munitions. Bombs and pyrotechnics of all types as well as their fuzing are taught here. These include the familiar mechanical fuze, and fuzes that operate on almost every source of power that can be crammed into the small space available. Proximity fuzes are also taught. This course is again complemented by practical work at Stump Neck, followed by the study of guided missiles. All U.S. and many foreign missiles are taught together with their intricate fuzing, and their maze-like propulsion systems.

Then the trainee is introduced to a field which is not generally associated with ordance. This has to do with explosive hazards found in aircraft, such as ejection seats and explosive bomb releases. To provide practical training in this subject, the school has acquired a complete jet fighter. Following the study of explosive hazards and safe methods comes the study of photography, and how to recover buried ordnance. This is officially designated "Access and Recovery" and nicknamed "Riggin' and Diggin'."

The next step requires actual surface EOD work, and the student is sent to Eglin AFB in Florida where he works on live ordnance under field conditions. The bombs are dropped specifically for the students by the Air Force. This is actual EOD work with standard ordnance performed under the close supervision of instructors TAD from the school, who are responsible for practical demolition training.

UPON RETURN from his surface stint, the student goes to the Special Weapons building. Here he is given an intensive course in the intricate procedures for rendering dangerous nuclear weapons safe.

CLEARING THE WAY—Navy frogmen prepare to blow obstacles from beach to make way for an amphibious landing of troops during training exercises.

At the end of 31 weeks, the course is completed. The new EOD personnel are sent by their various services to field positions. Since frequent refresher courses are required, they will return, sooner or later, to the school for the latest EOD information available.

Students must all be volunteers, whatever their service. Standards are high. Trainees may be dropped for "inaptitude" for EOD work because of lack of mechanical ability or nervousness in handling explosives.

Here the most damning comment an instructor can make concerning a student's suitability for EOD work is, "I would not care to work with this man in the field."

Graduates of the EOD School are spread throughout the services. Naval personnel are sent to minesweepers, carriers, ammunition depots, harbor defense units, and to the two EOD units maintained by the Navy in Charleston, S.C., and Pearl Harbor, T.H. Marines are responsible for their own bases.

The Navy's responsibility covers not only its own bases but also any ordnance below the low-tide line.

When the course is completed, all officers and enlisted men, Regular and Reserve on active duty, are eligible to go to the six-week Special Weapons Disposal course. This covers detailed instruction in the recovery, evaluation and disposal of special weapons.

The Navy EOD course is open to both officer and enlisted men, and runs for 25 weeks. All requests for quotas for Navy Explosive Ordnance Disposal and Special Weapons courses should be directed to the Chief of Naval Personnel. All officers and enlisted petty officers of MN, AO, EM, BM, GM, TM and EN ratings, Regular and Reserve, on active duty, who are volunteers and meet the requirements of BuPers Inst. 1500 series are eligible. A Top Secret clearance is required.

For enlisted personnel, GCT of 55 and Mechanical-Electrical or Mechanical of 50 is required. Those

who are not qualified Scuba divers before enrollment must first attend the Underwater Swimmers School in Key West. Officers must sign an agreement not to resign during the course and to remain on active duty for 18 months after graduation.

UDT personnel assigned the SPC 9954 and who are qualified second class and Scuba divers will be authorized to enroll in the Navy Basic EOD Course at the U.S. Naval Explosive Ordnance Disposal School three weeks after the convening of each class.

Underwater Demolition Teams

ONE OF WORLD WAR II's best-kept secrets was the existence of Navy Underwater Demolition Teams—the famous "frogmen" who etched their page in history all over the world, most effectively, perhaps, in the sign that greeted the first wave of troops at a Pacific island:

Welcome to Guam, U.S. Marines, USO two blocks to the right.
—Underwater Demolition Team Four.

The Navy is responsible in joint operations for the destruction or removal of all man-made or natural obstacles, underwater or to seaward at the high-water mark, that interfere with the beaching of landing craft. To accomplish this, to reconnoiter the beaches, and to obtain information vital to the landing, the Advance Force Commander creates an underwater demolition group. The normal technique is to employ groups of swimmers who place and detonate demolition charges against the obstacles.

During World War II, Hitler boasted that his forces would repel any assault on his "Atlantic Wall" in exactly nine hours. Shoring up that Wall were complex minefields which extended from Norway to Spain. As a preliminary to the Normandy landings in June 1944, the Allies conducted intensive minesweeps.

Into action went the famous UDTs (Underwater Demolition Teams) which had their origin in the amphibious (Tarawa) campaigns of the Pacific. The task of clearing underwater obstacles and mines by demolition charges carried in and planted by swimmers was a Homeric endeavor calling for the utmost in courage and skill.

In their mineclearing exploits, the American UDTs performed some of the greatest feats of the war. Leading the first wave at Utah Beach, they cleared wide passages for the assault forces. At Omaha Beach, fighting through a maze of snares and traps, they were able to slash only a narrow passage. In this action they lost almost half of their forces.

WHY DOES ANY MAN put in for this type of duty?

The answer, "We like it!" comes screaming from the throats of mud-caked UDT men during their third week of training. This period of training is aptly called Hell Week.

From dawn to dusk, dusk to dawn, for 16 weeks they undergo training designed to test human endurance. During that third week there is one day where they meet physical and mental tests that bring them to the near-breaking point. Mud becomes their home and explosions fill the air they breathe.

They climb into small inflatable boats, move out into the surf—the rougher the better—and wait until they are dunked. This tests and sharpens their skills for the time when such a spill could mean disaster. They're well protected. Their uniform consists of dungarees, kapok lifejacket and a baseball hat.

Sometimes the hat is replaced by a steel helmet. This usually happens when they crawl on their stomachs over sand and through half-buried tires. Then, when they least expect it, small demolition charges are exploded which send blossoms of sand into the air and cover them like rain.

In teams, the men lie down on the beach—but not to rest. Teamwork is all-important and one of the tests includes raising a heavy log higher and higher until it seems as though their arms will fall off.

There's a journey through the mud flats. They sit down in this mud, link themselves together and form human "boats."

Then they race other human boats. They work their way through gobs of mud until they become half buried in it. Mud quickly finds a way of plugging up the nostrils and breathing becomes a difficult and sometimes desperate burden.

The day and Hell Week ends with the men miserable, mud-covered and exhausted. That's when they pull themselves up out of the mud and give out with their call. Some 25 per cent fail to get beyond this point.

After graduation from the U.S. Naval Amphibious School, men are assigned to teams for regular duty and are embarked in APDs for training afloat. This period generally is of the nature of an amphibious force operation, conducted under combat conditions. During their first taste of this type of operation, the newly finned frogmen swim alongside veteran team members.

Each UDT is a commissioned unit. It is self-sustaining in that it conducts its own supply, medical, communications and other administrative and operational functions in a manner similar to that of a naval vessel. Essentially, however, it is a combat team, highly trained to carry out specific missions of a pre-assault or assault nature. Thorough training and careful screening have made it possible for men of all ranks to execute the most difficult assignments.

Reconnoitering enemy shores, whether located in frigid polar regions or in shark-infested tropical waters, is the primary mission of the Navy's Underwater Demolition Teams. But whether this phase of their work or any of a half-dozen other hair-raising tasks they perform is more hazardous, would be difficult to decide.

Beach reconnaissance is only one phase of the work performed by UDT personnel. After a beach has been scouted by UDT men, and before the assault landings, these highly skilled swimmers swim back into the beach area lugging heavy packs of TNT and other explosives. Charges are skillfully fastened to both man-made and natural obstacles, with time delay fuzes attached to a main trunk-line. When the charges have been planted, all swimmers except two leave the area and are picked up by speeding boats.

EMERGENCY RATIONS—Navy UDT instructor shows student frogman how two can use one aqualung in an emergency at a training session for divers.

The two fuze-pullers, on a signal, ignite the trunk-line fuzes and swim furiously for the recovery boat. Shortly after they are yanked out of the water the beach erupts with an ear-shattering roar.

After blasting a lane to the beach, the frogmen continue their work of clearing the beach area, improving landing points, blasting waterways through channels, and demolishing objects which may impede the landing operation.

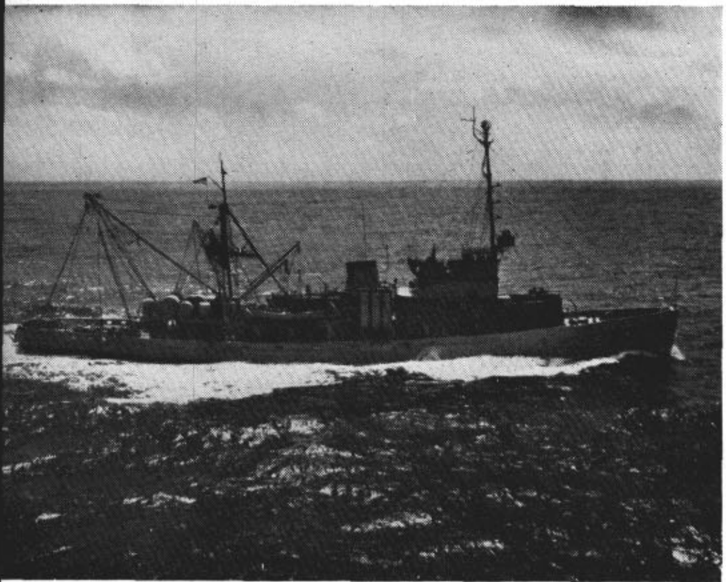
Underwater Demolition Team personnel, both officer and enlisted, are all volunteers. And they must have a specific and valid reason for requesting UDT duty. Individuals who can give only vague, indefinite, or general reasons for volunteering are not wanted. Those who simply desire a change of duty or the incentive pay, or who are chronic mast offenders, "prima donnas," or anti-social, cannot be accepted.

If you think you'd like this type of duty, check over the requirements outlined in Art. C-7406 of the *BuPers Manual*. You'll find you must:

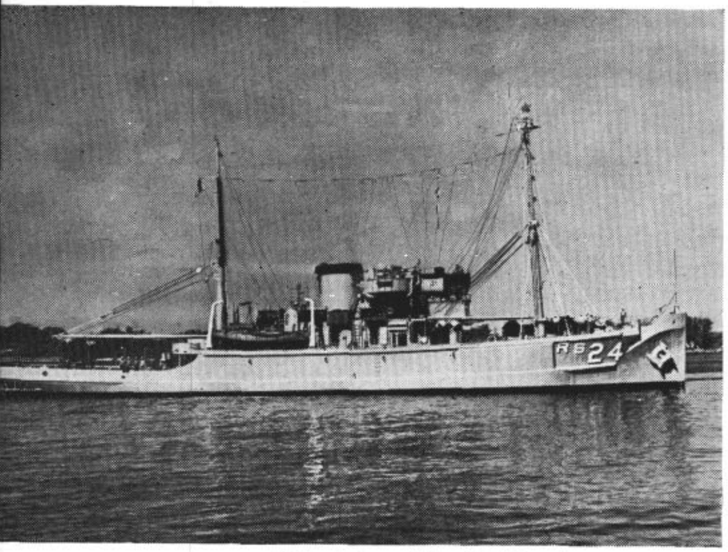
- Be physically qualified in accordance with the *Manual of the Medical Department* requirements.
- Be able to swim easily a distance of 300 yards in less than 15 minutes using at least three distinct strokes, such as crawl, back, side and breast.
- Possess an education of at least two years of high school or the equivalent.
- Be not over 30 years of age at time of assignment.
- Have no fear of the water.

If you are accepted for this type of training, you'll be headed for duty with either the Naval Amphibious Base, Little Creek, Va., or the Naval Amphibious Base, Coronado, Calif. And you'll be seeing some of the interesting sights of the underseas world. —Thomas Wholey, JOC, USN

OFF YOU GO—Frogmen go from water into speeding boat demonstrating slingshot technique of pick-up and return after mission on beach is finished.

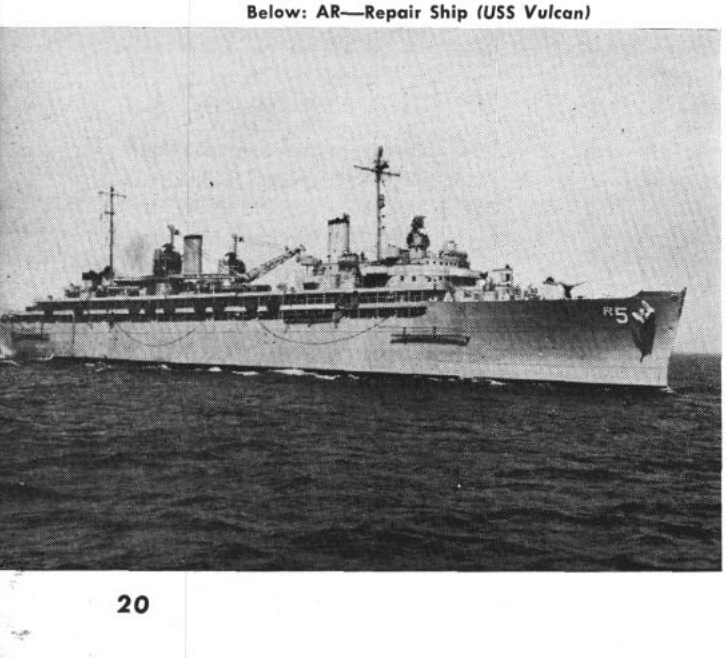


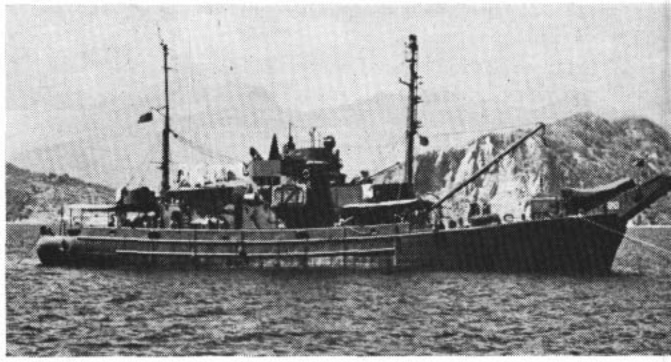
ASR—Submarine Rescue Vessel *(USS Chanticleer)*



ARS—Salvage Ship *(USS Grasp)*

Below: AR—Repair Ship *(USS Vulcan)*





AN—Net Laying Ship *(USS Elder)*

Sure, These Ships

WHEN IT COMES to underwater work—ship salvage, submarine rescue, search and recovery, inspection and repairs—the Navy's Operating Forces are divided into "diving type" and "non-diving type" ships.

The different types of ships pictured here are the Navy's "diving type" ships. There are more than 110 rescue, salvage, repair ships and tenders in commission today. Each of these ships has a specific mission which requires it to conduct deep sea diving or underwater salvage operations.

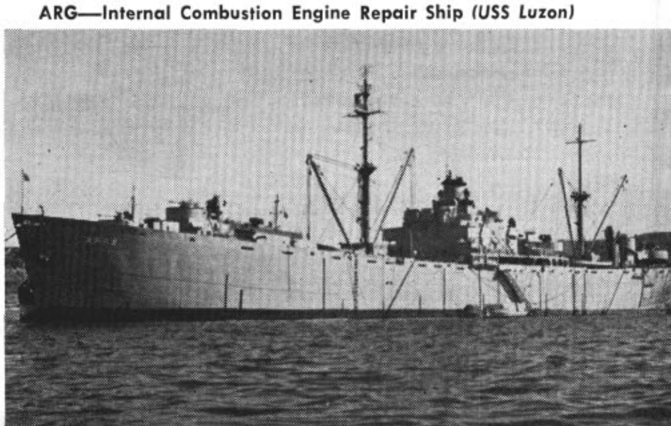
All "diving type" ships have an allowance for qualified diving personnel and carry deep sea, lightweight or Scuba diving equipment aboard.

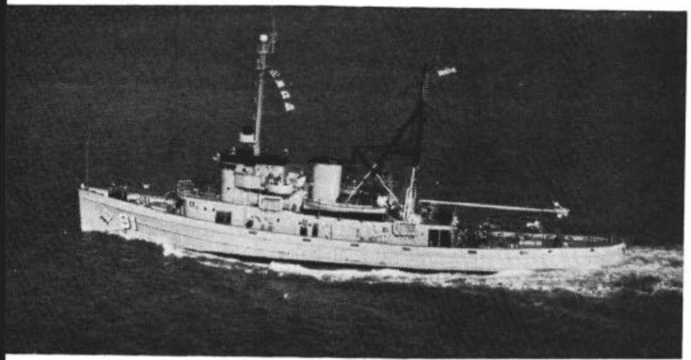
The Navy's "non-diving type" ships are those combatant or auxiliary ships that require the capabilities of shallow-water diving for damage control or investigative purposes. All non-diving type ships have an allowance for one lightweight diving outfit (LWT Special) but do not have an allowance for qualified diving personnel.

Ship Salvage—Raising sunken ships or repairing damaged ones is one of the most important applications of diving in the Navy today. Present-day ship salvage work is a specialized job which can put to use most types of diving equipment and almost every special skill a diver can have. It can require the use of pneumatic tools, use of explosives, underwater cutting and welding, and other techniques as well as the specific know-how of salvage work itself. The underwater phases of ship salvage usually consist of repairing damaged ships, raising sunken ships, refloating grounded ships and clearing harbors.

Submarine Rescue—Each submarine squadron has a submarine rescue ship (ASR) fully equipped, trained and ready to go to the aid of a submarine in distress. Each carries a submarine rescue chamber (see page 29)

ARG—Internal Combustion Engine Repair Ship *(USS Luzon)*





ATF—Fleet Ocean Tug *(USS Seneca)*

Are Diving Types

and is prepared to perform all kinds of diving. ASRs are the only ships in the Navy equipped for helium-oxygen diving. In addition to conducting repeated drills and periodic simulated rescue exercises to maintain a high degree of training and readiness, the ASRs provide many useful services, diving and other, to the Fleet.

Search and Recovery—Practice torpedoes and many other objects must often be located and recovered. All types of underwater search are tedious and time-consuming unless the location is accurately known and the underwater visibility exceptionally good. Even though the use of drags, sonar gear or electromagnetic detection equipment is often more effective in search than diving, a diver usually must verify the contact. Where these methods cannot be used, searching becomes wholly the diver's job. Once the object is located, a diver usually must rig the means of raising it.

Inspection and Repairs—All types of diving equipment can be utilized for inspection and repairs. Diving inspections are usually conducted more easily and efficiently with Scuba equipment because of the diver's mobility. Divers are usually sent down to inspect a ship's bottom for suspected damage, leakage, routine checks of sonar equipment and sea suction troubles. In time of war, divers often are required to inspect a ship's hull for underwater ordnance.

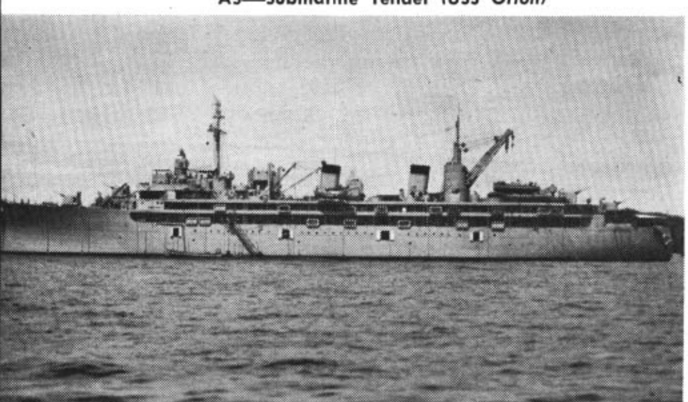
Much repair work on underwater parts of ships or other floating equipment can be accomplished by the use of divers, thus eliminating the expense and loss of time necessary for drydocking.

The pictures on these pages show all the "diving type" ships in the Navy except the ASRD.

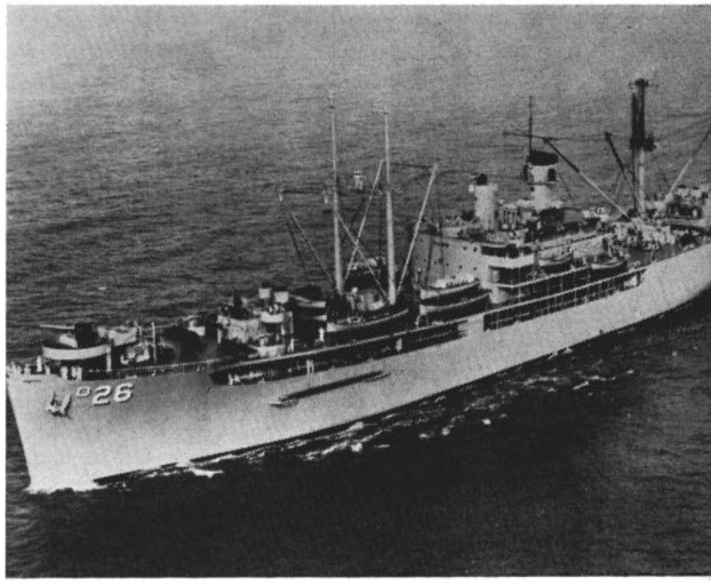
The only other member missing from this group is the divingest one of them all—the submarine—which, incidentally, is in the "non-diving type" category.

—H. George Baker, JOC, USN.

AS—Submarine Tender *(USS Orion)*

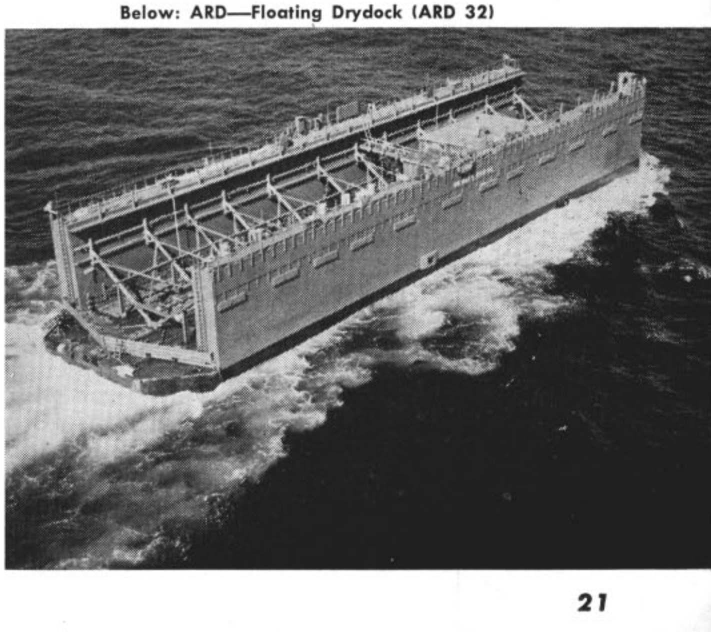


AV—Seaplane Tender *(USS Kenneth Whiting)*



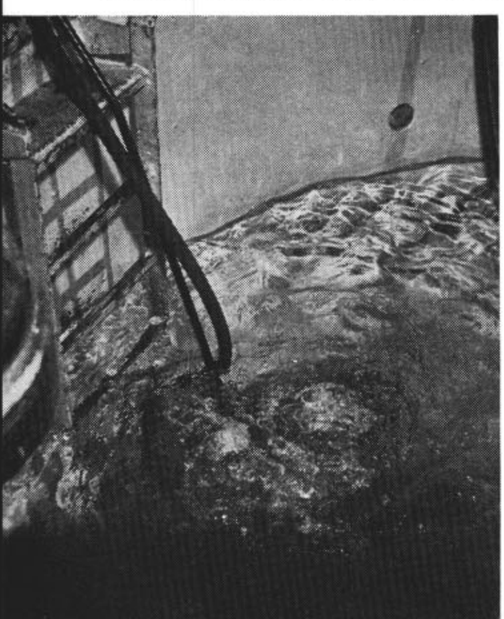
AD—Destroyer Tender *(USS Shenandoah)*

Below: ARD—Floating Drydock (ARD 32)



DRESSERS HELP prepare for dive.

GOING, GOING, GONE into tank.



Do-It-Yourself

When we finished some of the different reports in this issue on the various types of underseas Navymen, we were perplexed. We decided the personal touch was lacking—so we figured one of us might go down and see just what it was like—say, by making a descent in full diving gear.

How did it feel to wear that heavy helmet, the belt of lead, the size-20 shoes? Was all this gear necessary? Why? What was dangerous about diving? Or, was it dangerous? Was it difficult to walk, or to work, underwater? Why was an hour the limit of a dive? How did you breathe? Why were two hoses always attached to the helmet? Or were there two hoses?

We had learned through experience that those thoroughly familiar with their job had, as a rule, difficulty in explaining to a layman just what it was like. It was so routine—to them—that they were inclined to overlook the obvious and interesting parts. If a writer knew his business he would recognize the more significant portions and be able to present them in an interesting—more or less—manner, without resorting to technical jargon.

So our news editor volunteered to tell us what it was like to make a dive. This is his report.

LET'S FIRST set the scene.

When the Diving School was built in its present location back in 1943, the four diving tanks were erected, then the rest of the structure fitted around them. Two are pressure tanks with a maximum working depth of 788 feet, although the deepest any man has descended in them is 561 feet. Connected to each pressure tank is a recompression chamber. (There are also other, similar tanks used by the Experimental Diving Unit, located in the same building.)

The other two School tanks are open, used for more elementary training. They are 10 feet in diameter and some 12 feet high. However, for purposes of instruction, only 10 feet, or some 6000 (more or less) gallons of water are run into them.

The open tanks extend from the first to the second floor. At eye level into the wall of the tank on the ground floor are four sizable portholes so that the instructor and other students can watch what is happening within. At one porthole is a "telephone" (officially, a diving amplifier) which connects to the helmet of the man in the tank. The interior of the tank itself is brightly lighted by four underwater lights.

Above, the top of the tank is flush with the floor and is surrounded by a railing, loaded with gear and hoses, each item in its proper place. Near the opening in the railing is a heavy wooden stool on which the diver sits while getting dressed. There is a ladder leading down to the bottom of the tank and, on the bottom, is a metal framework of a table.

Two dressers help each man prepare for a dive but the role of a dresser is not, by any means, a menial one. He is an experienced diver himself and it is quite possible that, tomorrow, he will be the diver and today's diver will be helping him to dress.

There is also a diver's tender. This man, usually one of the dressers, must see that the diver receives proper care topside and in the water. He maintains contact with the diver by watching his bubbles and tending his lifeline and air hose. He is not, under any circumstances, to be distracted from his duty. He, too, is a qualified diver and this duty is also rotated.

THE SUN WAS SHINING BRIGHTLY and the building was warm, but that made no difference. I had to strip down to my underwear and slip on, first, a suit of diver's underwear, suspiciously similar to extra-heavy-duty sweatshirt and sweat pants. Then a pair of heavy wool socks.

Sweating profusely, I was led to the sturdy wooden stool a pace or so from the ladder which leads to the diving tank. Here, I was introduced by Lieutenant William E. Wise to my dressers J. L. Fuentes, DC1, and F. W. Jackson, BM3, and to James M. Kennedy, FPC, who was to act as my coach.

Fuentes and Jackson had already laid out the gear. First to go on is the suit which, when stretched out flat on the floor, looks as though it were intended for an eight-footer.

Diving

It is made of vulcanized sheet rubber between layers of cotton twill, with about the thickness and flexibility of a new heavy-duty truck inner tube. It has one opening—at the neck. The hands have three slots—one for the thumb and two fingers go in the next. Putting on the suit is routine; much like slipping into a pair of long-johns.

I stood while Fuentes and Jackson laced the back of my legs. Kennedy explained that this is to keep the air out. Without this precaution, I would find myself trying to walk on the horizontal instead of vertically. It didn't make too much sense to me, but I nodded anyway. Might as well go along with the guy. He was supposed to be the expert.

I THEN SAT WHILE a copper breastplate was fitted over the neck of the suit. One kneeling at each side, Fuentes and Jackson guided my feet into the shoes. Mister, those things are big! Designed more for endurance than hiking. The toes are covered with brass caps; the soles are of wood with lead plates riveted to them. Each boot weighs about 18 pounds.

The two of them then grasped the edge of my suit to help me stand so I could force my rubber-shod feet all the way into the boots. Already the outfit was growing a little heavy and unwieldy and, as soon as I put my full weight on one of the shoes, it was like trying to stand on glaze ice. Kennedy advised me to steady myself by hanging onto the shoulders of my still kneeling dressers. After my feet were all the way in, the shoes were laced (with line, not shoelaces), then buckled. Tightly.

Leather straps go around the wrists to hold the hands in place. From here on in, the dressers, assisted by Kennedy, moved fast. Never a wasted movement. The idea here was to get me into the water before I became too exhausted, simply trying to sit or stand up straight with the increasing load of gear on me.

They put a few more gidgets on the breastplate which, so far as I could tell, served as additional washers to help make the joint more waterproof but as I was busy trying to become adjusted to what was going on, wiggling my toes to see if I could and examining my rubber mittens, I wasn't really paying too much attention. Meanwhile, Kennedy was describing the various articles and advising me on their use but I was so busy trying to look nonchalant that I'm afraid I didn't pay much attention. Now that I have to describe the stuff, I wish I had.

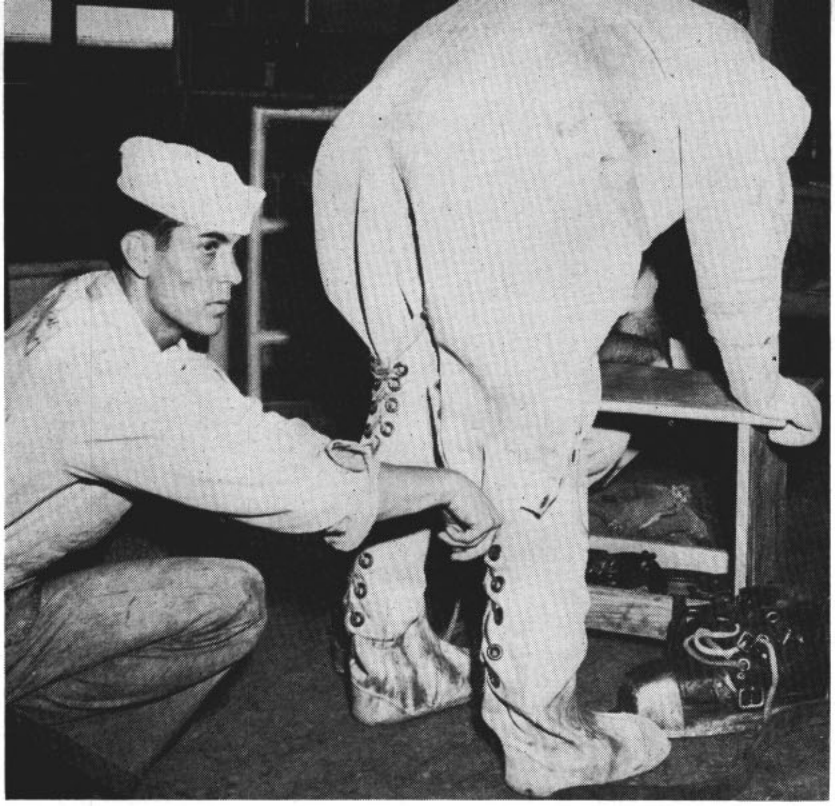
I did pay attention however, when Fuentes and Jackson moved downstage and picked up the belt which, just like every other item of gear, had already been very carefully laid out. I had noticed that fumbling, or wandering about the tank area looking for stray gear while the diver waited, half-dressed, just didn't go. The gear was ready.

EVEN IN TANK'S well lit, clear water, each movement was laborious.

THE BELT WAS A solid little number. It was of heavy leather about five inches wide, tastefully studded with lead billets its entire length, with the ends tapering off into straps and buckles. It weighed about 85 pounds and it was a two-man job to lift it and sling it around my waist.

It was while they were passing the two stout leather straps which ran up from the belt and crossed over the breastplate, that I began to doubt the wisdom of the entire venture. If I wasn't round shouldered before I became involved in this scatterbrained idea, I would be now and for the rest of my life. I had to admit the weight was well distributed but there was a lot to be spread around.

"What am I doing here, anyway?"



BATTEN DOWN—Legs of diver's suit are laced up the back to keep air out. Air in legs would cause diver to take a horizontal instead of vertical position.

I asked myself. "Who could care less what the well-dressed diver will wear? If anyone wants to know, let him find out for himself."

I DIDN'T HAVE TIME to follow this line of reasoning to its logical conclusion because Fuentes and Jackson, who were no longer my friends, were tugging at my collar.

I stood up and Kennedy told me to bend over. He had to tell me twice, because I couldn't believe my ears. Bend over in all this hardware? Ridiculous! I did though, with Kennedy steadying me. (I understand this wasn't cricket. I should have been able to do it by myself.) Jackson passed another strap between my legs to Fuentes, who, in turn, passed it through a buckle on the lower edge of the belt, and pulled it up as tight as he could.

"Does it feel uncomfortable?" asked Kennedy with a touch of compassion.

"Not at all. It's fine." Me, always the good sport.

"Bend over, please."

They tightened it two more notches and only desisted because they were afraid of breaking the belt. I was expendable, but good belts are hard to come by.

"You'll be glad it's snug when you get in the water," explained Kennedy. "If this strap were loose, the buoyancy of the suit and helmet would make them rise until the strap —or suit—stops them. If they rise too much, you might have a blowup because you wouldn't be able to reach your chin button."

Blowup? Chin-button? Oh, well. I'd probably find out about them in due time.

"By the way, try to sit up straight. If you continued to sit slouched over the way you are now, the weight will tire your back."

So what was supposed to get tired if I sat up straight? I had my mouth open to make a remark of this nature when they dropped the helmet over my head. A cozy little item. They started with the faceplate about four points off the port quarter, then both of them leaned on it to give it a good twist forward. Since I had no warning, they took my shoulders along with it.

THEY RESTED from their labors while Kennedy took over. You could see him trying to select words which even a simple-minded child could understand as he tried to explain the function of the various gadgets on the helmet.

"This valve on the right side of your helmet is the exhaust," he said, speaking slowly and distinctly. "It is set at ½ pound pressure and, under normal circumstances, there should be no reason for you to adjust it. You'll notice a small brass plate in the vicinity of your chin on your right. It is also a part of the exhaust valve. It's called a chin button. If you have any reason to exhaust the air in your suit, just give it a bop with your chin, or cheek, or whatever. As long as you hold it down, it will let the air out. Release it, and the air just continues to escape through the exhaust valve."

Mister, who wants to let air *out?* I like air fine. Lots of it.

"You'll notice that the air hose is lashed to the breastplate of your suit on the left side and conveniently located to your left hand is the valve which controls the amount of air admitted to the suit. Turn it away to cut off the air, turn it to if you need more. All clear? I'm going to turn the air on now."

Did they think I was crazy. Why should I cut off my own air? Would I cut my own throat?

THE AIR MADE a reassuring racket when it started coming in. I looked down to check on the location of the lovely little valve that was going to give me more air and discovered that I had a fine view of the inside of the helmet at a range of some two inches. Tipping the helmet forward to get a better view didn't work because, in order to move the helmet, the breastplate had to move. To move the breastplate, I had to move. If I wanted to look at the valve, I was going to wait until I was out of this straightjacket.

I could visualize difficulties ahead. I lifted my left arm to try to find the valve and discovered that it was real work to make any sort of movement. I fumbled blindly a bit and eventually struck an object which, through my glove, felt as though it might be a valve. I gave it a slight turn and very nearly blew my head off.

It certainly *was* the valve and it was also a good thing that the faceplate was still open or I would have, no doubt, found myself floating on the overhead, minus head. Getting enough air was going to be no problem.

Considering the limited field of vision through the faceplate, which was about three inches in diameter, I couldn't help but wonder how fully armored knights, with only slits in their helmets, ever found anyone to fight. And, if their armor was at all comparable to the weight and mobility of my outfit, how were they in any position to do any damage if they did locate their opponent?

Now that they had me utterly helpless, my companions in this venture did not look happy.

"Now all I need is a lance and a sword," I observed. This remark did not make them happier. I noticed LT Wise and Chief Kennedy, who was also going to be my talker, exchange uneasy glances.

LT WISE APPROACHED and looked at me closely through the faceplate. I understand that he had agreed to my making a dive but that was before he had seen me. Now, he was having second thoughts about the entire project.

"Are you sure you want to go through with this?" he asked.

"Sure. Why not?"

"No harm done if you change your mind. After all, you've accomplished your main purpose. You've learned how a diver gets dressed."

"I'll suffer," I replied firmly.

"OK," he said, and shut the faceplate. The rush of air increased to a loud roar which stayed with me until, hours later, they finally opened the faceplate. My two friends leaped at me, spun the lock nut down tight then leaned on it with a wrench, giving my head and shoulders a definite list to port.

"Diver No. 1, how do you read me," came from a small mike within the helmet to my left and above me.

"I read you loud and clear."

"I read *you* loud and clear. Carry on, and good luck."

This message from Chief Kennedy was reassuring. At least I couldn't go far wrong. He would be standing at the porthole watching every move I made. If anything were to happen, he could coach me.

I didn't quite dig the "Diver No. 1" routine until I had plenty of time for thought at the bottom of the tank. (At first, I thought he had me confused with someone else who was a Diver, First Class, but that didn't make sense. I finally figured it out that sometimes there were more than one diver on a job. Then they would be Diver No. 1 and Diver No. 2. Since there was only one diver on this project, I could only be Diver No. 1.)

AT THIS POINT one of the dressers gave me a sharp rap on my helmet. No one had bothered to tell me that I was supposed to do next, but it was obvious something was expected of me. Both dressers were tugging at my armpits trying to make me rise, so I decided to go along with them.

Like the old, old, man that I felt, I shuffled the two or three steps to the edge of the tank. The dressers turned me around so that I faced outboard, placed my hands on the ladder—which I couldn't see—and pushed down on my shouldders.

I'm not the type of person who goes charging madly into a situation where I can't see where I'm going—especially in water, which I don't trust anyway, and more especially when I'm so clumsy it takes two strong men to hold me upright. I like to know where I'm putting my feet.

Not this time. I had as little chance of seeing where I put my feet as I did of finding the air valve and for the same reason. With the delicate little ballet slippers I was wearing I'd be lucky to find the bottom of the tank, much less the rungs of the ladder as I descended.

I still don't know how others do it, but in the half-dozen steps it took me to submerge, I learned to kick the wall of the tank, then push my foot down until it wouldn't go any further. Then I would take the other foot off its rung and repeat the process.

I couldn't feel the water when I entered it, but I knew I was getting there because my legs and thighs felt as though they were in a clamp. Now that it had happened to me, I recalled that Kennedy had warned me of it. Nothing to worry about, he said. Perfectly normal.

With my helmet level with the surface of the water, I stopped to think things over. By tipping my head back I could see through the top eyeport the spectators above me.

"What am I doing here?" I asked myself. "How did I get into this mess? Do I want to go through with it?"

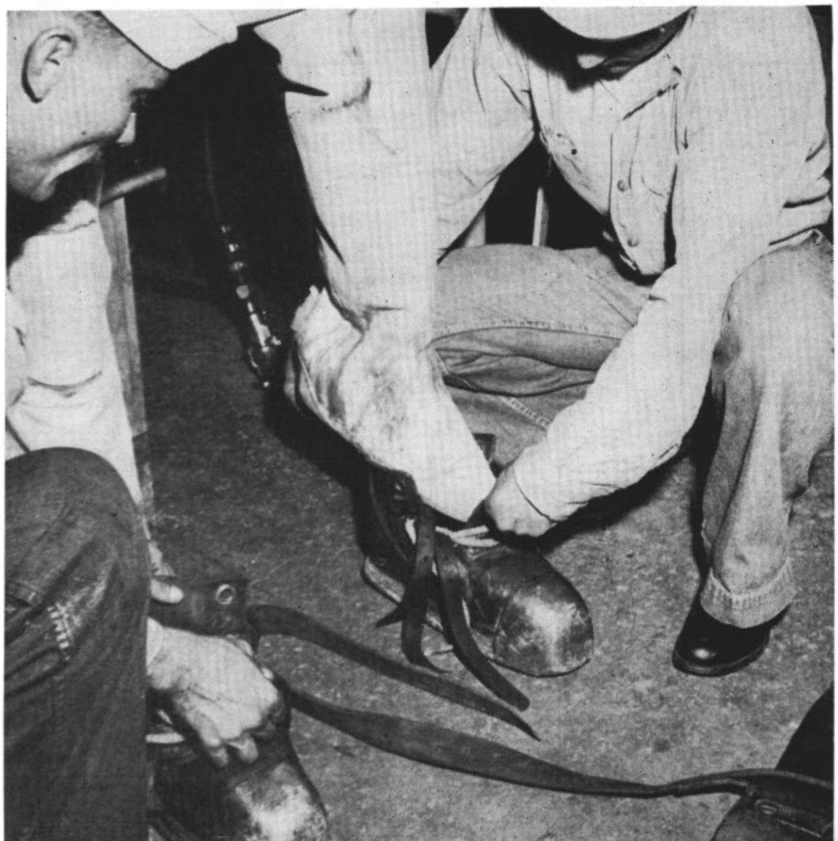
I didn't, but it would be easier to go than explain why I didn't. So I took the next step.

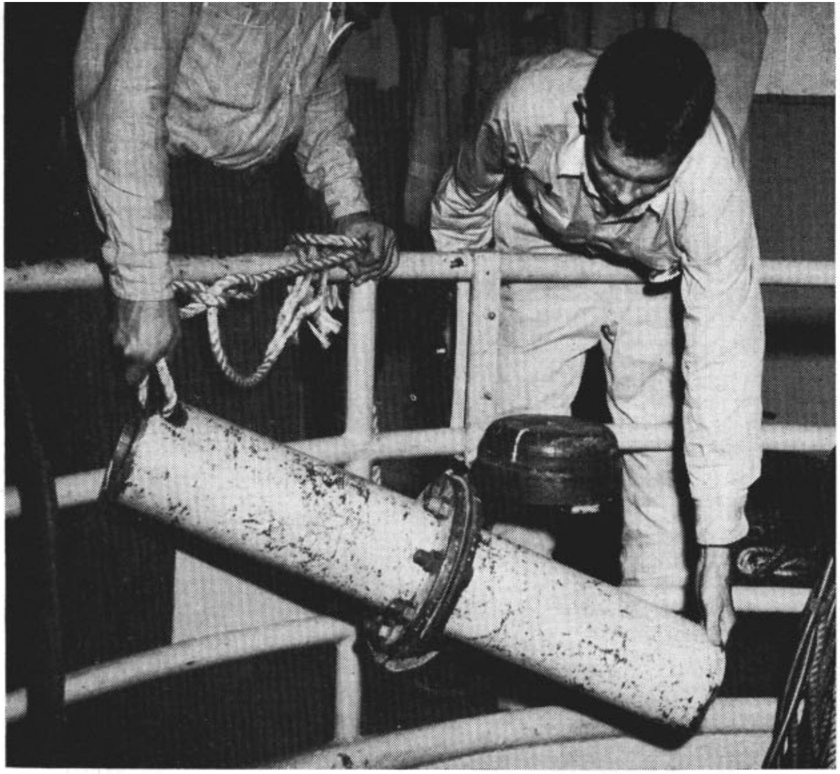
If the rush of air was strong before, it was now a torrent. I kept on going down until my feet wouldn't go any further. As soon as I let go of the ladder, I found I couldn't stay on the bottom. I started to float upward.

"This is ridiculous. It's impossible," and then with superb logic, I told myself: "There must be something wrong."

KENNEDY was saying something into the mike but there was so much noise in the helmet, I couldn't hear a word he said. Besides, I was

SHOE ENOUGH—Diver's shoes are big with toes covered with brass caps. They weigh about 18 pounds each laced with line and buckled tightly.





PIPE THIS PROBLEM—Unbolting pipe sections and removing gasket is one of the 'kindergarten' projects used to train divers how to work under water.

busy with problems of my own. It was only at this point that I recalled the gist of Kennedy's coaching concerning the use of the air control valve. With one hand still clutching the ladder, and with my toes and all 350 pounds of me dangling delicately a few inches from the bottom, I fumbled around until I found the valve and ever-so-lightly closed it.

My feet struck bottom with a thud.

Now that his instructions were so vividly brought to my attention, I also recalled that he had told me if I were to let too much air in the suit it would force my arms out to the sides and I couldn't get them down enough to grab that all-important air valve. A fine situation to be in! Then I remembered the chin button and tried hitting it with my cheek. Sure enough, it worked.

I also remembered that, during our earlier tour of the school, LT Wise, when describing various parts of the diving gear, would remark casually, "It took us a couple of men to learn how to do this."

A deep and sincere respect for the men who dived began the moment I hit that chin button and speculated on how many lives it had cost to put it there. This sense of respect was to increase as time went on. It was at this time that I began to wish I had paid more attention to Chief Kennedy's advice, instead of assuming that I could pick it up as I went along.

IT SEEMED RATHER silly just to go down and come right back up again, so I had asked LT Wise to give me one of the more elementary problems worked on by the students.

He obliged by giving me the kindergarten project. On the surface it would appear to be, literally, child's play. It consisted of two pieces of five-inch pipe, each about a foot or 18 inches long. Each had a flange at one end and the flanges were bolted together, with a gasket between the two pieces of pipe.

The problem was simply to take the eight ½-inch bolts out, remove the gasket, send it to the top so the instructor could see that you really had taken the pipe apart, then insert the gasket and bolt the two pieces together again. Finish the job in 10 minutes and you rated a 4.0; 20 minutes, and you were good for a 3.5. How elementary could you get?

My problem was lying at my feet, and beside it was a small canvas bag containing the two wrenches.

Walking was simple but kneeling down was something else again. I had the same difficulty I encountered when I tried to stay on the bottom. However, one learns from experience and it only took me five minutes or so to adjust the air valve enough to permit me to bend over and then kneel beside the pipe on the bottom.

I'm not sure of the reason, but I did discover that each movement was exceedingly laborious and that it required a positive mental effort to make any gross movement. This I found true all the time I was below and it appeared to increase as time went on. I had to tell myself, for example, there's the bag; reach over and get it. Stretch out your arm. Now pull it to you.

As soon as I did so, it disappeared from my range of vision, which meant that I had to reason out that I must either move the hand holding the bag up to my eyes, or move the helmet which, in turn, meant moving all of me.

As soon as I had solved the basic problem of removing the wrenches from the bag, I attacked the pipe. Here again, it wasn't as simple as it sounds. As soon as I managed to get a wrench in either hand, the pipe rolled away from me. It took no time at all to figure out that I had to wedge it up against my knees which were, by the way, already becoming tired from kneeling. At no time did it ever occur to me to simplify the whole thing by putting the pipe up on the table, even though I kept bumping into it. Don't ask me why.

THE NUT STARTED easily enough so that I could run it most of the way with my fingers but I couldn't help but appreciate that it would be a much different story if it had been rusted together for a few years and if I were working in a tight spot with, perhaps, no room to get a wrench on it. With the nut almost off the bolt, I faced another decision.

If I laid the wrenches down, would I be able to pick them up again? Ever try to pick up a penny while you were wearing a pair of mittens? Or even a quarter? If I were working out in the Anacostia River where the advanced work was done, I knew I couldn't lay down the wrenches because I could never find them again in the gooey mud.

This line of reasoning was no good, because I *wasn't* in the river and besides, whoever had earlier worked this problem in the tank must have done something with his wrenches. I dropped the wrenches on the bottom.

I presume I could have done the same with the nut and bolt but somewhere along the line I had grasped the idea that it wouldn't be proper. You were supposed to put them in the bag.

An excellent idea but I couldn't find the bag. It wasn't directly in front of me so it was invisible. It would do no good to pat around with my hand because even if I did find it, I wouldn't feel it. I must have looked pretty silly crawling around on my hands and knees with my head bobbing from side to side, but that was the way it was done.

This time, when I found it, I played smart and slipped the bag over my arm. To put the nut and bolt in it, it was necessary to raise the bag to the level of my eyes, then open the mouth of the bag, then drop them in. After the first one, it occurred to me that it might be wise to run the nut on the bolt so it would be necessary to find only one object in the bag when it came time to put the pipe together—if it ever did.

I also discovered that either Chief Kennedy or LT Wise had cheated for me by not running the nuts on tight enough to require a wrench to start them. A good thing, too.

THE EIGHTH BOLT represented a major triumph. All sense of time had long been lost and, so far as I was concerned, I had spent years kneeling on that floor, with a field of vision of about 18 inches, fighting with those stubborn bolts. Kennedy had fussed at me from time to time but only once could I hear what he said. This time he was asking, "Diver No. 1, are you all right?"

This was at a time when I had been kneeling for a long time and —from his point of view as I happened to be facing directly away from him—quite immobile. He must have thought I had gone to sleep. Somewhat irritably I had replied: "Sure, I'm all right. Why shouldn't I be?"

"I think you had better stand up for a minute," he suggested. "Rest your back."

The slight difference in depth from kneeling to standing meant a change in pressure which meant, again, difficulty in moving my arms. Again, a bang on that lovely chin button solved the problem.

All the rest of the time I was below I could hear Chief Kennedy making an occasional remark, but to me it was simply a bunch of static coming in with the air. If I hadn't been so concerned about taking that pipe apart and putting it together again, I would have figured out that other divers — pardon me, gentlemen, *real* divers—must have encountered this problem and that there was a solution. I might even have figured out the answer. (The answer is embarrassingly simple— turn off the air. You have about seven minutes' supply in your suit. Now you know, if you ever have occasion to make a dive.)

I like to think I'm not normally so stupid, but it was only after I had unbolted the two pieces of pipe that I realized: (1) I couldn't remove the gasket because the rope they had used to drop the pipe was still running through the pipe; and (2) Even if I did get the gasket out, I couldn't send it topside because I had no line for it.

IT BEGAN TO LOOK as though they had never expected me to get the gasket out in the first place. Or perhaps that was the second grade problem.

Just to show that I had, at least, freed the gasket I pulled it out as far as it would go and showed it to LT Wise, who had been nervously watching my sterling performance through a porthole. He nodded acknowledgement but didn't seem terribly impressed.

Now, I was on the home stretch. The first bolt wasn't bad. The second followed, eventually. By this time, I was going slower and slower, and each movement required a positive effort. My thumbs were aching from fighting against the heavy rubber of my gloves. Whatever I had for lunch, hours and hours ago, was beginning not to agree with me.

The first two bolts I had put into adjacent holes. For some inexplicable reason I decided to put the third on the opposite side of the pipe. For a long, long time the pipe and I wrestled with each other before I could convince it to make half a turn, and then lay still.

Then I couldn't get the hole in the gasket to line up. If I could have laid down and cried, I would have done so. I had already rationalized myself into abandoning the whole thing but I was determined to get this last bolt in.

It went, eventually, but not before I had time to pay my respects to the students who had preceded me. I was having trouble here in a brightly lighted, clean tank, with plenty of assistance standing by if I were to need it, working on the simplest manual problem possible.

Visualize, if you can, working in total darkness (as soon as you descend below the surface of the Anacostia, you may as well be blind), cold, lying in several feet of mud (it is probably completely covering you, but you wouldn't know it),

SCHOOL DAZE—Aqueous school room, where each simple movement had to be thought out, and bulky gear made a routine surface job a tough problem.

the current trying to sweep you and your tools and work downstream, on your back attempting to bolt a half-inch steel plate approximately 18 inches in diameter into place after you have inserted a gasket around the opening. When you have finished, it has to be watertight. And then, says LT Wise "You're not necessarily a diver after you finish with the school. But you may have learned enough for you to begin to be one."

Very well, sir. This is not my field.

IT WAS A VERY TIRED individual who finally straightened up. I was groggy enough to be stubborn, and I had recalled that one was supposed to bring the tool bag up with him, so this meant more searching before I found it. It was still on my arm.

Then I remembered that LT Wise had described how, through careful adjustment of the air, it was possible for a diver to hover deliberately just off the bottom. I had done it before, but not on purpose. Very well. I had to try that—and it worked. I also apologized to my dressers for my flip remarks about 86 pounds of lead floating up around my armpits. Whatever they said went, from here on in.

I could also see why the strapping up of the legs made good sense and I could see why it would be inadvisable to try to do a handstand in a diving suit.

I had one more thing to learn. Coming up the ladder underwater was fine. Again, the change in air pressure made the suit a little awkward to handle but I was in no mood for the niceties of the trade. I just wanted to get out of there so I could sit down and rest and, come to think of it, draw a breath of fresh air. Suddenly I was dying of thirst and had been all the while I had been below.

THE MORE I CAME OUT of the water, the heavier the suit grew. So far as I was concerned, it took half an hour for each step. It was a matter of plotting very carefully the mechanics of taking a step upward, of mustering all my strength into the poor, tired leg that was going to do the lifting and then telling that leg to move. Mister, I never worked so hard.

Again, LT Wise had given me good advice which I had ignored.

"Coming up may be a little difficult," he had said. ("A little difficult" indeed!) "But like everything else, there's a sort of trick to it. If you bend your arms so as to keep your body close to the ladder, you'll be putting too much weight on them.

"But don't straighten them all the way or you'll be leaning too far backward. Bend them just a little. Once you start coming up, swing your body from side to side a bit. It will help you make the next step. And, whatever you do, don't stop to rest. If you do, you're whipped. You won't be able to start again."

He should talk! I was stopping to rest at every step, and glad of it.

When my head came up over the rim of the tank, I could see my dressers waiting for me and as soon as my arms were within reach, they latched onto them and tried to help me up. It was a nice gesture but didn't help much. It was my legs that had to do the work and they weren't doing so well.

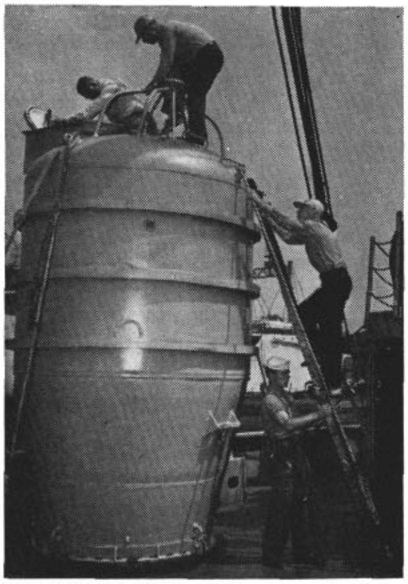
I have an indistinct recollection of Jackson trying to relieve me of my wrench bag but I had one major problem to whip before I dared let go the ladder on his side.

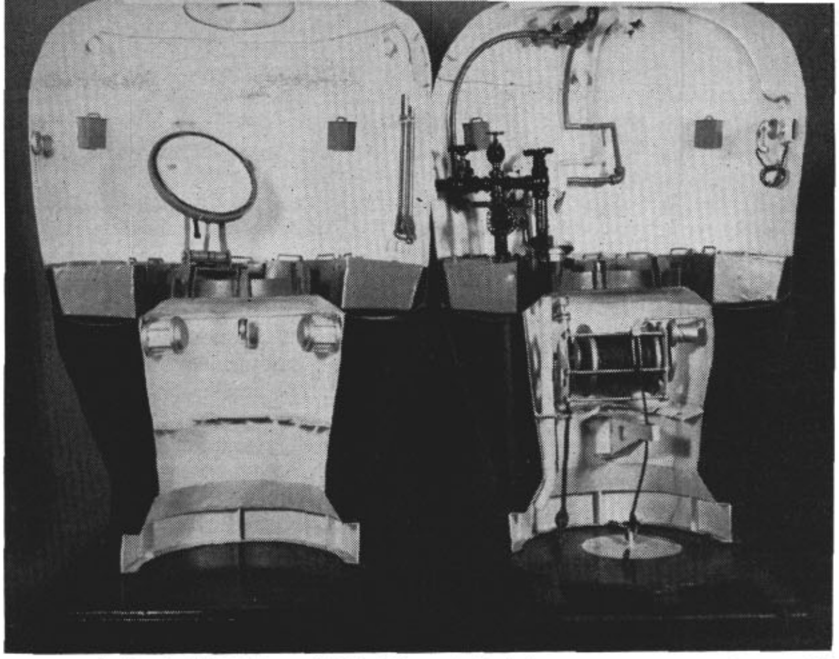
Around the rim of the tank there is a four-inch steel coaming. I can't imagine what purpose it serves, other than to trip tired divers. I could feel it with the end of my boot but I could not, under any circumstances, lift my foot over it. This was the end of the line, and as far as I was going.

Since I'm not still standing at the edge of the tank at the present moment I presume I must have gotten over it somehow. Fuentes and Jackson walked me the long half-mile to the stool, turned me around and indicated that I should sit down but I wasn't taking any chances. I insisted on taking a look for myself to be sure the stool would be there when I sat. It would be just my luck to miss the stool and go sprawling on the floor.

If I did, I would never have gotten up. But, I made it.

DONE—This is routine way divers are assisted from their heavy work clothes.





THIS WAY OUT—Sub rescue bell is shown on deck of *USS Tringa* (ASR 16) and (right) as a cutaway scale model.

Saved by the Bell

STILL THE MOST spectacular submarine rescue on the books, USS *Falcon* (ASR 2) in 1939 was able to save the lives of 33 crewmen of USS *Squalus* (SS 192) from a depth of 40 fathoms (see pages 59-63). The key to the whole operation was the McCann rescue chamber (or diving bell) developed in the 30's. The Navy maintains a fleet of submarine rescue vessels, each equipped with an improved version of the McCann rescue chamber.

The bell-shaped device has two chambers, upper and lower, separated by an air-and-water-tight hatch. The upper compartment is enclosed; its occupants depend on the ASR's compressors for air, while the lower compartment is open to the sea.

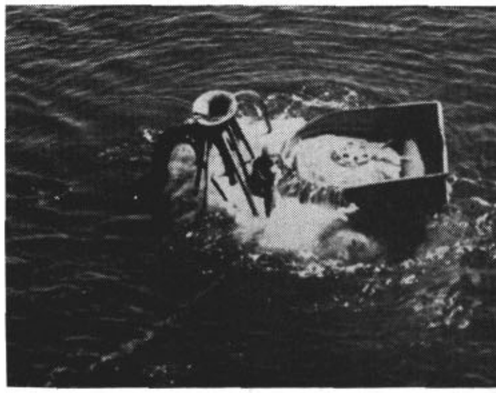
In the lower is an air-powered winch, and along its sides are ballast tanks for taking in and expelling sea water as necessary.

By adjusting valves so that their ballast tanks take in sea water, the chamber's operators regulate the buoyancy of their tear-drop-shaped bell. A cable guides the chamber.

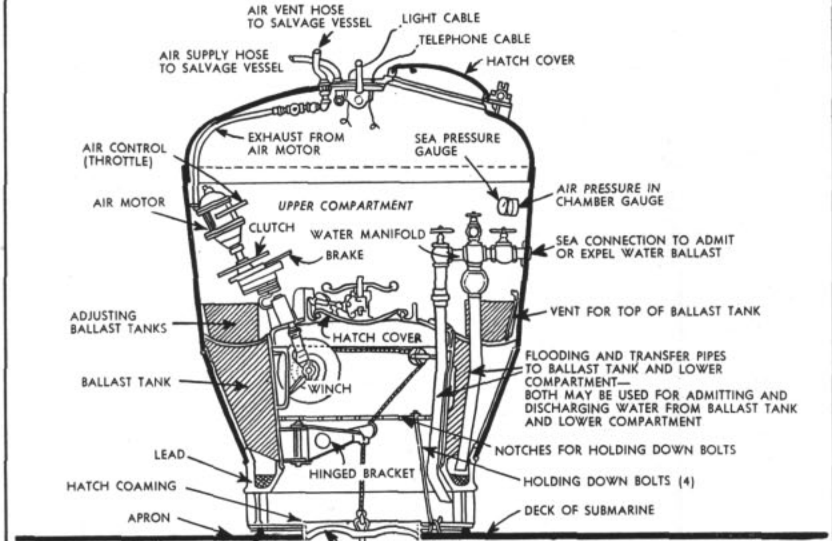
When the chamber rests directly over the sub's escape hatch, the operators flood the ballast tanks to increase its weight and hold it in place. Then, using air pressure, they blow all water from under its skirt and then vent excess air from the lower compartment into the bell. Gravity, plus undersea pressure, keeps it dry and in place.

Now it's up to the humans. One of the bell's operators opens the hatch and drops through into the lower compartment. He clamps and tightens down on four special fittings at the rescue hatch to clamp the bell to the sub.

The rest is simple—relatively. The operator reaches down, opens the submarine hatch, and embarks the men below, seven at a time.



THE WORKS—Artist's drawing *(below)* shows parts of rescue chamber. *Above:* Submarine rescue chamber starts trip to bottom during training exercises.



Meet Navy's Deepest Boat

VISUALIZE if you will, a visit of strange beings from another planet. As the air which we breathe would, they believe, kill them, they are unable to leave their flying saucer. Because of the atmospheric pressure on the face of the earth, their craft can approach the surface no nearer than five or six miles. They are able to determine their distance from the earth only by instruments, for clouds, dirt and moisture prevent them from actually seeing the object of their exploration. Their eyes aren't adapted to air, anyway.

To form *some* idea of what the earth is like, they drop a line overboard and trail it along the ground. It could snag into almost anything and, if it did not become caught on a good-sized rock it might, perhaps, be pulled back into the craft with a branch of a tree and a few leaves stuck to it. Our mysterious beings would examine it carefully and conclude that the area over which they were traveling was capable of supporting some kind of vegetation.

Then they would go on a few miles and repeat the process. This they might just possible snatch from the clothesline of some indignant housewife a few intimate items she had hung out to dry. Or a haystack of some furious farmer might suddenly rise out of sight in the sky. With rare good luck they might—just possibly might—snare a slow-moving animal such as a turtle or, pehaps, a human being.

Then they would go home and write a scientific paper on the flora and fauna of the earth. Or perhaps they would conclude there was none.

In abbreviated and somewhat clownish form, this might serve as an account of the state of our exploration of the underwater world.

However, the Navy and ONR now have a craft, *Trieste,* which can actually reach the bottom of our unknown planet—if the bottom isn't too far away.

Trieste is a bathyscaph (derived from two Greek words "bathy" and "scaph" meaning "deep boat") which is the underwater equivalent of a lighter-than-air craft, much like a blimp operating in reverse. Very briefly described, it consists of a 50-foot hull, 12 feet in diameter, filled with gasoline to make it buoyant, since gasoline is lighter than water. Beneath this hull is suspended a sphere 6.5 feet in diameter which holds two men and scientific gear. It is capable of descending with reasonable safety, some three miles.

It is now operating out of San Diego, Calif., exploring the ocean depths off the Southern California coast.

The 70-ton diving craft, purchased by ONR from the Swiss scientists Auguste and Jacques Piccard, has been made available to the west coast oceanographers to conduct basic scientific research involving acoustical and biological investigations in the San Diego area.

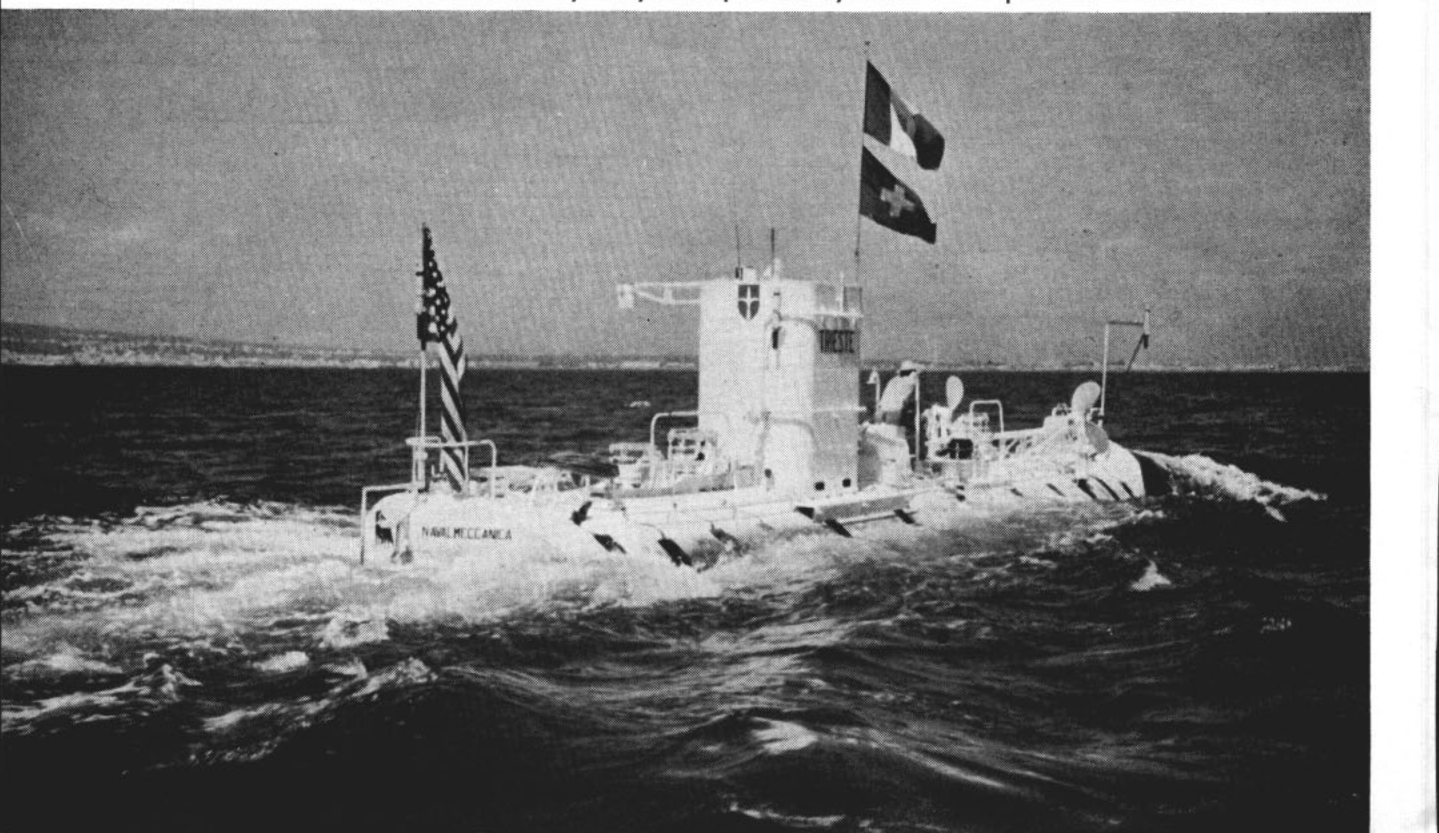
Between June and October of 1956, Navy scientists made a series of 26 dives in the Mediterranean with *Trieste.*

Trieste, constructed with Italian-Swiss collaboration, is the second bathyscaph to be built and designed under the supervision of Professor Piccard. The first, known as FNRS-3, is owned and operated by the French Navy, and has been used off the coast of Japan.

ONR had four good reasons to acquire *Trieste.* It wanted to:

- Investigate the ocean environment at great depths.
- Evaluate the potentialities of the bathyscaph as a research tool.
- Encourage modification and further development of the bathyscaph or similar craft.
- Examine possible naval uses for this type of craft, such as a submarine rescue vessel or a deep-diving submarine and other devices.

LOOK OUT BELOW—*Trieste* **now owned by Navy and operated by ONR will help reveal secrets of ocean's floor.**



Here are the ways NEL (Navy Electronics Labobratory) oceanographers will use it. They will:

- Make direct observations of the ocean bottom, of bottom currents and organisms, and of the deep scattering layer.
- Study sound propagation and light penetration in the deep sea.
- Explore deep-sea canyons, sea mounts and other underwater features.
- Examine the orientation of sediment samplers, current meters, bottom corers and other gear lowered to the ocean floor from ships.

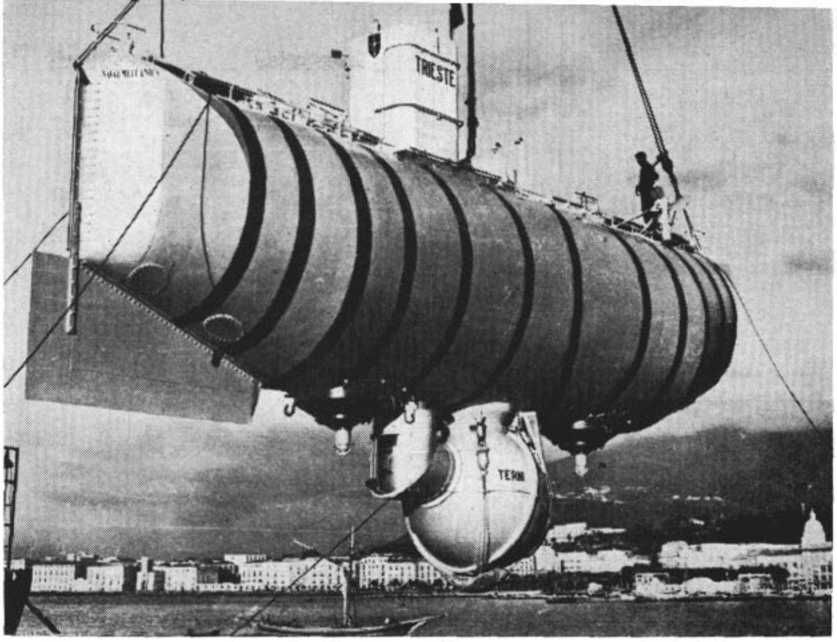
Trieste is not the first of such vessels to be built by Professor Piccard. His experience goes back many years—to the 1930s, when he began work on *Trieste's* prototype, *FRNS-2* (*FRNS-1* was a stratosphere balloon).

Although construction was begun before World War II, it was not completed until 1948. The tests which were made off Dakar with the assistance of the French navy, consisted of an unmanned dive to about 4600 feet and a manned dive to 82 feet. Although the dives themselves were successful, the ship was unseaworthy while at the surface, particularly in heavy seas and while being towed. In 1950, *FRNS-2* was turned over to the French navy. The ship's original flotation hull was replaced with a new one capable of withstanding rough water and long tows. At the same time, she was rechristened *FRNS-3*. About 30 dives have been made with *FRNS-3*, one of them in 1954 to a record depth of some 13,000 feet.

Trieste's cabin has two portholes, one looking forward and slightly down, the other aft and upward. The ports are truncated right-angle cones of six-inch plastic, firmly forced into their metal seats by outside pressure. The two portholes give the observers a 90-degree field of vision.

Communications between *Trieste* and the surface are provided by special-purpose 15-watt battery-powered underwater telephones installed by the Navy's Underwater Sound Laboratory. This allows communication between the bathyscaph and the motor launch which always accompanies it. The telephone unit in *Trieste* is constructed in a rectangular box with a cushion on top and is used as a seat.

As a rule, communications were excellent during a descent, on the bottom, and during the ascent, but at shallower depths, with the horizontal range greater than one-half mile, communications were poor. The telephone picked up sounds of noisy fish during the dives. An unexpected dividend was that the release of the ballast could be heard on the telephone and could be checked. Otherwise, it was necessary to turn on the outside lights and watch the ballast drop from the portholes.



ON THE BALL—Gasoline-filled bathyscaph, now operating out of San Diego, can lower its sphere and Navy scientists to a depth as great as three miles.

Generally, the bottom of the ocean area explored was surfaced with a brownish grey mud and indented with numerous holes. These appeared to be about one-quarter inch in diameter and were assumed to be inhabited by animals. On one dive, a large hole about four inches in diameter was photographed. One group of five holes arranged in the manner of a dog's paw was seen. This appeared to be the same formation noticed by observers in other bathyscaph dives. While no occupants of these holes were discovered on the deep dives, a long worm was seen to disappear into one of the holes on an earlier dive.

Among the fish seen were several which appeared to have bodies covered with white down. They had a large brown eye with a blue semicircle behind it and a tail with a V-notch. This variety was seen to swim vigorously for a short distance, and then lie on their sides on the bottom. They appeared to be undisturbed when the ballast was dropped, sending up a cloud of mud.

Most of the bottom fish that live below the penetration of sunlight showed little concern for the strong artificial illumination of the three mercury vapor lamps that lit up the ocean for the observers, although species of isopods accumulated in the light zone by the hundreds.

The sea was filled with minute suspended particles, looking like snow. However, there seemed to be no indication of a large population of plankton which may be responsible for the deep scattering layer.

At mid-depths, the noise level differed significantly from that at higher and lower depths. It also appeared that this noise came from a horizontal rather than a vertical direction. No one has figured out an answer to this, yet.

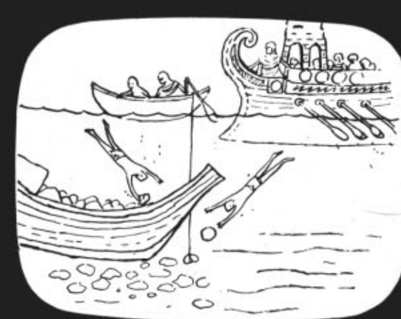
Photographs were taken with a special camera and flash designed and built by the famed Dr. Harold Edgerton. The camera and flash were located about 15 feet from the sphere near the bow where it could photograph objects illuminated by the mercury lamp. The Edgerton camera is capable of taking 800 35-mm exposures at the rate of one every five seconds.

On one dive, the bathyscaph remained submerged for eight hours, making continuous observations. To demonstrate the control possible, Jacques Piccard was able to suspend the bathyscaph 900 feet down from a surface float and maintain equilibrium for three hours.

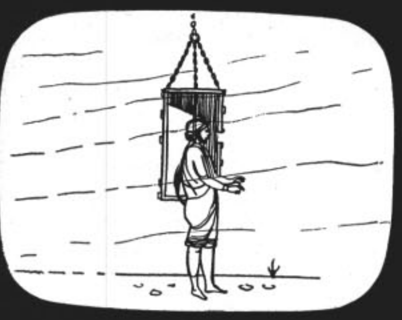
NAVYMEN IN THE UNDERSEAS WORLD

NATURAL INTEREST by ancient man in undersea world was sparked by superstition, mythology and adventure.

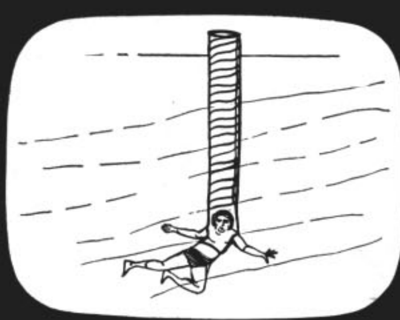
EARLY MAN probed the depths to obtain food, shells and coral, learning techniques still used in sponge-gathering.



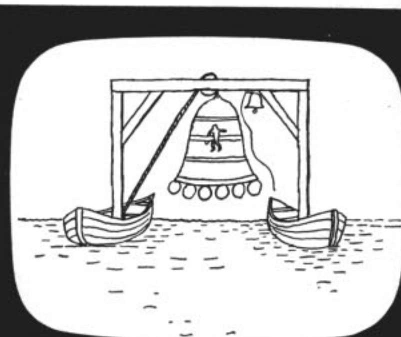
ROMAN NAVY divers foiled enemy plan for blocking harbor with sunken ships. Stones removed, ships refloated.



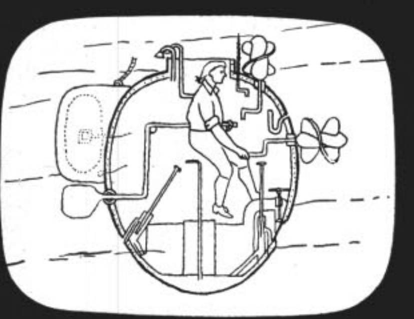
FIRST DIVING BELL on record was successfully used in 1531 for one hour by inventor Lorena to hunt sunken treasure.



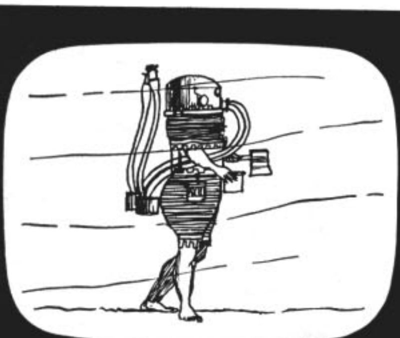
SEVENTEENTH CENTURY theorist Borelli recommended a large breathing tube; seemed logical but did not work.



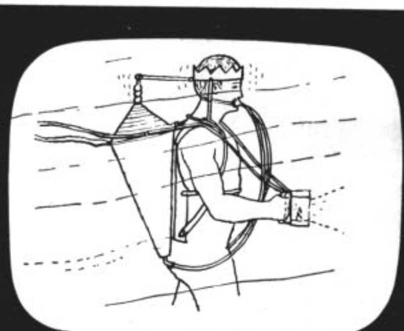
WOOD AND IRON diving bell lowered between boats to recover Spanish treasure in 1677. Dives lasted two hours.



1776 UNDERWATER ATTACK by Bushnell's *Turtle,* attempt to blow up British man-of-war, Revolutionary War.



DIVING SUIT takes modern shape in 1797 in Klingert's metal helmet, belt, leather jacket, trousers (Germany).



1808 "TRITON" was bellows strapped to diver's back, designed to operate by nodding head to and fro to pump air.

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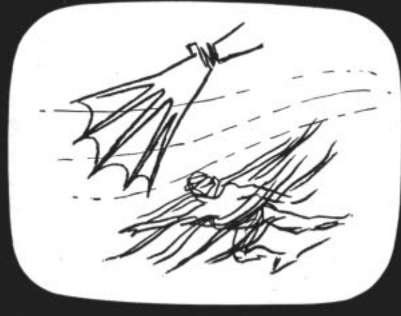
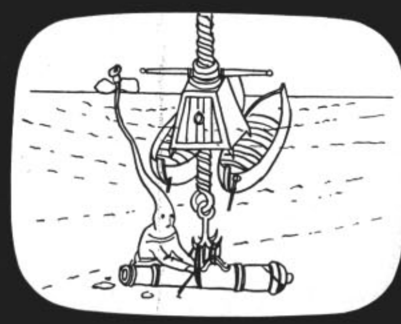
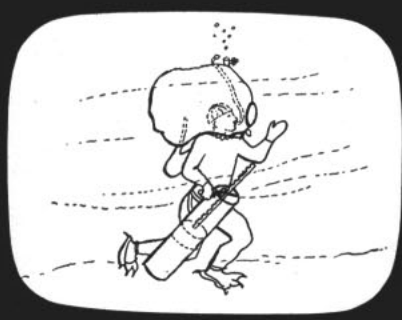


WEBBED GLOVES and frog-like flippers by Leonardo da Vinci for pearl divers showed astonishing foresight.

DA VINCI'S leather underwater mask with rigid hoop reenforcement and breathing tube was along right track.

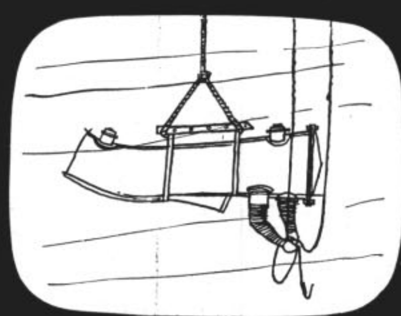


GREASED COWHIDE hood, carefully stitched, with tube floating on surface, was plan of Ufano to salvage cannon.

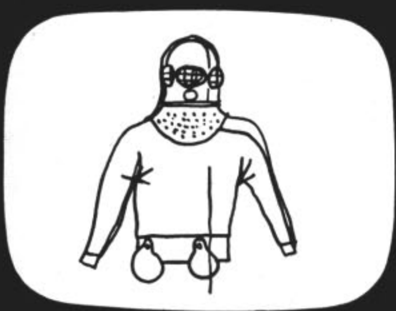


GOATSKIN "AQUALUNG" by Borelli in 1680 had closed circuit breathing system that diver could replenish at will.

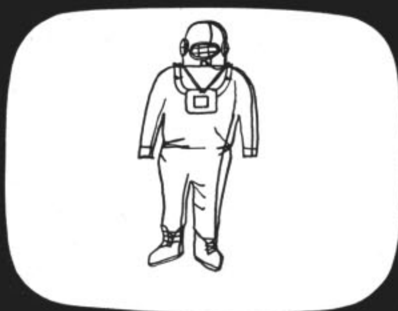
ASTRONOMER HALLEY conducted diving-bell experiments in 1690 leading to solution of breathing problems.



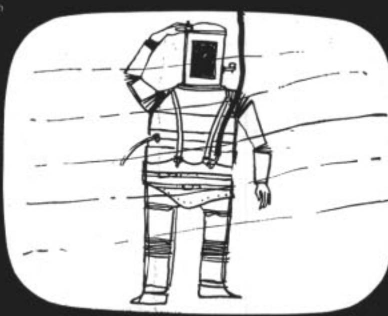
PRESSURE PROTECTION in watertight barrel, 1715 attempt to provide rigid dress and air at atmospheric pressure.



AUGUSTUS SIEBE'S 1819 "open dress" was successful forerunner of modern gear. Pumped air escaped at waist.



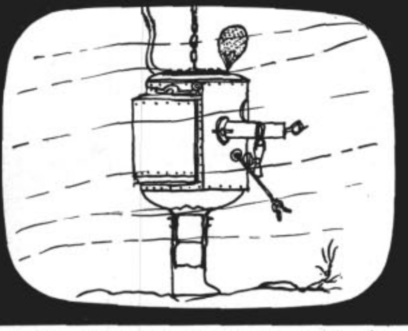
SIEBE'S "CLOSED DRESS" of 1819, waist-length "open dress," developed into the full-length suit used today.



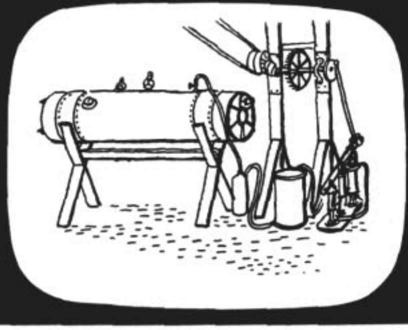
1838 ARMORED ATTEMPT by Taylor to design deep-water diving gear was on right track, had dangerous defects.

continued on next page

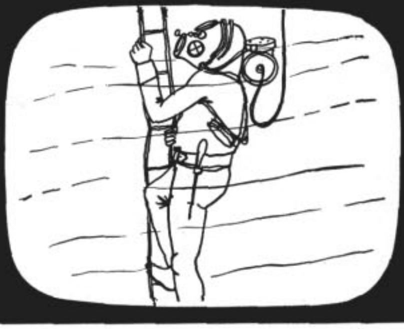
NAVYMEN IN THE UNDERSEAS WORLD continued



1856 ARMORED DRESS by U.S. designer Philips had sound influences on present gear except for "gadgets."



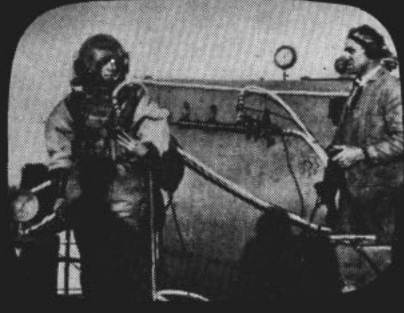
1869 COMPRESSION AND DECOMPRESSION tests by Professor Bert of France led the way to safer diving.



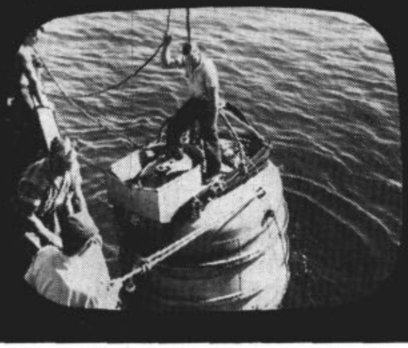
1872 FACE MASK and compressed air apparatus by Rouquayrol-Denayrouze introduced the equalized air pressure.

PERSISTENT CHIEF Gunner's Mate Stillson brought success to Navy with British Haldane safety tables in 1912.

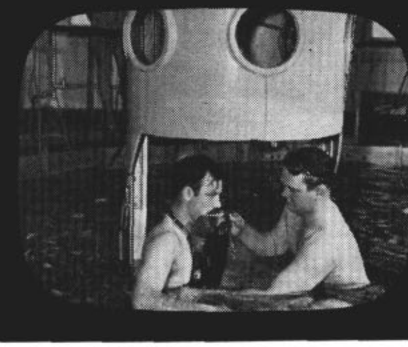
1914 SUBMARINE ESCAPE apparatus used by U.S. Navy was British Siebe-Gorman unit similar to 1819 design.



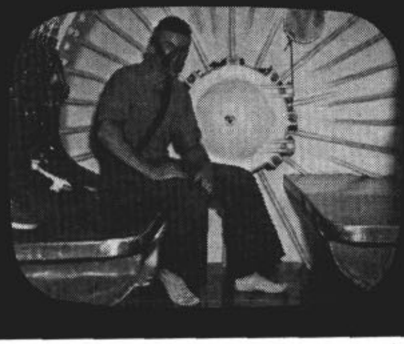
DEEPER DIVES in open sea from *USS Walke* in 1914 went to 274 feet by use of stage method of decompression.



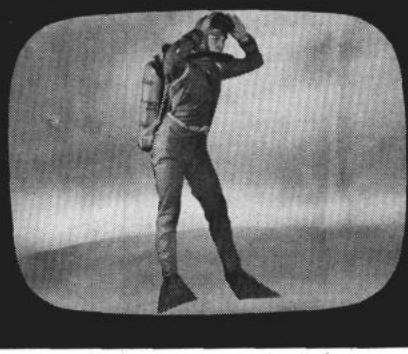
SUBMARINE RESCUE BELL training continues to develop safety techniques that assist in probe of underwater world.



MOMSEN LUNG qualification was a must for all Navy under-the-sea men. Replaced by "blow and go!" method.

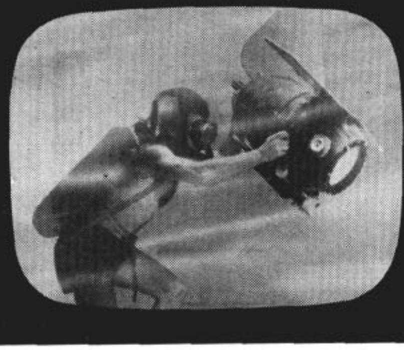


RECOMPRESSION CHAMBER is used not only for emergencies but also to qualify for UDT, EOD and submariners.



SCUBA—Self Contained Underwater Breathing Apparatus—plus rubber suit is gear for cold water longer missions.

COLD-WATER SERVICE dress and face mask, no breathing apparatus, let frogmen handle the short jobs in icy waters.



WARM-WATER TASKS requiring long submergence, as operating Aquaflex-encased movie camera, using Scuba.

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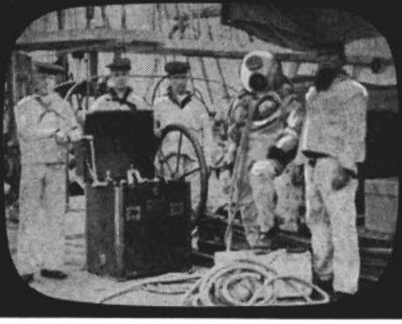
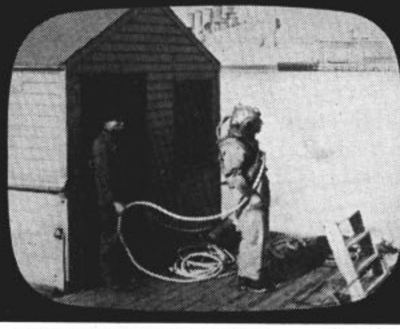
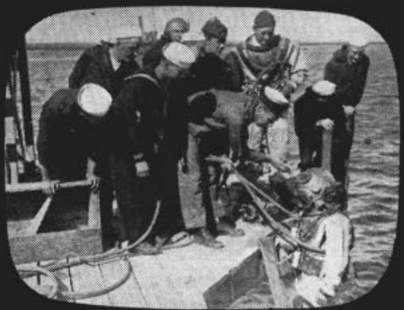


USS HARTFORD had "diving school for enlisted boys" in 1877. A hand pump on the deck supplied the air.

NEWPORT, R.I., 1900. Young officers learned to dive at the Torpedo Station under Master Diver Caleb West.



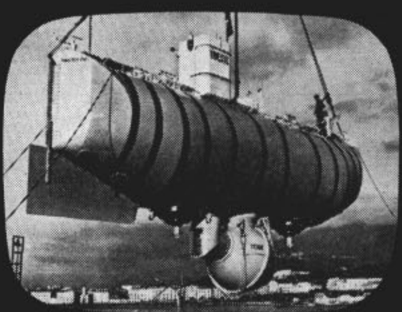
1909 NAVY DEEP DIVES were limited because of the lack of facilities to iron out the decompression problems.



WORLD WAR I U.S. Navy Diving Unit performed invaluable salvage operations off the French Coast.

HEROIC SALVAGE work on sunken subs *S–4* and *S–51* enabled Navy divers to rescue trapped *Squalus* submariners.

WW II AND KOREA FROGMEN went in first for reconnaissance and UDT work and prepare for amphibious attack.

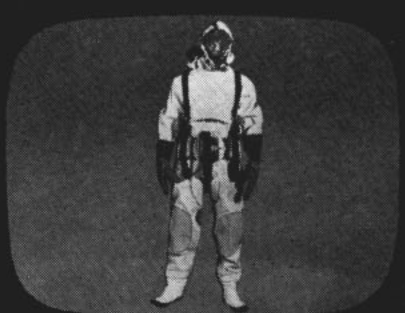


DEEP-WATER RESEARCH continues with ONR bathyscaph *Trieste* designed by Auguste and Jacques Piccard.

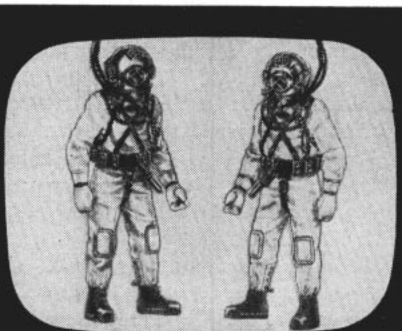
"BLOW AND GO!" is latest recommended method of submarine escape. Inflate jacket, exhale, and up you go!

MINIMUM GEAR in warm-water short-duration dives calls for just mask and flippers. No breathing apparatus used.

WIDE-VISION OXYGEN MASK and weighted belt serve as warm-water shallow-dive gear in emergency repairs.



SHALLOW-WATER lightweight dress for cold-water quick dives for repair, uses wide-vision mask. Ship feeds air.



DEEP-WATER GEAR IN USE today in Fleet has experience-tested safety features. Oxygen-helium suits are similar.

The Momsen Lung: Gone But Not Forgotten

ESCAPE TECHNIQUE

The Momsen Lung was a lifesaver to the Navy in more ways than one. It helped the sea service over a hump when the submarine was going through its early growing pains, after a period that came to be known—so far as subs were concerned—as the "Tragic Twenties."

The Momsen Lung did much to increase morale and help rebuild public confidence in the submarine. A quick look at those times will tell you why. A Navy doctor tells also what is now the approved technique that replaces use of the Momsen Lung.

THE TRAGIC HISTORY of submarine disasters of the 1920s pointed to need of a new kind of safety device. The United States, with its losses of USS *S-5*, *S-48*, *0-5*, *S-51* and *S-4*, was not alone in facing this problem.

In 1921, *K-5* of the British Royal Navy failed to return from a Fleet maneuver. The next year, *H-42* of the Royal Navy surfaced in front of a destroyer and was lost with all hands. In August of that year, the German *U-111* foundered. In 1923, the Japanese submarine *No. 70* sank because of premature opening of hatches. In 1924, *L-24* of the Royal Navy was rammed and sunk by a battleship, and another Japanese submarine was lost in a collision with a cruiser. 1925 saw three disasters: The Italian *Sebastiano Veniero* was sunk in collision; *S-51* rammed and sunk; and the Royal Navy's *M-1* also rammed and sunk. In 1928, Italy and France each lost a submarine and in 1929 two British subs rammed each other.

Each of these disasters meant the loss of many lives—usually of all hands aboard. In many instances, these men could have been saved had some type of escape mechanism been devised.

In response to this need, two developments made their appearance. One of these was the rescue chamber such as that used to rescue the crew of USS *Squalus* (see pages 59-63) attributed to LT A. R. McCann, USN, and the other was the submarine escape apparatus attributed to LT C. B. Momsen, USN. Today, the McCann rescue chamber is still in use aboard each ASR in the U. S. Navy.

Use of the Momsen Lung was discontinued in 1958 in favor of the present buoyant ascent technique. Nevertheless, the submarine escape apparatus (Momsen Lung) played an extremely important role in helping to promote the development of the underseas Navy.

It was essentially a closed cycle rebreathing device. The volume bag was charged with oxygen and as the wearer inhaled, he drew the oxygen through a canister containing a soda lime and then exhaled into the volume bag. The Lung used a mouthpiece with a set of spring-loaded mica disc valves to maintain the flow in one direction in a cycle. To-and-fro breathing was prevented by the valve system. Thus, the gas breathed in was drawn through the soda lime which removed the carbon dioxide exhaled in the preceding breath. The user could breathe in and out of the bag until the oxygen content was reduced to levels too low to sustain mental and physical activity.

IN THE EARLY DAYS of thought on this subject, it was believed that the development of diver's bends would be a problem. At first, a man was taught to slide up the ascending line until he met a knot. Here, he was supposed to stop and take a certain number of deep breaths, then continue. This would provide a rough form of stage decompression. In theory, and in the Escape Training Tanks, which were built a few years later, the idea was a good one. Unfortunately, it didn't work in the open sea.

Divers learned that in escapes from any appreciable depths, where decompression might be important, there were apt to be currents that led out the buoy holding up the ascending line in a long catenary. This meant that the knots on the line did not tell the distance from the surface.

VADM C. B. Momsen, USN (Ret.)

Thus, as men learned more about the sea and how to use the Lung, instruction went through a process of evolution over the years. It was realized, for example, that the bends could be offset by shortening the time under pressure just as well as providing decompression stops on the way up. In time, the emphasis shifted to the principle of simply getting out of the lower depths as quickly as possible.

The Lung also went through several revisions. The long tubes, connecting the mouthpiece to the volume bag in the early models, disappeared. In the later models, the mouthpiece and neck containing the valves was fitted directly into the top of the bag. It was this style which, over the years, became most generally known as the "Momsen Lung."

A rebreathing bag attached to the Lung, and an oxygen supply aboard submarines, suggested additional uses. A dual threaded filling cap was fitted into the canister; it could be removed and additional filters used in its place. The proper filter, therefore, enabled this gear to serve as a smoke, chlorine, ammonia or carbon monoxide mask.

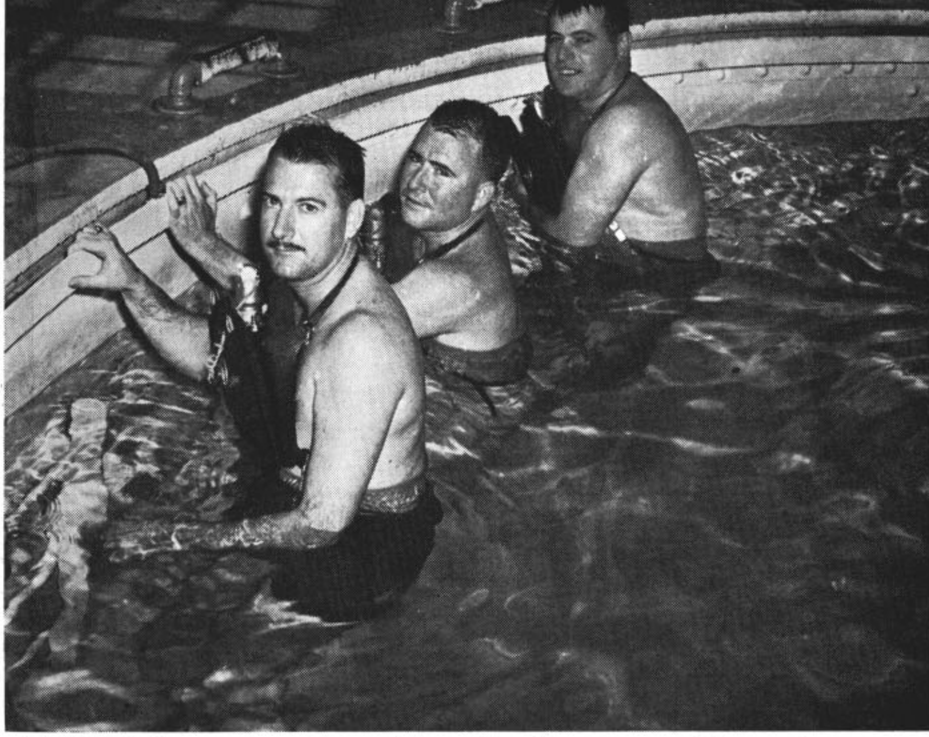
Although these accessories met with somewhat indifferent acceptance among submarines, the Lung itself was a tremendous success. Each man was convinced that he could, at least, save himself in the event of a disaster.

IN 1945, studies were started at the Escape Training Tank, New London, in a method of escape known as free ascent. Instructors had long since learned to work underwater while holding their breath. They had learned that a man buoyant at the surface was, if his chest was equally distended, buoyant at any depth. The flesh and bones of his body act as a fluid medium and are not compressed at any depth.

However, if a man took a large breath from an air pocket deep in the water, and began to float to the surface, he *must* exhale. If he were to hold his breath as he ascended, the air in his lungs would expand and possibly tear his lungs. If he exhaled too slowly, the effect could be much the same as if he held his breath. If he exhaled too rapidly, he might lose his buoyancy and sink like the proverbial rock.

This method had been demonstrated to submarines during World War II but, if there was any choice, it still was not the approved method of escape.

A committee report issued shortly after World War II disclosed that, in spite of all their training, many submariners had not used their escape apparatus at all. Even among those who tried to use it, many had used it improperly. As a result, it was found, as many men had made successful escapes (unintentionally, or by force of circumstances) without any apparatus as those who had made successful escapes with the Lung.



GOING UP—Momsen lung shown during submarine escape training session did much to increase morale, rebuild faith in subs after 'Tragic Twenties.'

THE QUESTION AROSE, of course: Why use the Lung? Inevitably, interest in free ascent increased, and it became a standard part of escape training at New London. Trainees often expressed a preference for free ascent. For some time, training included both the use of the Momsen Lung and the new technique. However, two fatalities within six months in 1952 brought the free ascent training to a halt.

At the same time, the theory of "buoyant ascent" gained more attention. It, too, was simple.

Wearing a Scuba and a standard life preserver, the first man goes out the escape hatch of a submarine to make sure the exit route is clear. When ready to make his escape, he inflates the life vest until it is comfortably full and checks the spring loaded relief valves to make sure they will vent excess pressure. Then he flushes his lungs with a few breaths of fresh air to extend his breathholding time. Then he holds his breath while making his exit out the hatch.

When in the clear, he exhales most—almost, but not quite all—of the air in his chest, and turns loose. He knows the life vest will bring him rapidly to the surface. The air remaining in his chest will expand and refill his lungs. He should continue to exhale during the ascent.

In many cases, he will pop up out of the water almost waist high. Then he relaxes in his life vest which holds him face up and head out of the water, until his shipmates join him. That's all there is to it.

The essential idea had been known for several years and demonstrations had been included as a stunt in "shows" at the Tanks for some time. At first, it was regarded as more dangerous than the free ascent method because the rate of ascent was more rapid.

Eventually, this was found not to be true. In addition, the method was not only simple to teach, but could be taught with relatively little risk. Its simplicity, plus the fact that it meant a good life preserver was at hand at the surface, soon created an enthusiastic group of supporters for this "new" method.

IN 1956, *buoyant-assisted ascent* became the approved method of individual escape from a submarine.

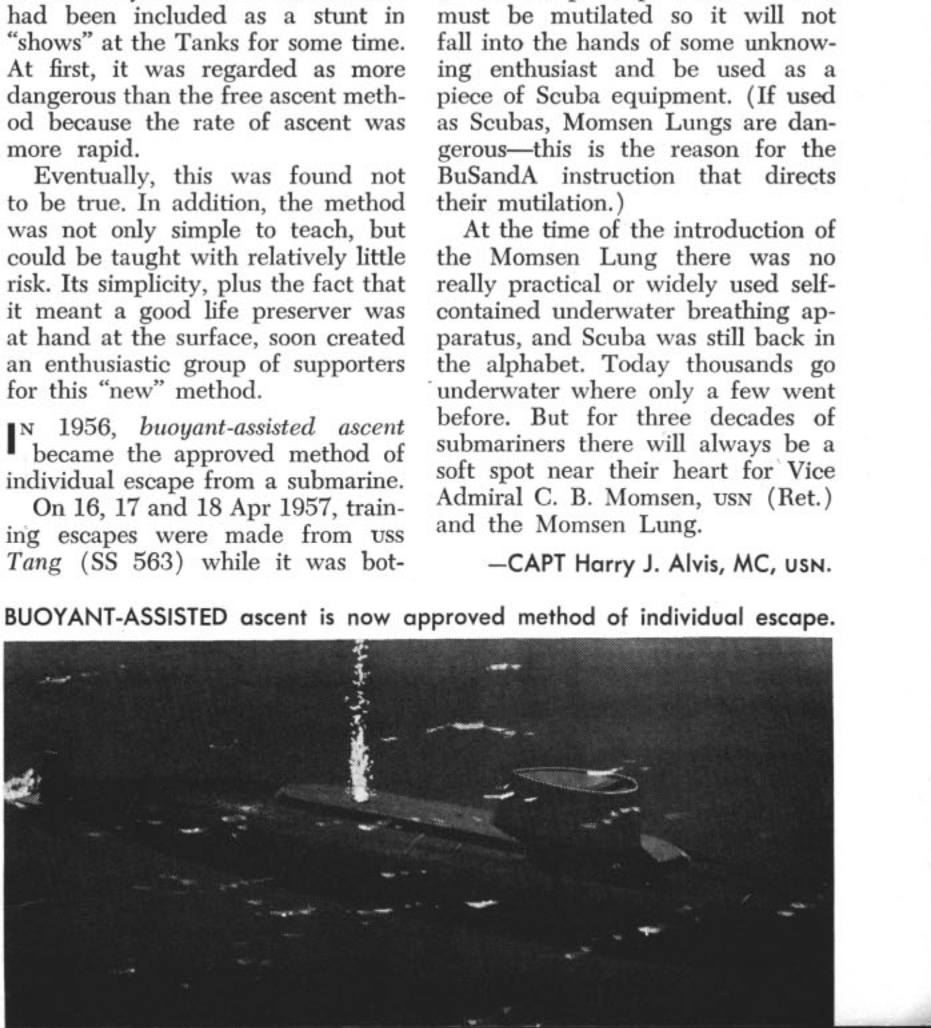
On 16, 17 and 18 Apr 1957, training escapes were made from USS *Tang* (SS 563) while it was bottomed in 142 feet of water.

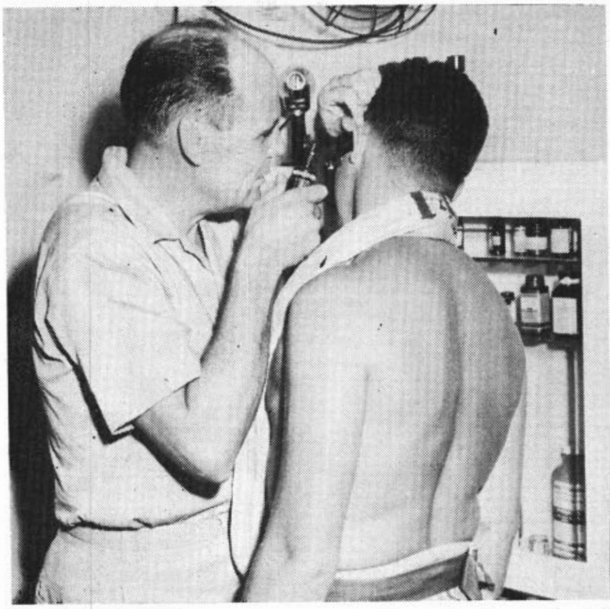
With this event, 30 years of history came to a close. An invention which made it possible for the Submarine Service to continue, has gone to the scrap heap. Even there it must be mutilated so it will not fall into the hands of some unknowing enthusiast and be used as a piece of Scuba equipment. (If used as Scubas, Momsen Lungs are dangerous—this is the reason for the BuSandA instruction that directs their mutilation.)

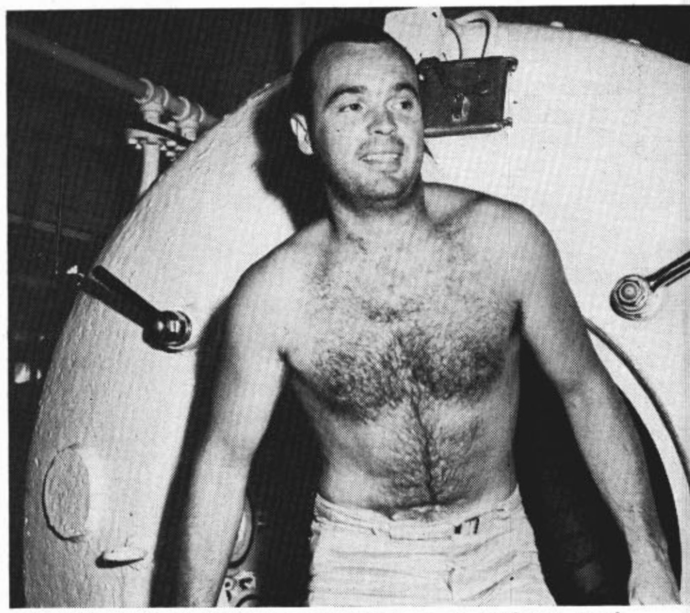
At the time of the introduction of the Momsen Lung there was no really practical or widely used self-contained underwater breathing apparatus, and Scuba was still back in the alphabet. Today thousands go underwater where only a few went before. But for three decades of submariners there will always be a soft spot near their heart for Vice Admiral C. B. Momsen, USN (Ret.) and the Momsen Lung.

—CAPT Harry J. Alvis, MC, USN.

BUOYANT-ASSISTED ascent is now approved method of individual escape.







AT WORK—Diving corpsman checks trainee, and *right* HM leaves recompression chamber after 44-hour vigil.

Deep Sea Corpsmen

THE NAVY'S HOSPITAL CORPSMEN pop up in all sorts of places all over the world—from the battlefields where they serve with the Fleet Marines to the shadow of the Egyptian pyramids where they help search out the causes of little-known diseases.

One of the oddest of the corpsman's many odd jobs—and one of the most hazardous—is that of the Medical Deepsea Diving Technician, the Navy "Doc" who not only does the everyday job of tending the sick, injured and wounded, but who also functions as a deepsea diver. Thoroughly skilled in both specialties, he may be called upon to perform the duties of either any time of the day or night.

How does a man get into something like this? Well, here's the way James "Happy" Chandler, big six-foot, three-inch HMC, puts it:

"I was on independent duty during the war, serving in DEs. Because I was the only medical man on board it was interesting work.

"After that challenging and sometimes exciting work I was assigned to a shore station dispensary and then to a naval hospital. Compared to DE duty the shore station jobs seemed tame, and, I might add, somewhat boring, so I looked around for something that would really test my mettle.

"I hadn't known, nor even suspected that corpsmen worked as deepsea divers until one day when I was shooting the breeze with a boatswain's mate diver who told me about them. The more he talked, the more interested I became and, finally, after thinking it over, I decided this was just the thing for me. I put in a request to go to diving school, the Chief of Naval Personnel approved it, and I've never been sorry."

Since he became a diver the chief has made some 250 trips underwater, but he still says, "Never a day goes by that there isn't something new. I don't know of any job that could be more interesting."

To qualify as a "Diving Doc," a hospital corpsman is sent to the Naval School, Deepsea Divers, in Washington, D. C., for 28 weeks of rigorous training—26 weeks for the regular Diver First Class course, plus two more weeks to study diving diseases, gas analysis and such.

DIVING 'DOCS' work with divers and with submarine escape trainees.

After Chandler completed his training he drew a submarine rescue vessel assignment. He reported to USS *Kittiwake* (ASR 13) and got right on his job.

Although he did a normal amount of deepsea diving, his primary duty was to help in the treatment of the other divers on board. Every time they went over the side he stood by and, since he knew their work as well as his own, he was a good man to have around—especially when medical aid was necessary.

Chief Chandler now works at the Escape Training Tank on the Submarine Base at Pearl Harbor. Here, in a towering edifice, 134 feet high and filled with 210,000 gallons of water, submarine crews are trained in the latest underwater escape techniques, practicing the actual steps they would take to get out of a sunken sub alive.

At times the corpsmen at the tank also battle the grim reaper—usually when amateur aqualung enthusiasts are brought in with the bends, acquired from too deep a dive, too long a time underwater and too rapid a surfacing.

A victim of the bends must be taken into a decompression chamber and, by means of air pressure, brought to the depth (pressure) at which he finds relief from the symptom. This is a long and involved procedure in which there is no room for mistakes. A corpsman or doctor must stay with the victim the whole time he is in the chamber, which can mean a matter of several days. During that time pressure is released little by little as the victim is "brought up" from the deep.

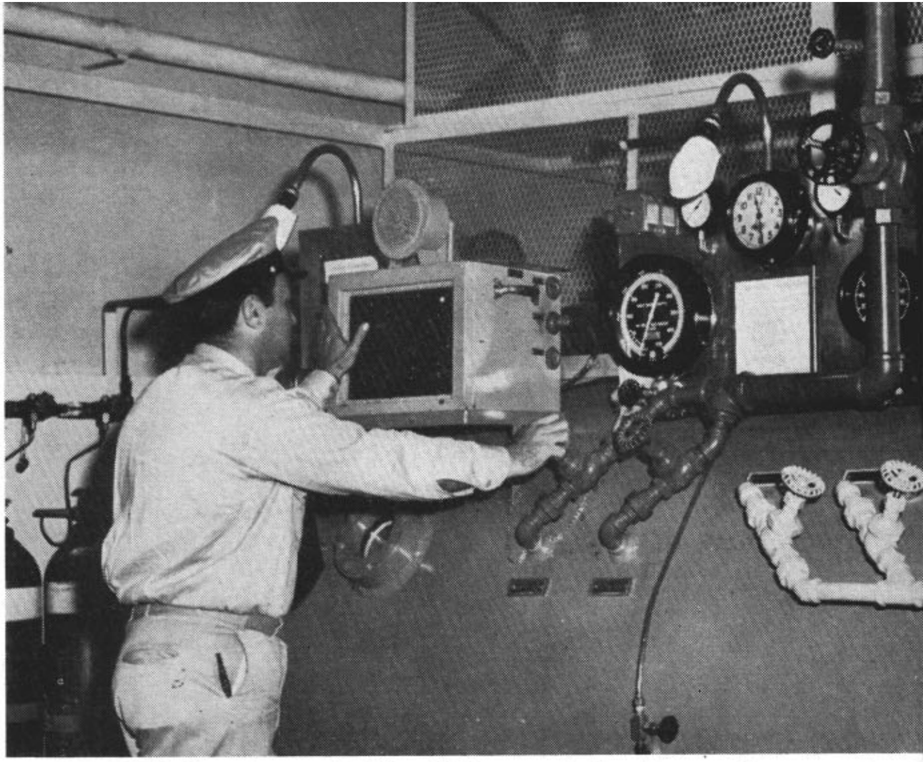
Chandler has spent many a night and day in the chamber, ministering to sick divers, testing pulse, respiration and such, and taking care of all the other details that need tending.

The treatment of air embolism also takes a long time for both victim and corpsman. To treat this disease the victim is put under pressure, and then brought up very slowly through decreasing pressures until he has reached "the top." During this ordeal the victim's condition must be given close attention, so a doctor or corpsman remains in the decompression tank with him.

One such case involving the "diving docs" at Pearl Harbor occurred early in 1957. Joseph L. Reynolds, a first class corpsman and diver, put in a 73-hour vigil with a Navyman who was suffering with the bends. The victim recovered and returned to duty. Some time later an Army sergeant was stricken while aqualunging with two companions at a remote beach almost at the other end of Oahu Island.

The incident illustrated the importance of proper indoctrination and the dangers involved. The sergeant's oxygen supply became depleted while he was submerged and he was forced to ascend too rapidly. Although he was rushed to the decompression chamber as quickly as possible, two hours elapsed between the time his distress was first noticed and the time he entered the chamber. Those two hours turned out to be irreplaceable. Reynolds, called from sick bay at noon, spent the next 46 hours in the chamber. Despite all that he and the two medical officers on the case could do, the sergeant died eight hours after he had entered the chamber. After the soldier's body was removed, Reynolds still had to remain in "the igloo" for 38 hours more. Because he had been under great pressure for a considerable length of time, he had to be taken through "table four," the longest and slowest ascent table in the book.

—Bryant Arbuckle, JO1, USN



DOUBLE DUTY—Experiences of diving HM's come in handy around recompression chamber and under sea. *Below:* J. Reynolds, HM1, readies for dive.

WHAT'S IT LIKE ON THE

As with so many other areas of human endeavor, exploration of the ocean bottom first began slowly, then grew at an ever increasing pace.

So far as we know, Magellan was one of the first to make the attempt. Somewhere in the far Pacific, he lowered his standard 200-fathom sounding line and, when it failed to touch bottom, came to the conclusion that he was over the deepest part of the ocean. His was not the last error to be made during the development of this science.

The next recorded attempt was made some 300 years later. In latitude 27° 26′ S., longitude 17° 29′ W., Sir James Clark Ross tied together every available line aboard *Erebus* and *Terror* and finally touched bottom at 2425 fathoms. This was, apparently, the first successful deep-sea sounding.

A sounding such as this was a major operation. The weather had to be nearly perfect, the ship had to stand as nearly motionless as possible, and the operation itself, involving as it did, miles of recalcitrant line, usually required a full day. Little wonder that skippers were reluctant to waste the time.

By 1854, when LT Matthew F. Maury, USN, collected all available records, only 180 deep-sea soundings had been made in the Atlantic and, by the time the modern echo sounder was introduced (in 1922, by the Hydrographic Office), a world-wide total of about 15,000 had been recorded. This averages out to roughly one sounding for every 6000 square miles of sea.

Today, hundreds of ships are equipped with sonic sounding instruments that trace a continuous profile of the ocean's bottom. This is a generalized summary of what they have found:

Once clear of the tidal areas, the oceans consist of three distinct areas: the *continental shelf;* the *continental slope;* and the *floor of the deep sea.*

The shelf has much in common with the land itself. Sunlight penetrates most of it to a varying degree; such vegetation as grows in the ocean may be found here; and much of the shelf consists of material washed into it from the land. The more familiar forms of fish may be found here. It is this relatively narrow portion of the sea that has been, up to now, of the greatest immediate importance to us. Parts of it may have been dry land at one geologic time or another.

At one time, the 100-fathom line was generally accepted as the line of demarcation between the continental shelf and the continental slope. At the present time, however, it is the fashion to mark the division wherever the relatively gentle slope of the shelf suddenly begins its plunge into the great depths. This abrupt dropping off averages, the world over, at about 72 fathoms, although there are some spots where the shelf ends at between 200 and 300 fathoms.

On the Pacific coast of the United States, the shelf is relatively narrow —not much more than 20 miles wide. On the Atlantic coast, the shelf is usually much wider. Somewhat north of Cape Hatteras it is as much as 150 miles wide; yet at the Cape

OCEAN BOTTOM?

itself and off certain parts of Florida, the plunge begins almost immediately.

Beyond the shelf, no matter how deep nor how far from land, the bottom drops off abruptly. Here, if man could enter it, would be a new and uncomfortable world. A frightening and awesome world. There is little light, no plant life; the pressure, cold and silence increase; the scenery is mud, rocks and clay, inhabited by large and small carnivores such as those encountered only in nightmares. The slopes are well below the familiar surface wave action, yet strong currents and tides move back and forth and, to some extent, up and down.

It is highly probable that these areas have never seen air and sunlight since the ocean's basins were first filled with water. It is not likely that they will again be revealed to view until the waters of the earth dry up for the last time.

In a way this is a pity, for the slopes are regarded by those who know as perhaps the most impressive physical manifestations on earth. They drop off abruptly from the continental shelves to the really deep ocean at as steep an incline as gravity will permit. Their average height is some 12,000 feet, although drops of 30,000 feet have been recorded.

One of the most spectacular features of the slopes are the tremendous submarine canyons which, with steep cliffs and winding valleys, cut into the shelves almost to the continents themselves. These canyons have been found everywhere, soundings have been made and, in all probability, are of world-wide occurrence. Geologically speaking, they are relatively young—no more than a million or so years old—but how they were formed, and why, no one knows.

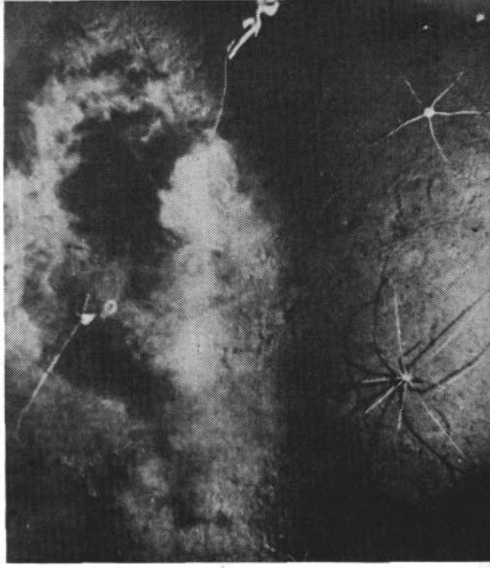
There are dozens of such canyons along the slopes and the most spectacular of our terrestial scenery, the Grand Canyon could, in some cases, be dropped into any one of these with hardly much more than a splash. They are usually found near the mouth of a continental river.

Geologists suggest the obvious clue (but any theory offered is promptly challenged by contradicting evidence) that the submarine canyons were cut by rivers at some time when their gorges were above sea level. It is agreed that the sea level dropped during the Ice Age, but only a few hundred feet at most. Some canyons are a mile or more in depth.

The most completely surveyed canyon in the Western North Atlantic is the Hudson Canyon. This extends from the 100-fathom curve, 90 miles southeast of New York harbor to a 2650-fathom plain some 300 miles offshore. This 200-mile long canyon is a chasm 1000 feet deep in places and has several sizable tributaries entering it. The canyon cuts through the continental slope and joins a depression in the continental shelf which marks the entrance of the Hudson River channel off New York harbor. In this instance, the Hudson Canyon system acts as a sluiceway down which sediment is carried by currents to the deep sea bottom which, at this spot, is an enormous plain of just plain mud. A near neighbor of the Hudson Canyon, the Mid-Ocean Canyon, starts near Greenland and extends some 2000 miles south. So far as is known, there are no major rivers in Greenland. Glaciers are thought to be the origin of this little number.

The floor of the deep ocean—the abyss—has not been subjected to the type of erosion responsible for our most spectacular scenery but this does not mean that no geologic action has taken place. The floor of the sea, like the continents, is a thin crust over the molten center of the earth and, like a pot of thick fudge, the entire crust is slowly—very slowly, with thousands and millions of years between each blop—bubbling and boiling.

That, at least, is one theory. This explains the wrinkles and folds where, at one spot, the interior cools imperceptibly and shrinks away from its covering. In another area, it falls away into the famous deep trenches and in still another, it pushes up conelike shapes of underseas mountains as volcanoes boil upward from the depths of the earth.

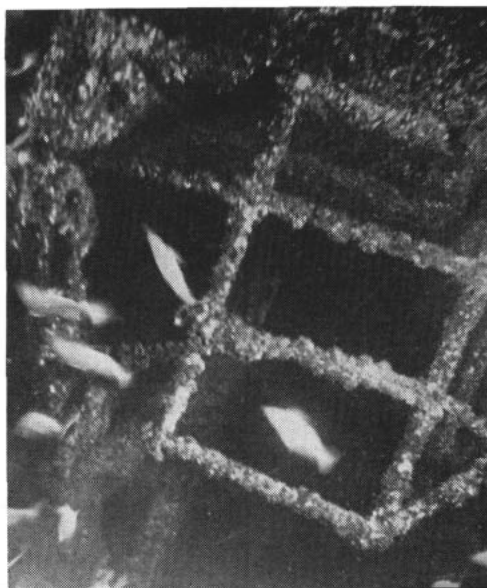


SEA STARS—Starfish and sea spiders were photographed on bottom of the Atlantic ocean 975 fathoms down.

The deepest depressions occur not in the center of the ocean's basins, as might be expected, but near the continents. The Mindanao Deep, east of the Philippines, is some six and one-half miles deep. The Tuscarora Trench, east of Japan, nearly as deep, is one of a series of long narrow trenches that border the outer rim of a chain of islands that include the Bonins, the Marianas, and the Palaus. The greatest deeps of the Atlantic lie near the West Indies, and also below Cape Horn. In the Indian Ocean, the curving island arcs of the East Indies have their accompanying deeps.

In addition to these trenches, or deeps, the existence of a continuous underseas crack some 45,000 miles long has been claimed by the Lamont Geological Laboratory within recent years. They say this rift aver-

DEPOSITS on floor include things dating from beginning of time. Shipwreck discovered off Cape Hatteras.



Mud Comes in Handy

So the bottom of the ocean is covered with mud! Who cares?

The Navy cares and, at times, is glad of it. The California Academy of Sciences, while engaged in an oceanographic survey sponsored by the Office of Naval Research, reported that not far off the coast of California the ocean bottom was covered with large areas of thick, gooey mud. Since the ocean's depth at that point was some 500 fathoms, this appeared to be further fascinating information—to be filed.

Then some unsung genius connected this sticky fact with the problem of disposing of large quantities of radioactive waste.

Now, the waste is loaded into steel drums, carried to muddy-bottom areas, and heaved overboard. The drums sink far into the mud long before they disintegrate and the mud absorbs the radiation. This avoids contaminating large volumes of sea water which would happen if the drums happened to be dropped on a sand or rock bottom.

The moral? Basic research is a fine thing whenever applied.

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ages 20 miles wide and one and one-half miles deep. It coincides with a world-wide active earthquake zone along its entire length. Almost all of the earthquake shocks along the 45,000-mile line occur almost exactly within the limits of the rift.

The main line of the rift system is believed to extend through the North and South Atlantic Oceans, around the top of Africa into the Indian Ocean, and then branches through the Arabian Sea.

The other branch is supposed to pass between Antarctica and New Zealand, then branches again near Easter Island. Deepest point in the rift line is about four miles below the surface.

UNTIL RECENT YEARS, not much was known about the bottom of the Pacific. Most soundings had been taken near the coast and, as the ocean floor was relatively smooth in those areas, it was assumed that the floor was equally smooth all over.

Not so. Oceanographers of the Navy Electronics Laboratory tell us that only about 10 per cent of the bottom is smooth.

For a long time, geologists have wondered about the relationship between the great linear features of the earth's crust. On the continents, these have been so eroded that little more than "ruins" remain. Under the sea, however, where they have been protected from erosion, many more details have been revealed.

Between 1950 and 1953, four great parallel cracks or fracture zones were discovered by NEL on the floor of the northeastern Pacific. The northernmost, called the Mendocino Escarpment, extends westward from Cape Mendocino, Calif., for more than 1400 miles. One of its walls is 10,500 feet high. South of this is the Murray Fracture Zone, which can be traced from a point near the Pacific coast almost to the Hawaiian Islands. It hasn't yet been confirmed, but it is considered possible that this crack may run through the islands and continue into the undersea Mid-Pacific Mountains further west.

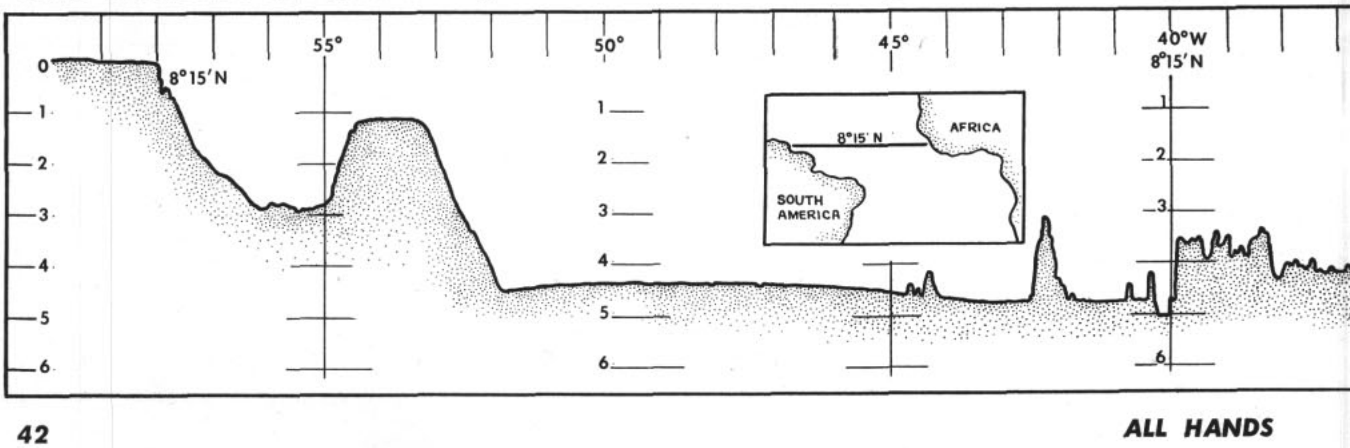
Off the coast of Mexico is a third great zone called the Clarion Fracture Zone. It cuts the ocean floor for at least 1700 miles and is thought to cross the continent along the lines of the volcanoes of southern Mexico. The last zone to be discovered and still under study, is the Clipperton Zone, which has been traced for more than 3300 miles. This lies farthest south of the four.

How are these breaks to be explained? It is believed (at the moment), that they and portions of California and possibly the Hawaiian Islands were created in one great upheaval of the earth's surface between some 150 and 50 million years ago—give or take a few million. Two possible reasons are given for the cracking. The first and most likely is the slow movement of great convection currents in the "plastic" material of the earth's mantle under the harder surface crust. The other —which is questionable—is the migration of the north pole from a position in India to its present position. Take your choice or, if you prefer, offer your own theory.

EXPLORERS HAVE, for a long time, realized that many of the islands of the oceans are simply the tops of mountains that rise from the floor of the sea. Most of the islands of the Central Atlantic, for example, are peaks of the Mid-Atlantic Ridge (see below, page 42). The Hawaiian Islands are peaks along the top of a great submarine ridge more than 1600 miles long. The Marshall Islands are coral caps on great volcanoes. Thousands of other mountains rise from the bottom of the Pacific but do not quite reach the surface. Dozens of other peaks were islands at one time but have sunk and now lie below the sea's surface.

While the transport USS *Cape Johnson* (AP 172) made its long voyages across the central and western Pacific during World War II, Dr. Harry Hess, formerly of Princeton University—her navigator and

SONIC SOUNDINGS have given new light on the contours of the vast region of earth covered by oceans.



later her commanding officer—studied the records of the ship's echo sounder. One day the soundings showed the presence of a large submarine mountain whose top was too flat and too big to have been the crater of a submerged volcano.

Later, he crossed 10 more of these strange "islands," and later discovered others in the records of the Hydrographic Office. Since that time more of these islands have been discovered and, in 1950, the Scripps ship, *Horizon,* discovered the Mid-Pacific Mountains, a submarine range extending from the vicinity of Necker Island of the Hawaiian group, to the vicinity of Wake Island.

Many of the peaks of this range, the highest of which towers more than 13,000 feet above the sea floor, have the peculiar flat tops first noted by Dr. Hess.

Material obtained by dredging and coring along the tops and upper sides of these seamounts have provided clues as to their origin. This material consisted of pebbles, cobbles and boulders of basalt, many of which appeared to have been rounded by the action of rivers or beach waves; and of limestone containing coral of about 100 million years ago. It was concluded that, during the time when dinosaurs still roamed the continents, this undersea range formed a chain of islands.

At this time, the sea eroded the projecting peaks of the chain to flat surfaces. Reef coral larva drifted to the islands, probably from the east, and lodged on and among the debris. In the warm tropical surface waters, enough of the corals grew and accumulated to form banks, but not enough to conceal the rocks and finer sediments and thus form atolls.

Probably, as a result of adjustments of the earth's crust, the great range sank, at first fast enough to kill the reef coral, then more slowly until the present depth was reached.

There it still remains—the oldest uneroded group of mountains known on earth—disturbed only by weak currents and the slow rain of tiny organisms from the waters above.

THE MID-PACIFIC MOUNTAINS may lay claim to being the oldest, but the Atlantic claims to have the biggest range of mountains. It winds from the Arctic to the Antarctic with peaks averaging 10,000 feet. One undersea giant, Pico, in the Azores, rises 27,000 feet.

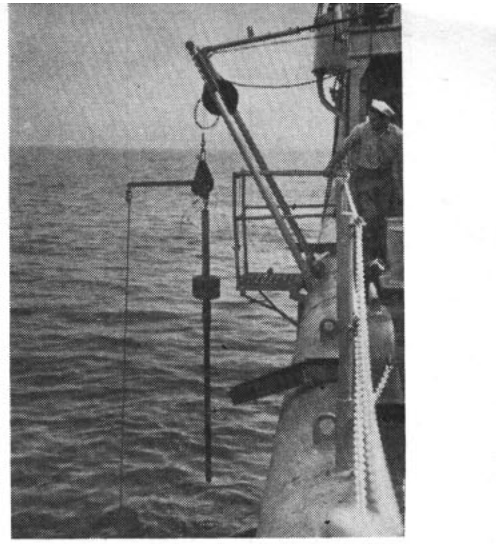
Known as the Mid-Atlantic Ridge, this chain of submarine peaks and plateaus runs the length of the vast S-shaped trough of the Atlantic. Throughout much of its 10,000-mile length it gives the impression of an object formed by the interplay of great, opposing forces.

The range is about twice as wide as the Andes, and several times the width of the Appalachians. Near the equator a deep gash—the Romanche Trench—cuts across it.

The greater part of the Ridge is, of course, submerged. Its central backbone rises 5000 to 10,000 feet above the sea floor but there is another mile of water above most of its summits. Here and there peaks form the islands of the mid-Atlantic. The Rocks of St. Paul, near the equator are not much more than a quarter of a mile across, but their slopes drop off so rapidly that water more than half a mile deep lies only a few feet off shore.

NOT ONLY DO THE OCEANS contain mountains, valleys and plateaus, but rivers also have been found.

One, an estimated 250 miles wide and 1000 feet deep has been mapped in the Pacific by the *Dolphin*



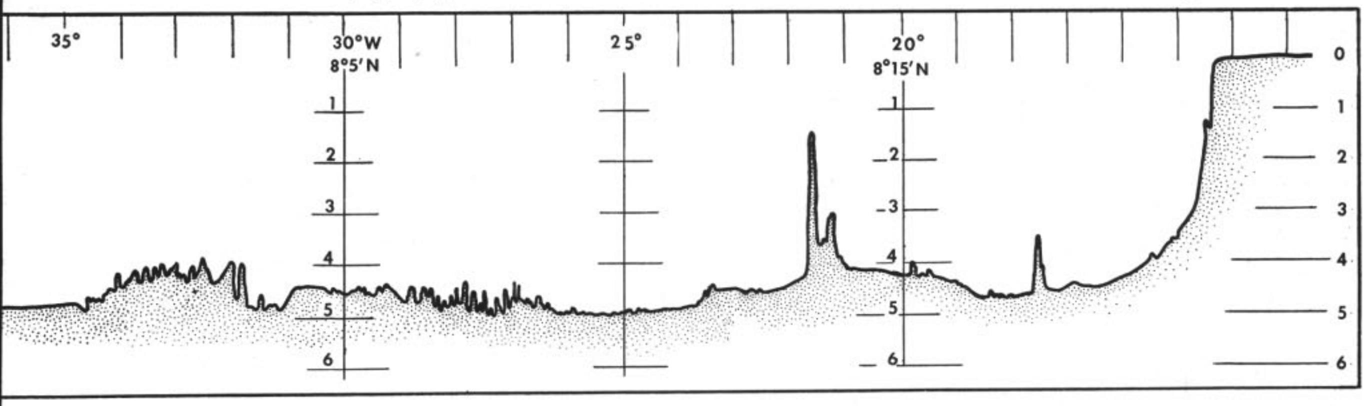
RECENT STUDIES sponsored by Navy Hydrographic Office came up with a deal of new information on bottom.

expedition of Scripps. This river flows eastward along the equator for at least 3500 miles.

The current was discovered in 1952 by a member of the U. S. Fish and Wildlife Service in his studies of long-line fishing, a technique used in Japan. A series of fishing lines are attached to a rope several miles long which is supported near the surface by buoys. When Townsend Cromwell, the Wildlife Service man, put out his lines, he found that they did not move westward with the surface current as expected, but in exactly the opposite direction—and at high speed.

Measurements showed that, at one point, the core of the current lies about 300 feet below the ocean's surface, that the current is about 700 feet thick, and that it is about 250 miles wide. It is more rapid than the surface current, averaging almost three knots compared to the surface current's one knot. The amount of water transported in a given time was found to be about equal to that of the Gulf Stream

CHART OF BOTTOM topography of Atlantic Ocean between South America and Africa was made by Woods Hole.



CURRENTS and rivers and effects of waves such as this rippled bottom have been found at depths where it was previously thought the water was still.

as it emerges from the Straits of Florida. The core of the current gradually rises until, near the Galapagos Islands, it is only about 140 feet from the surface.

The *Dolphin* expedition also found *another* current beneath the Cromwell current. This one, relatively weak, flowed westward. Thus, in one area of the Pacific, within the first few thousand feet of the surface, we have three considerable currents lying like ribbons on top of one another and being pulled in different directions.

Are there more than three? Where does the water come from, and where does it go? We don't know. But we'll find out, some day.

IN RACHEL CARSON's truly great book *The Sea Around Us,* she describes in one of her finest passages, "the long snowfall—the steady, unremitting, downward drift of materials from above, flake upon flake, layer upon layer—a drift that has continued for hundreds of millions of years, that will go on as long as there are seas and continents."

That, in short, is what lies on the bottom of the sea.

In addition to the silt of every river that empties into the ocean, there are other materials that make up the sediment. Volcanic dust, which may have been blown half way around the world, eventually finds its way to the ocean, floats for a while on the surface, then sinks. Dust from the desert is blown out to sea. Gravel, stones and small boulders, picked up by glaciers, fall to the bottom when the ice melts. Meteoric debris that enters the earth's atmosphere over the oceans finds its way to the bottom. A flake at this point; then, a minute, an hour or a year later, another flake there—each is added to the bottom of the sea. Added, but rarely subtracted.

Impressive as the total of this material may be, it is of minor importance compared to the billions upon billions of tiny shells and skeletons of the minute creatures which, for millions of years, have lived in the upper levels of the sea and then, upon death, have drifted downward.

HOW DEEP is this sediment? Until a few years, ago, no one could have spoken with any assurance. Now, educated guesses have been made. The rates of fall in different parts of the ocean presumably vary, but in any event, it is very slow. Cores, first 10 feet deep and later, 70 feet deep, have been taken from the bottom. It is assumed that each of these cores represents millions of years of geologic samples. Through a tricky technique of seismic refraction, by means of which sound waves travel horizontally through rock, sediment layers of 12,000 feet have been found in the Atlantic basin. No sediment layers thicker than 1000 feet have been found in either the Pacific Ocean or the Indian Ocean.

The Atlantic Ridge was mentioned earlier. Consider this: As the approach to the foothills from the American side of the ridge begins, the sediments deepen as though they were mammoth snow drifts—snowdrifts 1000 to 2000 feet deep against the slope. Farther up the Ridge, where occasionally the terrain flattens out into plateaus, the drifts increase at times to 3000 feet. The peaks are bare.

Near the continents, on the edges of the continental slopes, is just plain mud—blue, green, red, black or white—washed out to sea by the rivers. Farther out, the sediment is composed primarily of the shells of the tiny, one-celled creatures mentioned earlier—*globigerina.*

The sea floor over large areas in the temperate zone is covered with these shells. Over the ages the species have varied somewhat, so that it is possible through their shells, to estimate the age of the deposit. Like most one-celled creatures, an individual globigerina normally does not die but, by division, becomes two.

When this occurs, the old shell is discarded and each of the two tiny blobs grows new ones. The old shell falls to the bottom. Each shell is small, but in their numbers they have covered millions of square miles of ocean bottom, sometimes to a depth of thousands of feet, or even more.

The discarded husks of other living creatures also help form the bottom. *Radiolarians,* similar in appearance to snowflakes, form broad bands of ooze in the North Pacific. *Diatoms,* the microscopic plant life of the sea, are abundant only in cold waters. Because silica is resistant to solution in salt water, and because diatoms possess coverings, there is a broad belt of diatom ooze on the floor of the vast Antarctic Ocean.

Again, in the North Pacific, immense areas of the bottom are covered with a red, soft sediment. It occurs only at great depths and the only organic remains found so far are sharks' teeth and the ear bones of whales.

Where did the red come from? No one knows, but it has been proposed that the material may be windblown from the world's desert areas.

As you read this, more flakes of the "long snowfall" are drifting downward to the bottom of the oceans; acres of ooze are sliding down a sharp slope; slow currents are pushing their way silently through the black, cold water as they have done since time began.

This is the underseas world.

Treasure Below

NAVY DIVERS have gone below to do jobs including treasure hunting.

MOST SEEKERS OF BURIED treasure find little to reward them for their time and effort. But such was not the case in the Navy's search for silver in the Philippines' Caballo Bay, as well as Tokyo Bay, back in 1945.

The story of the treasure of Caballo Bay began in the early part of World War II.

When the Japanese advanced on Manila the government of the Philippine Commonwealth moved its money to Corregidor. USS *Trout* (SS 202) carried some of the money to safety. However, seven to eight-and-one-half million dollars worth of Philippine pesos still remained on the Rock. To prevent all that silver from falling into enemy hands, it was dumped into the Bay.

After the Japanese took Manila they attempted to salvage the treasure, using POWs and native divers. Altogether, more than one million dollars in coins were recovered before the Japanese discontinued the operation in November 1942.

In 1945 Manila was retaken by American troops. At first, salvage crews were too busy clearing up shipping facilities to pay much attention to the underwater treasure. However, when "bootleg" divers started seeking the money, the Navy was asked to help recover it. The Navy set to work in June 1945.

The silver rested in mud about 110 to 120 feet below the surface of the Bay. It had been in bags, packed in wooden boxes, but the boxes were now so flimsy that they had to be loaded into GI cans before they could be raised to the surface. The weakness of the boxes was partly due to natural damage from three years underwater and partly due to the deliberate efforts of the POW divers to weaken the boxes and scatter the coins.

When the money was brought up it was dumped on the deck, counted in the presence of an Army auditor and taken to an Army bank.

The Navy continued the job until about April 1946. By then some two-and-one-half million dollars worth of coins had been recovered. That, together with what the Japanese had brought up, made a total of around $3,500,000. The government of the Philippines recovered some more of the money in later salvage operations. However, a very considerable sum still remains on the bottom to tempt future treasure seekers.

The treasure in Tokyo Bay—more than six tons of silver ingots—was recovered in November 1945. It was valued at approximately $200,000.

In the latter part of August 1945, when the U. S. Third Fleet was entering the waters of East Japan, the Japanese had tried to remove the bullion from the Yokosuka Naval Base, where it had been stored. A typhoon and the Navy's arrival prevented any transfer.

The existence of the silver was not reported to the Navy when it took control of Tokyo Bay on 5 September, nor was it mentioned in the official report of 15 September on the list of assets of the Yokosuka Yard.

Meanwhile, salvage operations in the harbor were getting underway. Captured Japanese floating cranes were used to clear the shipyard, and it was a chief boatswain, in charge of one of these cranes, who turned up the first clue to the treasure.

He reported finding a bar of tin aboard the crane. The "tin" turned out to be almost pure silver.

Japanese yard workers (including the former operator of the crane) and officers and enlisted men who were known to have been in the area all denied any knowledge of the matter. However, the questioning resulted in a letter from the former Japanese deputy chief of staff to Commander Fleet Activities. The letter said there were 200 bars of silver just 40 yards offshore. It also explained why the silver had not been reported earlier.

On 23 August, the admiral wrote, the barge which was to have taken the silver from Yokosuka sank in a typhoon. Four days later it was refloated and brought back to the yard, where the barge—silver and all—was scuttled off Dock No. 3. The admiral had been unaware of the refloating and scuttling.

USS *Protector* (ARS 14) was assigned to the salvage job. She began operations on 2 November.

At 1200 on 3 November a wire cargo net, full of silver ingots, was found under 40 feet of water. The divers used probing bars and high-pressure water hoses to clear away the mud, and loaded between five and 10 bars at a time into canvas sacks which were then hauled aboard *Protector*.

Six days later, 182 ingots, each weighing 60 pounds, had been recovered. The search for the other 18 bars continued until 24 November, but without further success.

GOLD RUSH—Navymen shown evacuated Philippine gold before surrender. Some still remains at bottom of Caballo Bay in spite of attempts to find it.

OCEANS OF RESEARCH—Men have sailed sea's surface for years, but only recently they're finding out what's below.

Space Research — Under Water

"WATER, WATER everywhere . . ." The Navy has been sailing on it and in it for years, but still would like the answers to a lot of questions about the sea. For example . . .

How can fish, traveling in large or small schools, turn or stop, go up or down, as one unit? We have only a few hints.

Why do deep sea fish literally "explode" when brought to the surface, yet a great change in depth doesn't seem to bother others? How can a whale—a mammal—dive for hundreds of fathoms, then come charging to the surface at the exact spot from which he descended? We have some idea, but we're not too sure.

What caused the enormously deep chasms in the bottom of the ocean? We have a theory. We have several theories.

What caused the bottom of the sea to become so jagged and irregular? Again, our answer depends on theory.

Why, in the major ocean stream, does the current flow in one direction and, immediately below, flow in the other?

We don't know, even though we can justify the existence of ocean streams in theory.

The questions listed above could be extended for pages if we wanted to but we're learning at an increasingly rapid pace. Even when we don't have the complete answers, we know that many of our earlier theories about some of these problems were wrong. That's something.

A REVOLUTION is taking place and, whether or not you know it, you're taking part in it. In recent years we have, with a sense of shock, realized that although men have crawled over the face of the ocean for thousands of year, we know almost nothing about the sea below the surface. Until our present era, we took it for granted nothing much was there. Our present limited knowledge has only helped us to comprehend the great potentials ahead of us. The more we have learned, the more important the subject has become.

The ocean—what it is and what it does—is, of course, of peculiar interest to the Navy. It's the environment in which it operates. It takes only a minimum imagination to appreciate that, with the growing importance of the nuclear submarine, from here on in, we will operate not only *on* its surface but, for the first time, *in* it.

It is our thesis that the oceans, their behavior and their contents might be as important to all of us as that equally unexplored area, the space above us. It is a tribute to our present stage of knowledge, limited as it may be, that we are in a position to ask the questions mentioned above.

After all, on the face of it, once you've seen one piece of ocean you've seen it all. It is quite an accomplishment that we have learned that there *are* deep chasms, that the bottom of the sea *is* irregular, that there *are* definite currents below the surface of the ocean. In time to come we will discover the reasons for all these phenomena.

THE STUDY of the ocean is, of course, by no means new. Men have been writing and telling sea stories about it ever since Homer described the adventures of Ulysses. But it was an American naval officer, CDR Matthew Fontaine Maury, who in the 1840s and 1850s, first dignified the subject with a scientific approach. He charted the currents of the ocean and proved that these immense streams have stability and direction and that they have a profound influence on climate. In short, he taught the Navy how to navigate with the seas rather than against them.

It is only reasonable that the Navy should have a deep interest in oceanography. Consider, for example, this list of Navy activities which depend upon the subject for basic information: The Bureau of Ships, the Hydrographic Office, the Bureau of Ordnance, the Naval Research Laboratory, the Underwater Sound Laboratory, the Navy Electronics Laboratory, the Chief of Naval Operations, the Fleet Sonar School, the Amphibious Forces, the Bureau of Medicine and Surgery, the Bureau of Supplies and Accounts and the Bureau of Aeronautics.

This demand has grown, to a large extent, since the end of World War II. As the intricacy of naval operations and armament increases, the need for technical understanding of the sea keeps the same pace.

At the present time, the Navy's research program is under the direction of Gordon G. Lill, Head, Geophysics Branch, Office of Naval Research. Rather than set up its own laboratory (one already exists in the Oceanographic Division of the Hydrographic Office), the Navy underwrites the costs of projects in a number of existing civilian institutions. ONR does not closely specify the kind of investigations to be undertaken by these organizations. A free hand, it is felt, tends to foster healthy competition and leads to separate lines of attack by the competing groups.

These laboratories — there are nine—are located on all three of our major coastlines. This enables them to study, for example, the deep temperature gradients of the Western Atlantic and the shallow ones of the Eastern Pacific; the shallow bays of the East Coast and the fjords of the Pacific Northwest.

Our Atlantic coast is typical of the western edges of most oceans. It has strong currents, a broad continental shelf, shallow "drowned river" estuaries, and a climate similar to that found on land.

The Woods Hole Oceanographic Institution is the major facility on the Atlantic coast. For the past 28 years it has carried out general oceanographic research as well as North Atlantic surveying. It has been active in research for the Navy, particularly in the field of underwater sound.

The Chesapeake Bay Institute, a fairly new branch of Johns Hopkins University, located near Annapolis, concentrates on shallow estuary problems such as harbor flushing and sedimentation. It is also concerned with the development of biological resources of the Chesapeake Bay. The Navy was somewhat startled to discover that the mud which affects the "setting" of oysters, also affects the setting of mines.

The Lamont Geological Laboratory of Columbia University specializes in marine geophysics and geology and in studies of the propagation of underwater sound.

The Narragansett Marine Laboratory of the University of Rhode Island is mainly devoted to the problems of biological oceanography, and its findings concerning fish noises are of interest to the Navy.

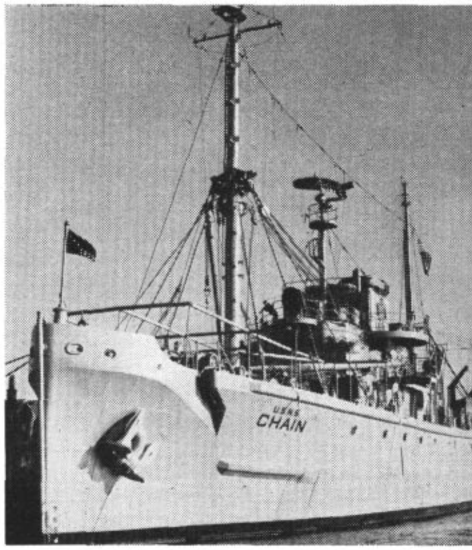
Yale University and the University of Miami also maintain oceanographic laboratories.

The Gulf Coast area has sometimes been called the "American Mediterranean," not only because of its importance but also, like the European Med because it consists of a series of deep basins separated by relatively shallow sills. For some reason, it appears that the temperature of the water in these deep basins increases with the depth. That doesn't follow the rules. The area is of unique interest for two reasons: Its tremendous oil resources; and the enormous discharge of the Mississippi River. Also of interest are the frequent tropical storms.

Since 1950, Texas A and M University has organized a Department of oceanography and has begun a regular oceanographic survey of the Gulf. Some petroleum companies also carry out specialized research.

The Pacific Coast is characteristic of the eastern boundary of oceans the world over and is very similar to western Europe. Its special oceanic features include a slow southerly coastal current, steep shores with a narrow continental shelf, less oxygen than customary, and long-period waves.

The Scripps Institution of Oceanography of the University of California, at LaJolla, is the chief oceanographic facility on the Pacific. During the war it was the chief center for training naval officers in techniques for forecasting sea, swell and surf. At the present time it carries on general oceanographic work in cooperation with the Marine Physical Laboratory and the Navy Electronics Laboratory.

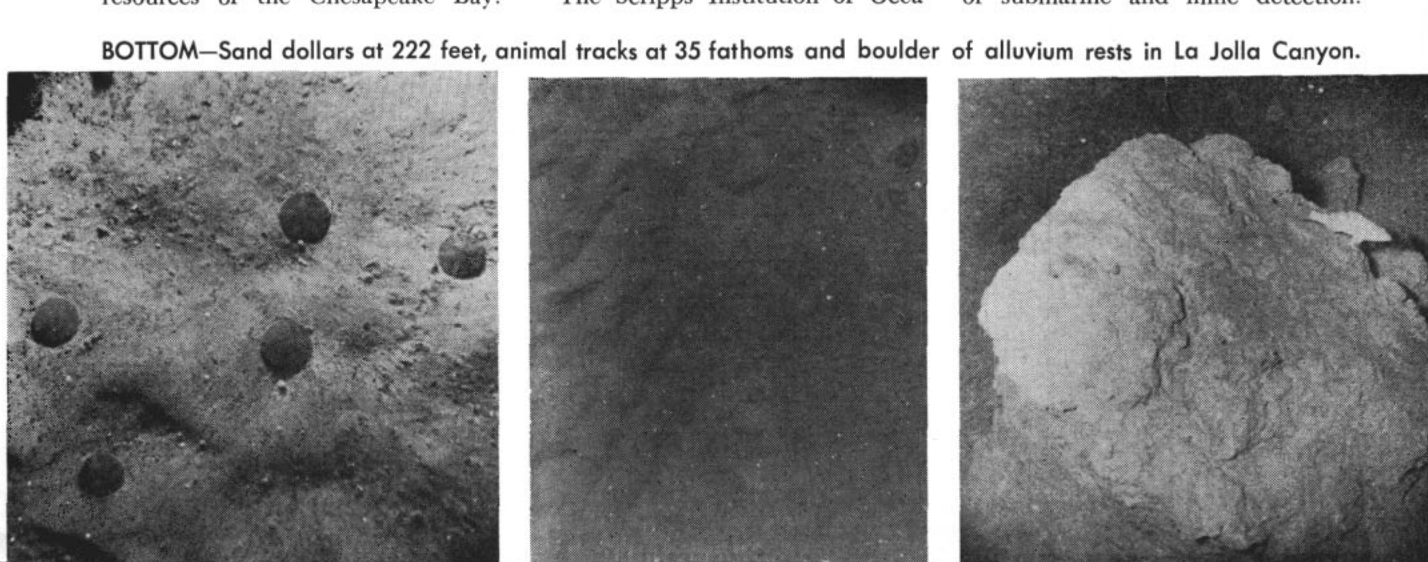


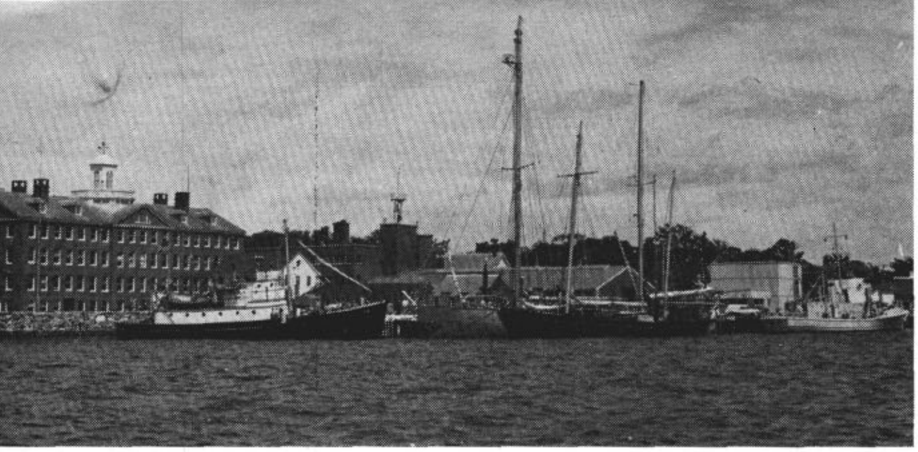
NEW JOB—Ocean research vessel, *USNS Chain* is doing deep-sea studies with scientists from Woods Hole lab.

The University of Washington at Seattle, Oregon State College at Corvallis and the College of Engineering of the University of California, at Berkeley, also maintain oceanographic laboratories.

Since 1947, ONR has taken over most of the support of oceanographic research for the Navy. Considerable research had been done by the Bureau of Ships during World War II and later, which has contributed a great deal to our knowledge of the oceans as applied to problems of submarine and mine detection.

BOTTOM—Sand dollars at 222 feet, animal tracks at 35 fathoms and boulder of alluvium rests in La Jolla Canyon.





HEADQUARTERS—Woods Hole Oceanographic Institution is major facility on Atlantic coast. Shown here is institution and its fleet of research ships.

THE OPERATION of research ships has been sponsored along with the research. As a general rule, about one quarter of all research funds during the past 10 years has gone for the operations of ships, including maintenance and fitting out.

What does an oceanographic research ship do? In very broad and general terms, it studies: The currents of the ocean, temperatures, the development of instruments and techniques, contours, sediments and structure of the bottom, heat flow, sound transmission and speed, noises, biological activities and specimens, radio activity, and water samples for different kinds of chemicals.

To accomplish this somewhat formidable job, the nine laboratories described above are provided with some 16 ships ranging in size from the 12-ton dragger operated by Rhode Island U. to the 760-ton ATA *Allegheny* operated by Columbia University. Scripps operates the largest "fleet" of five vessels, consisting of two 505-ton ATAs, a purse seiner, a Coast Guard patrol vessel, and a yacht. Woods Hole has three: *Atlantis,* a 298-ton ketch; *Bear,* a coastal freighter; and *Crawford,* a 280-ton cutter. The most modern ship of this group is the trawler, *Gerda,* which was built in 1949 and is now operated by the University of Miami.

IN ADDITION to these ships in operation, three additional ships are being added to the oceanographic fleet.

USNS *Josiah Willard Gibbs,* an oceanographic research ship (AGOR 1), will serve as the principal research ship of Columbia University. USNS *Chain,* (ARS 20) converted from the former Navy salvage ship of the same name, will be used by Woods Hole. Another salvage ship is scheduled for alteration this year and will be used by oceanographers on the West Coast.

Gibbs is a 310-footer with a displacement of 2800 tons and a maximum speed of 18 knots. With accommodations for a crew of 48, plus 28 scientists, she will be used to study the physics of the ocean itself, and of sound in the ocean.

The large size of *Gibbs* permits additional space for scientific purposes. There are several large laboratories aboard which can be equipped with scientific gear. In addition, the ship can handle heavier weights at greater depths and provide greater stability for delicate scientific measurements than any U. S. oceanographic research ship now in use. In addition to the two main propellers, the ship also has an auxiliary propeller which will enable it to maneuver precisely at speeds from zero to four knots.

A special feature will be the largest and heaviest deep sea winch ever used by this country for oceanographic research. It is capable of handling up to 40,000 feet of wire rope and lowering and raising as much as 20 tons of equipment.

Gibbs was named after Professor Josiah Willard Gibbs (1889-1903), who is generally conceded to be America's greatest physicist.

Chain, placed in operation last year, about one month before *Gibbs,* is 210 feet long, has a displacement of 1800 tons and a maximum speed of 14 knots. Capable of working in the North Atlantic in winter, *Chain* has accommodations for a crew of 40, and 28 scientists. She carries among her oceanographic equipment: A large thermistor winch; three hydrographic winches with 20,000 feet of wire each; one deep-sea winch with 30,000 feet of wire; three small winches; and four laboratories.

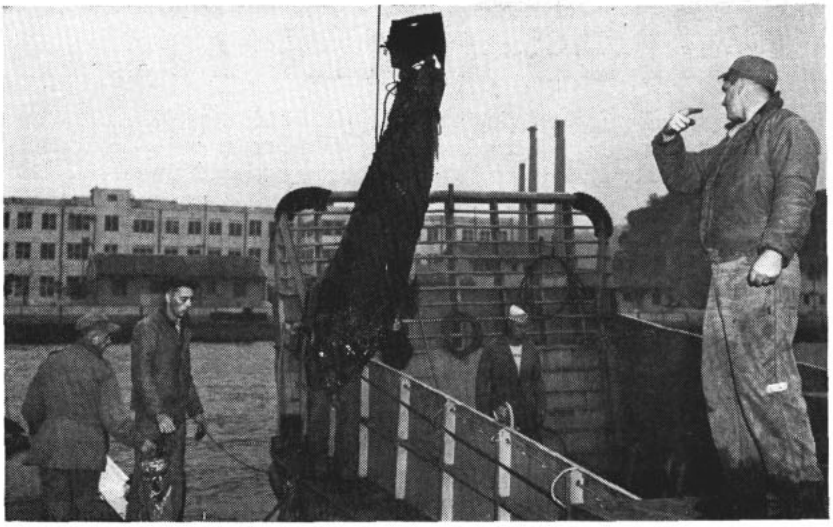
MSTS has the operational responsibilities for the ships.

All this is not to suggest that the Navy does no research itself. The Navy Electronics Lab and the Underwater Sound Lab each operates an EPCE; the Hydrographic Office operates *YF 854* and two 2700-ton former seaplane tenders, *San Pablo* and *Rehoboth.*

Itemized in this fashion, it might almost appear as though oceanography was one of the major sciences of this country. It is; and it isn't.

The number of individuals involved and money spent is relatively insignificant; the results, enormous. It has been estimated by ONR that there are no more than 500 recognized oceanographers in the United States; no more than 2000 world-wide. Yet, within a generation, the amount of useful information they have made available is far out of proportion to their numbers. The basic research these scientists have already accomplished will take years to evaluate properly.

HOWDY *STRANGER*—Oceanographic research ships like *Stranger* serving with Scripps Institution's fleet are continually studying mysteries of the sea.



BY THE TAIL—Bomb is pulled up and loaded on board EODT's landing craft.

TIME OUT—R. Parker, GMC, takes a breather after a hard day's work.

EOD Team on the Job

WORLD WAR II ENDED almost 14 years ago, but the U.S. Navy's Explosive Ordnance Disposal Team operating out of the Naval Ordnance Facility at Yokosuka, Japan, still faces vivid evidence of the conflict. The team's job is removing remnants of WW II ordnance that could still be deadly.

The team spotted some ordnance during a two-month search of Briggs Bay last September and began the job of removing 12 mammoth Japanese bombs about 100 yards from the base. The bombs weighed as much as 3300 pounds each.

Seabees from Amphibious Construction Battalion One operated the crane barge off which the EOD men were working. The EOD team, all second class divers, was made up of LTJG John P. Ellis, Richard Parker, GMC, John De Hahn, MNC, and John H. Briody, BM1.

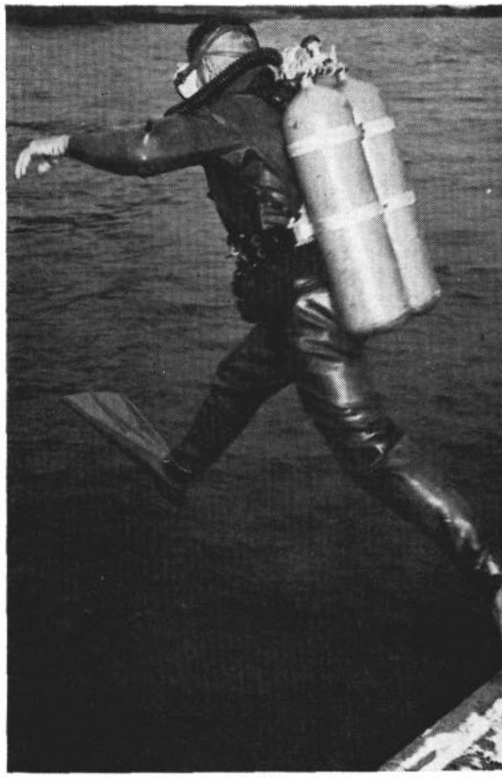
Red buoys, each tied to a different bomb, marked the location of the projectiles which were submerged in about 35 feet of water. Although the largest bomb contained some 500 to 600 pounds of explosives, the EOD team figured there was little probability they would explode. But they were taking no chances.

Chief Parker got into a rubber diving suit, strapped on his aqualung, and jumped flippers-first into the bay. He located the bomb at the bottom of the bay and worked the cable he had carried with him toward the nose of the projectile. The sea bottom was muddy and it was like reading by Braille. With his bare hands he felt the rough barnacled surface of the bomb, and finally managed to wrap the steel cable several times around the casing. This done, he returned to the surface and was handed the end of another cable which he wound around the bomb.

Seabees attached the crane hook through eyes at the ends of the cables. Slack went out of the cable and there was a strain as it inched upward. A few more inches and the crane was beginning to tilt and creak as the strain increased from the bomb which was sticking obstinately in the mud.

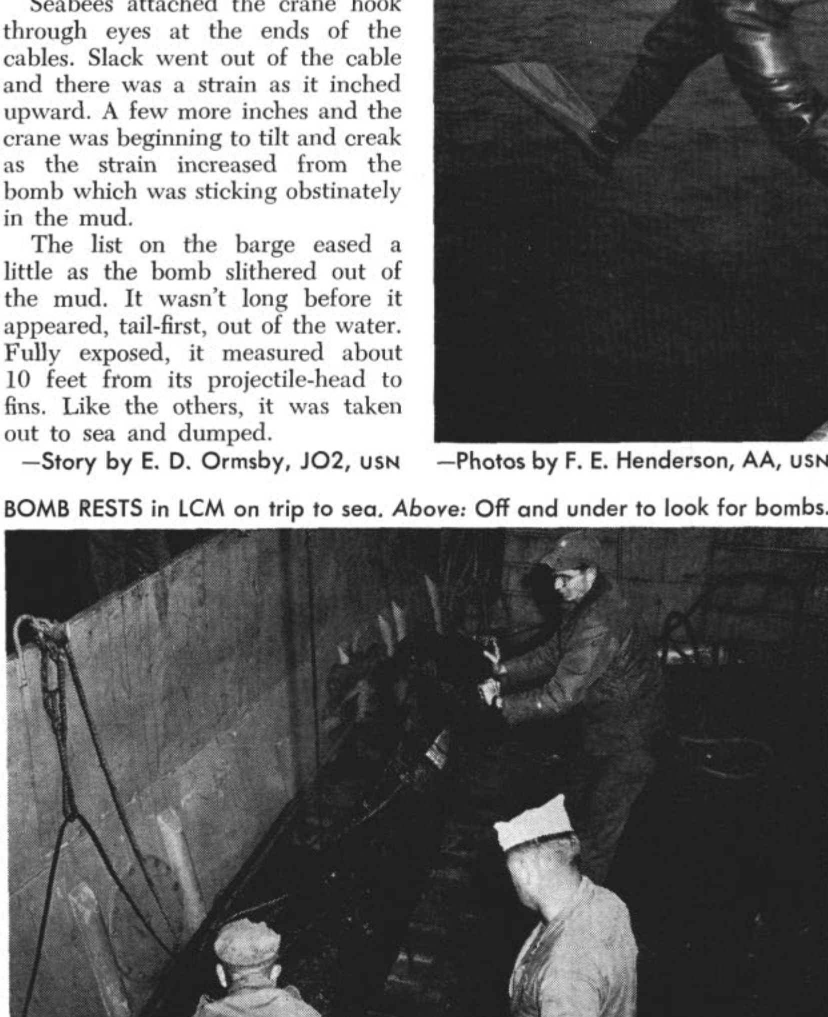
The list on the barge eased a little as the bomb slithered out of the mud. It wasn't long before it appeared, tail-first, out of the water. Fully exposed, it measured about 10 feet from its projectile-head to fins. Like the others, it was taken out to sea and dumped.

—Story by E. D. Ormsby, JO2, USN



—Photos by F. E. Henderson, AA, USN

BOMB RESTS in LCM on trip to sea. *Above:* Off and under to look for bombs.



Davy Jones Has Noisy

DURING THE EARLY DAYS of World War II, USS *Permit* (SS 178) recorded in her log: "Picked up unusual noise . . . could see nothing through periscope on that bearing. Sounded like hammering on steel in a non-rhythmic fashion accompanied by porpoise noises. Headed for sound. At times could be heard through 360 degrees."

A week later, USS *Tarpon* (SS 175) reported: "Noises which sounded as if the deck grating over the boat storage had been lifted and dropped three times. Shortly thereafter, sound heard echo-ranging from two ships bearing in the direction of the Gulf (Albay, P. I.), but no propeller noise was heard. Nothing in sight through the periscope."

USS *Salmon* (SS 182) "heard screws dead ahead. Nothing in sight."

Other submarines told of encountering the gamut of sound ranging from: Mild beeping, clicking, creaking, harsh croaking, whistling, grunting, hammering, moaning and mewing, to the staccato tapping as of a stick rapidly and steadily drawn along a picket fence, of coal rolling down a metal chute, fat frying in a pan, the dragging of heavy chains. Only the limitations of the language prevented further description.

As might be expected, sonar operators were rapidly approaching the point where they huddled in dark corners chewing their fingernails and starting violently when anyone spoke to them—even kindly.

The first break in this symphonic madness came when it was noted that serious variations in noise levels in waters near Fort Monroe occurred during the dawn and dusk listening periods. A "strangely loud background noise" occurred in early spring when croakers were known to tune up.

With this as a clue, investigators from a number of aquariums and laboratories were able to reassure submariners that their sonarmen were not suffering from excessive ear fatigue. Marine animal sounds, they said, were not only widespread, but "a source of significantly high background."

THE MATTER was not merely academic. It was rumored that mines planted inside the Great Barrier Reef of Australia by enemy raiders had been exploded by sonic fishes. The noise made by a single toadfish was measured on the North Carolina coast and it was apparently loud enough to detonate the type of acoustic mine then being prepared by the Navy for use in the Pacific. A double-actuation mechanism had to be developed for protection against such biological interference. *The silent sea was no longer silent.*

(It might be mentioned here that, even with the limited resources then available, the U. S. Navy was still able to determine the causes of these sounds two important years before Japan came to the same conclusion. Not until late 1944 did a prominent ichthyologist from Tokyo Imperial University discover the biological source of the sounds which were causing as much trouble to the Japanese fleet as to us.

Even though U. S. scientists were learning more and more, information was not immediately available to explain the phenomena or to predict when and where these sounds might be met again. In 1942, so little was

NOW WE KNOW that sea creatures are noisy. They are a source of frustration to sonarmen as well as fishermen.

Neighbors

understood of the underwater noisemakers that a list of all known (world-wide) forms of marine life producing subsurface sound included only 14 families of fishes and 17 families of shellfish. Descriptions were mostly in broad terms such as "nasal whine," "loud grunt," or "hoarse croak." Magnitude and frequency had not been measured, and much was merely hearsay.

This wasn't enough. The Navy had to know the methods of sound production by different species, the character of the sounds, the regional and seasonal variations, and the conditions under which they were produced.

Detailed research had to wait until after the end of the war, but between 1949 and 1954, 62 species of temperate coastal fishes, 105 subtropical and tropical fishes, 20 shellfish and two species of mammals had been auditioned. This was not simply a matter of sitting down and listening to the little creatures speaking their pieces. Hydrophones (underwater sound detectors) and tape recorders monitored the reactions of specimens when fed, annoyed, frightened, crowded, drawn into competition and otherwise stimulated. A reference file was established which will eventually, it is hoped, include the characteristic sounds of all important marine species.

IT WAS LEARNED that although fish have no organ developed solely for the production of sound, nature has modified various organs to accomplish the same purpose. Quite often the air bladder or swim bladder becomes a sort of resonator or soundbox. Sometimes muscles are embedded in the air bladder and, by contraction, set up vibrations of walls and gaseous contents; sometimes slender muscles connecting the bladder to the vertebrae vibrate like violin strings. This helps to explain the muffled grunts of rock hinds, the sustained resonant rumbling of groupers, growling of trunkfish, drumming of croakers and the tomtom beating of sea catfish.

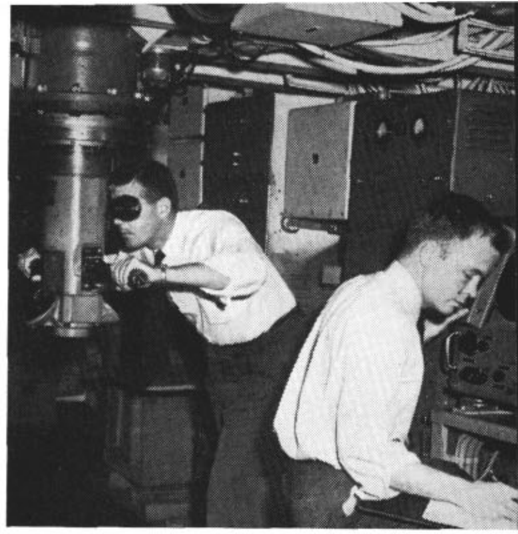
Others scrape bone against bone to produce sound. The sculpins of northern waters produce a dull droning, buzzing or long continued rumbling sound (something like a generator hum) with their pelvic bones; the king-size ocean sunfish grates its teeth. Puffers and burrfish manage long bursts of nasal croaking by rubbing together their upper and lower plates, and the sharp whining swish and chirp of filefish also come from the mouth—in this case by special transverse grooves in the uppers.

Each species, it has been found, has a characteristic range of sounds. These sounds are so characteristic with respect to range limitation, harmonic quality, duration and repetition rate that an experienced listener can soon learn to recognize the various sources—much like the expert birdwatcher can recognize a long list of birds from their calls.

The volume of sound appears to have a direct relation to the intensity of stimulation as well as to the size of the soundmaker — which seems only reasonable. Toadfish, for example, have been found to be somewhat louder in the open sea than when in laboratory tanks.

MOST SPECIES USE sound of one kind or another as a means of communication, as an expression of fight or fright, for defense or offense, as a response to changes in the environment, or as a means of orientation. A large portion of the noises heard, however, simply results from eating—a situation frequently known to exist in human society. Rays, for example, may be found by a loud crackling as their pavement-like teeth crush shells on the bottom, and hydrophones in shallow water populated by cunners may pick up constant clicking and chirping, which are chewing sounds.

Again, as in human society, the period of greatest noisemaking is frequently connected with social affairs and with the preservation of the species. Since spawning habits are known, the biologist can usually predict dates and locations of fish concentrations. Although the sound of an individual may be insignificant, the combined output of a school results in considerable volume. One drumfish croak, for example, may not reach more than 50 feet; however, a nighttime chorus of spawners has markedly raised the general background level of a large bay



FACT-FINDING—Personnel of Navy's Underwater Sound Laboratory run an experiment from their floating lab.

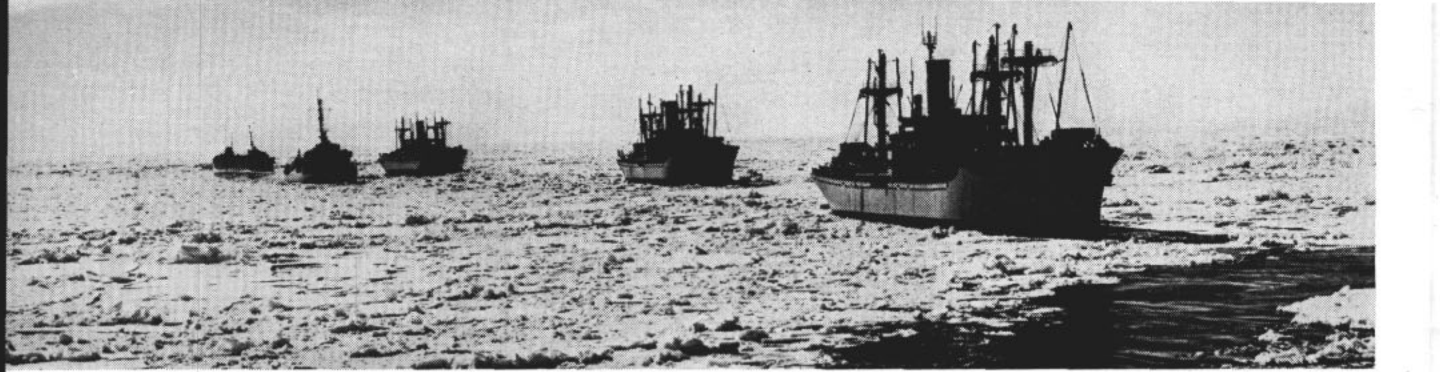
over the audible frequency range. The characteristic drumming, which sounds like a pneumatic drill working through concrete, may very well mask the sound of a slow-moving submarine.

Fortunately, croaker noises and that of many other fish, are restricted to a comparatively low and narrow frequency band. Experiments have shown that the sounds of most North Atlantic species can be almost eliminated by filters.

Shrimp noises frequently cause sonarmen to act the way they do. The shrimp have been found during certain seasons to reduce sonar ranges by as much as 40 per cent and seriously mask the sounds of torpedoes and cavitating subs.

Here again, the marine biologist offers practical advice: Shrimp and the equally noisy squilla can be expected in waters with coral, rock, stone or shell bottom almost anywhere around the world between 35 degrees North and 35 degrees South. But, he warns, if the noise you hear under these conditions comes from a depth greater than 30 fathoms, better tear out of there. It isn't shrimp.

However, one class of marine fauna simply does not lend itself to such neat classification. About the only useful information the biologist can offer concerning porpoises and whales is that they like submarines. Inquisitive and gregarious, they have at times followed their newfound friends for miles, sounding off with assorted false propeller noise, phantom echo-ranging pings and miscellaneous pings. This has frequently caused the sub and porpoise friendship to become unilateral.



PLANNING A VOYAGE?—Navy's Hydrographic Office has on issue more than 4400 standard nautical charts.

Pioneer: Navy Hydrographic Office

No discussion of oceanography will ever get far before it runs into rocks and shoals if it does not include mention of the U.S. Navy Hydrographic Office.

Founded in 1830 and given early impetus by Maury's wind and current charts first published in 1847, Hydro has led the world in its contributions of deep sea soundings and bathymetric charts ever since 1922. It was in this year that the Navy developed the first practical sonic sounding machine and two destroyers obtained a complete profile of the ocean's bottom along their track in a cruise across the Atlantic and through the Mediterranean.

Aerial photography was used for the first time by the Hydrographic Office that same year in conducting surveys of the coast of Cuba.

Throughout the years, Hydro has been engaged in various scientific fields. These include studies in meteorology, investigations in terrestrial magnetism, marine surveying, oceanography, cartography, photogrammetry, aerial photography, marine geography, engraving and printing. Some of these areas have become so highly specialized that new government organizations have been established for the exclusive study of these sciences.

Long-range over-water aviation, development of radar, loran, and other electronic devices for navigational purposes, new systems and methods of computing fixes from celestial observations, the oceanographic research demanded for modern antisubmarine and amphibious warfare—all have influenced the activities and functions of Hydro.

The mission of the Hydrographic Office is enough to make strong men tremble:

To collect, evaluate, compile, produce and distribute accurate and timely hydrographic, oceanographic, and aeronautical information, including nautical and aeronautical charts and publications calculated to afford the maximum possible navigational safety and facility to ships of the Navy, Coast Guard and Merchant Marine, and to naval aircraft operating over areas of strategic interest to the Navy.

And: To produce special charts and related publications for use of the Navy and its operating forces, for training and operational purposes, including those for amphibious, air and undersea warfare.

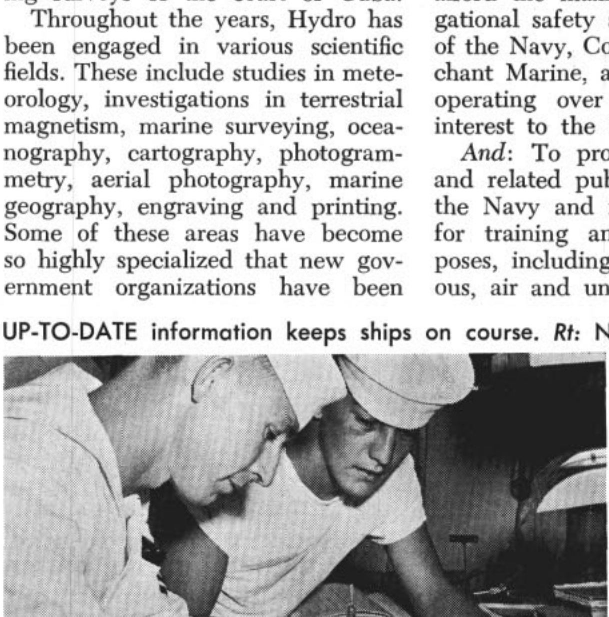
And: To produce special hydrographic, oceanographic and aeronautical charts and related data in cooperation with the Army and Air Force to meet the needs of joint operations, and further to meet the requirements of the Joint Chiefs of Staff in support of war plans.

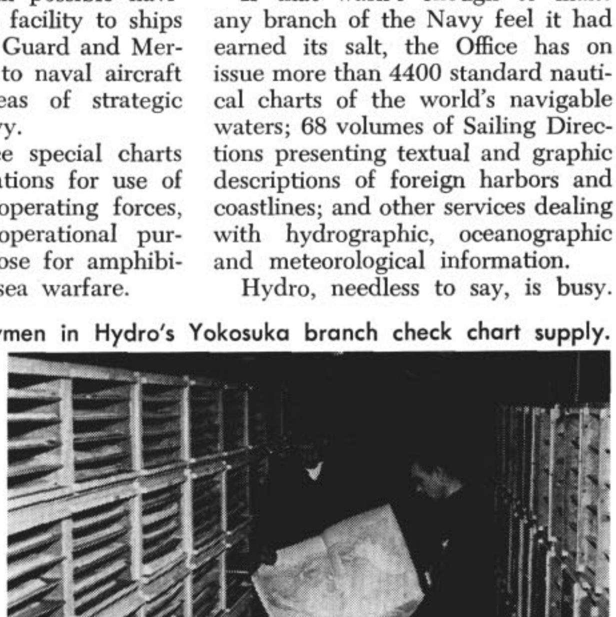
And: To serve as the Navy Department repository of record of technical source material relating to hydrographic, oceanographic, cartographic, magnetic, geodetic and gravity matters; and, further, to serve as the principal agency of the Navy Department to administer, regulate, and manage the exchange of such material with the Army Map Service, the Aeronautical Chart and Information Center, the Geodetic Survey, and other departments.

If that wasn't enough to make any branch of the Navy feel it had earned its salt, the Office has on issue more than 4400 standard nautical charts of the world's navigable waters; 68 volumes of Sailing Directions presenting textual and graphic descriptions of foreign harbors and coastlines; and other services dealing with hydrographic, oceanographic and meteorological information.

Hydro, needless to say, is busy.

UP-TO-DATE information keeps ships on course. *Rt:* Navymen in Hydro's Yokosuka branch check chart supply.





NAVY DIVING QUALS

WHAT'S THE DIFFERENCE between a Scuba, Master, First Class, Salvage, or Second Class Diver? And how about pay—do qualified divers receive any added compensation? Or what?

Here's a rundown on the Navy's various designations and details concerning special pay for diving duty.

Briefly, all divers fall into one of two categories, depending upon the type of diving equipment they use. Those that use self-contained breathing apparatus are often referred to as "free swimmers" and are classed as Scuba divers. The others, those who use special helmets or diving suits and receive air from the surface, come under the surface-supplied category. This includes shallow-water as well as deep-sea diving.

Shallow-water diving is made by those who dive to depths less than 36 feet and use a helmet or diving suit that receives air through a hose from the surface. Deep sea diving is made by men who dive to depths greater than 36 feet and receive their air through a hose from the surface.

The Navy has three different deep sea diving classifications. They are Master, First Class and Second Class Diver. These different ratings are assigned to men according to their degree of qualification. These qualifications are spelled out in detail in Article C-7408, *BuPers Manual.*

Master Divers are the Navy's leading divers. They are designated by the Chief of Naval Personnel only, in accordance with the needs of the service and with the recommendations of the individual's commanding officer and a special selection board. To be eligible, any qualified Diver First Class must meet the following requirements:

- Be a Chief Petty Officer.
- Have served a minimum of two years with the designation and qualifications of a diver first class (this includes Scuba diver qualifications).
- Have served as a qualified diver for a minimum of 12 months aboard a helium-oxygen-equipped diving vessel (ASR), and a vessel equipped for ship salvage (ARS/ARSD).
- Demonstrate ability to take charge of all phases of helium-oxygen diving (see page 61).
- Demonstrate ability to plan and take charge of all diving operations.
- Demonstrate ability to take charge of operation and maintenance of a submarine rescue chamber.
- Demonstrate knowledge of all Navy-procured types of self-contained underwater breathing equipment, including their advantages and limitations.
- Know the methods and materials used in unbeaching ships on strand under various conditions of beach, sea and water; and refloating sunken vessels.
- Understand the principles of the General Gas Law and its derivatives (Boyle's and Charles' Law); understand the principles of Dalton's Law of partial pressures and Henry's Law of fluid saturation; understand the theory of inert gas saturation and desaturation of body fluids and tissues; understand the principles involved in the computation of various decompression tables; recognize the different forms of decompression sickness and know the required treatment of them.
- Understand the effect upon the respiratory system of such poisonous gases as may be encountered in diving, and know the treatment required.
- Know the name and use of equipment required for safe diving operations.
- Know the causes, symptoms, treatment of, and preventive measures for all types of diving accidents.
- Have a comprehensive knowledge of the scope, content and application of Navy publications and instructions pertaining to diving such as the *Diving Manual* (NavShips 250-538), and applicable sections of the *Bureau of Ships Manual, Manual of the Medical Department* and *BuPers Manual.*

With all of these qualifications, Master Divers are required to direct

ON DECK—Dressers attend to students as they prepare for test dive into muddy Anacostia river at School for Deep Sea Divers in Washington, D.C.

other divers in underwater salvage, repair, construction, demolition, recovery and rescue work. They must supervise personnel during diving operations from topside or underwater as necessary. When not serving in this capacity, Master Divers often survey the job themselves to determine the most effective method of accomplishing the task, especially when the depth of water is greater than 150 feet.

It is also the job of the Master Diver to see that all divers under his supervision are properly trained and that they keep up to date on the latest techniques and maintenance of all types of diving gear and associated salvage, rescue and repair equipment.

They also treat personnel who are afflicted with maladies common to diving, such as caisson disease.

Master Divers are assigned a primary job code number for an Underwater Mechanic—ESM-5311-Master Diver. So long as they remain on diving duty and keep up their qualifications, Master Divers receive $33 per month diving pay in addition to their basic pay and allowances.

All Navy deep sea divers, regardless of their rank, rate or diving classification, are also paid an extra $5.50 for each hour or fraction of an hour when engaged in actual salvage or repair operations in depths over 90 feet. This $5.50 hourly rate is also paid for dives in depths less than 90 feet when the officer in charge determines that extraordinary hazardous diving conditions exist.

Divers First Class are deep sea divers, trained, qualified and designated at the U.S. Naval School for Deep Sea Divers, Washington, D.C.

They are responsible for underwater salvage, repair, construction, demolition, recovery and rescue work at depths greater than 150 feet. They must be able to operate underwater hand and power tools, gas and electric cutting torches, and electric welding equipment.

They are also required to lay out beach gear for hauling off stranded vessels, rigs for lifting submerged objects by washing tunnels and reeving lines, wires or chains under the object; enter submerged vessels to perform salvage or repair work; connect air hoses to submarines during salvage operations; operate and maintain diving gear and associated salvage, and repair equipment.

Divers First Class receive an extra $20 per month so long as they remain designated as such and are assigned to diving duty. In addition, they receive two cents per minute during any dive for which they do not receive the $5.50 hourly rate; and five cents per foot of total depth of dives over 120 feet or equivalent pressure. The amount payable to Divers First Class at the two cents per minute and five cents per foot rate is limited to $13 per month.

(There are over 200 ***Salvage Divers*** in the Navy today who are being phased into the Diver First Class Program through 13 weeks of "cross training" at the U.S. Naval School for Deep Sea Divers. All Salvage Divers must attend this course and convert to Diver First Class by June 1962 or revert to Diver Second Class.)

Divers Second Class are trained, qualified and designated by commands authorized by the Chief of Naval Personnel.

WHAT'S IN A NAME

Underwater Jeep Drivers

One night back in 1954 USS *LST 291* was churning her way through the waters of the Great Bahamas after completing two weeks of amphibious training exercises at Vieques, Puerto Rico. On her decks she carried 114 vehicles and 56 tons of equipment.

About 1800 yards off James Point, Eleuthera Island, a resounding crunch shattered the silence of the night. The LST had hit a submerged coral reef, which tore a two-foot hole in her evaporator room and twisted, warped and gashed her hull at many other points. Water poured in through the openings to flood all of the lower compartments. Personnel were ordered over the side. Before long two DEs arrived to take them off the island to which they had gone after the grounding. A volunteer salvage party was left with the ship.

The first step in the salvage operations was to flood all compartments. This was done to increase the weight of the ship and prevent further damage from the heavy seas which had been driving her closer to the beach and scraping new holes in her bottom.

When frogmen from Underwater Demolition Team Two reached the scene they began a survey. In spite of a 25-knot wind and far from ideal weather conditions, they made a mass underwater swim, in Scubas, to explore a reported channel across the reef. They found a shallow channel, but revealed that it was obstructed by coral pinnacles up to 100 feet in diameter. These would have to be blasted out of the way before the ship could be brought off.

About 400 pounds of explosives were used in the first effort. More was rushed in by sea and air, and the channel began to take shape. While the frogmen blasted, utility landing craft from two LSDs were busy removing cargo, and salvage operations aboard the LST, directed by Commander Robert K. Thurman, USN, had also gotten under way. Divers flown in from COMSERVLANT or furnished by salvage ships, carried out this part of the job. Large amounts of grease, oil and gasoline in the water made the going rough for them.

During the salvage operations, vehicles in the ship's flooded tank deck had to be removed. As a result, two of the divers found themselves qualifying as "underwater jeep drivers."

To do this, the underwater motorist would seat himself behind the wheel of a submerged vehicle. Then, while a heavy crane pulled, he would steer the jeep into position beneath a hatch so that the crane could lift the car out. This went on until all the jeeps were removed from their underwater parking lot.

After 11 days of hard work the LST was finally ready to be filled with compressed air and refloated. By then the frogmen had blasted out a 1000-foot channel, the cargo had been salvaged and the holes and gashes in the hull had been patched.

A towline was attached to the salvage ships, USS *Discovery* (ARS 43) and *Opportune* (ARS 41). Then landing craft began washing heavy streams of water under the LST's stern to move her off the ledge which held her. After a few tense moments when the towline caught on a coral pinnacle and the LST almost got out of the channel, the ship at last floated clear of the reef and turned on her running lights.

The UDT men, the ships that had come to the LST's aid and the salvage crew—including the underwater jeep drivers—had completed their task.

To qualify as a Diver Second Class, an individual must graduate from the six-week qualification course and:

- Understand the care, preservation and use of all air diving equipment such as compressors, hose, helmets, suits and Scuba.
- Test, repair and adjust all air diving equipment and determine whether they are safe for use.
- Know the nomenclature of diving equipment and function of component parts.
- Dress and tend diver expertly.
- Know standard diving signals; know the instructions for keeping diving log and entries required.
- Understand the theory and practice of decompression and use of the decompression table; know the cause, symptoms, treatment and prevention of air embolism; know the dangers of oxygen poisoning during the administration of oxygen under pressure, its usual symptoms, warnings and treatment.
- Demonstrate the back-pressure armlift method of manual artificial respiration.
- Have knowledge of first aid related to the treatment of common diving accidents.
- Know the physics of diving.
- Know the methods and procedures employed in searching for and recovering objects on the bottom.
- Know how and when to use a recompression chamber; know how to administer oxygen properly for treatment purposes.
- Demonstrate practical application of marlinespike seamanship to diving operations.
- Perform work at depth of 50 feet of water for one hour—this to constitute a qualifying dive.
- Know the contents and use of the *Diving Manual*.
- Estimate an underwater situation and give an intelligent description of same.
- Care for and operate Navy standard rescue breathing apparatus.
- Use oxygen-electric torch underwater.
- Use and know the advantages, limitations and safety precautions of open-circuit demand Scuba.

Divers Second Class receive $13 each month in addition to their basic pay and allowances so long as they remain qualified and are assigned to diving duty. They also receive the extra two cents per minute and five cents per foot for dives that do not qualify for the $5.50 hourly rate, but not to exceed $20 per month.

All divers are required to requalify every six months or else lose their designation. Master and Divers First Class are required to make four requalification dives in depths of 150-170 feet; 170-200 feet and over 200 feet; while Divers Second Class must make a series of four dives at any depth up to 150 feet.

Qualified divers are authorized to wear a distinguishing mark on the right sleeve of their uniforms. It consists of a diving helmet and breast plate with the letter "M" for Master, the letter "S" for Salvage Diver, and the figures one or two, for First or Second Class Diver, centered on the breastplate of the diver's insignia.

Scuba divers do not have any special distinguishing mark nor are they authorized to draw special pay for diving.

In addition to the special pay for diving duty explained above, some divers are entitled to an extra $55 per month incentive pay for the performance of hazardous duty. This includes:

- Master and Divers First Class who are assigned to duty (aboard ASR) involving the use of helium-oxygen for a breathing mixture in the execution of deep sea diving.
- Duty at a submarine escape training tank, when such duty involves participation in the training.
- Duty at the Naval School for Deep Sea Divers or the Navy Experimental Diving Unit, when such duty involves participation in training. —H. George Baker, JOC, USN.

Under the Seas

A publication has recently become available which should enable you to understand your submarine Navy better.

The Complete Book of Submarines by CAPT William C. Chambliss, CDR Charles W. Rush, Jr., and CDR H. J. Gimpel tells the story of the submarine from its beginning through the modern nuclear boats. The authors tell of the training that makes submariners, and relate man wartime exploits of our underseas crafts. They also probe into the future and discuss the possible commercial uses of subs.

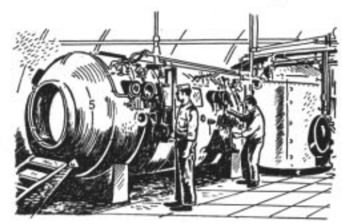
HERE'S YOUR NAVY

The U. S. Navy has always been interested in diving—but it has been investigating *deep-sea diving* problems since 1912. By 1925 the experiments had grown to such an extent that the Experimental Diving Unit was set up as a permanent activity under the Bureau of Construction and Repair (now BuShips). The EDU is located at the Naval Gun Factory, Washington, D. C.

One of its principal items of laboratory apparatus in diving research is the pressure tank and re-

compression chamber unit. This consists essentially of three sections: the wet tank, with the dry tank (or igloo) above it, and the recompression chamber. All sections are capable of withstanding internal pressures up to 350 pounds per square inch (785 feet of sea water).

In operation, the vertical cylindrical wet tank is filled with water to a depth of about seven feet. Divers enter by way of the igloo and the wet tank hatch. The wet tank is then sealed shut, or (depending on the type of dive) the wet tank and igloo are



operated as a single unit or lock. In either case, air is admitted to the space above the water to build up pressure to simulated depths of up to several hundred feet.

Three line officers, three medical officers and 18 enlisted divers at EDU are at present working on more than 20 continuing projects. Several of these pertain to the physiological aspects of diving. Others include equipment development and evaluation, extending the limits of helium-oxygen diving, and underwater television.

The unit maintains a small but well equipped laboratory containing many types of gas analyzing equipment and other instruments which assist in diving-physiology studies. There are also a carpenter's shop, metalsmith's shop and machine shop.

Here's List of Instructions and Schools for Underseas Sailors

THE NAVY under the sea covers a lot of ground. And for men who work in this part of the Navy, there's a lot to learn. This knowledge is picked up from Navy training courses, Navy schools, and from various instructions and manuals.

Here's a rundown where pertinent information about this phase of the Navy can be found. A list of schools is also included. Note: This is *not* a complete list. For additional training, see your Education Officer. For general information see BuMed, BuPers, BuShips, diving manuals.

DIVING

SOURCE	*SUBJECT*
BuPers Manual	
Article C-7313	Officer qualifications for Scuba training.
Article C-7314	Officer qualifications for deep-sea helium-oxygen diving.
Article C-7315	Qualifications for Salvage Diving Officer.
Article C-7408	Diver qualifications.
Article C-7418	Qualifications for enlisted Scuba divers.
Article A-4202	Diving pay.
BuMed Manual	
Article 15-30	Physical requirements for deep-sea and Scuba divers.
BuPers Inst. 1500.15C	Selection and training of candidates for diving duty.
BuPers Inst. 1500.36	Mobilization planning guide for Diver's Second Class schools.
BuPers Inst. 1520.4D	How to apply for officer deep-sea diver's training.
BuAer Inst. 9940.1	Use of self-contained underwater breathing apparatus (Scuba).
OpNav Inst. 9940.1B	Divers and their equipment.

UNDERWATER DEMOLITION (UDT)

BuPers Manual	
Article C-7305	Officer qualifications for Underwater Demolition Teams.
Article C-7406	Enlisted qualifications for Underwater Demolition Teams.
BuPers Inst. 1520.7	How to apply for underwater demolition training.
BuShips Inst. 3990.1	Underwater noise measurements of submarines.
OpNav Inst. 10126.3	Coral Shoe for use by Underwater Demolition Teams and Explosive Ordnance Disposal Units.

EXPLOSIVE ORDNANCE DISPOSAL (EOD)

BuPers Manual	
Article C-7306	Officer qualifications for EOD.
Article C-7407	Enlisted qualifications for EOD.
BuPers Inst. 1320.5A	Duty involving the demolition of explosives.
BuPers Inst. 1500.31	Mobilization planning guide for EOD schools.
OpNav Inst. 8027.1A	Responsibilities for EOD.
OpNav Inst. 8027.5A	Requirements for EOD equipment.
OpNav Inst. 8027.6	Naval responsibilities for explosive ordnance disposal.

SUBMARINES

SUBJECT	*SUBJECT*
BuPers Manual	
Article C-7303	Qualifications for submarine officers.
Article C-7304	Enlisted qualifications for sub duty.
Article C-7309	Qualifications for submarine medical officers.
Article C-7310	Qualifications for submarine engineering duty officer.
Article A-4301	Submarine pay.
Article D-1502	Submarine training for officers.
BuPers Inst. 1520.6G	Application for officer submarine training.
BuPers Inst. 1540.2C CH-1	Assignment of enlisted personnel to initial submarine duty.
OpNav Inst. 3360.11	Training policy for ASW personnel.

OCEANOGRAPHY

SecNav Inst. 5430.33	Navy's responsibility for the provision of oceanographic services to the Department of Defense.
OpNav Inst. 9010.130	Approved characteristics of Oceanographic Research ship (AGS).

SCHOOLS *(Submarines)*

Catalog of U.S. Naval Training Activities and Courses.

Page 53	Submarine Periscope repair (8 weeks), at U.S. Naval Opticalmen Class A school, Great Lakes, Ill.
Page 78 & 95	Torpedoman's Mate (class A) course (10-19 weeks), Key West, Fla. and San Diego, Calif.
Page 74	Underwater cutting and welding (6 weeks) at San Diego, Calif.
Page 78	Advanced Undersea Weapons School at Key West, Fla. Courses range from 2 to 19 weeks.
Page 86	U.S. Naval Schools, Mine Warfare, Yorktown, Va. Courses offered are: 1. Submarine Mine Warfare Familiarization (officer), 1½ weeks. 2. Submarine Mines Maintenance (officer), 6 weeks. 3. Submarine Mines Assembly (class C), 6 weeks. 4. Submarine Automatic Degaussing (class C), 6 weeks.
Page 95	U.S. Fleet Submarine Training Facilities, San Francisco, Calif.
Page 97	U.S. Naval Submarine School, New London, Conn.

SCHOOLS *(Diving)*

Page 79 (see also BuPers Inst. 1500.25E)	U.S. Naval School, Deep Sea Divers, in Washington, D.C. Courses offered are: 1. Diving Officers, 26 weeks. 2. Diving Officers, 10 weeks. 3. Salvage Officers, 16 weeks. 4. Salvage Officers, 5 weeks. 5. Medical Officers, 8 weeks or less. 6. Medical Deep Sea Diving Technician (enlisted), 27 weeks. 7. Divers "Cross-Training" (a) Deep Sea Diving (13 weeks). (b) Salvage Diving (7 weeks). 8. Divers, Second Class (enlisted), 6 weeks. 9. Divers Refresher (Master, First Class, Deep Sea, and Salvage Diver), 10 weeks or less. 10. Helium-oxygen divers refresher (officer and enlisted), 2 weeks. 11. Divers requalification (Master, First Class, Deep Sea, Salvage, and Diver Second Class), 2 weeks or less.
Page 91	Scuba Divers School (officer and enlisted), 5 weeks at Key West, Fla.

BOOKS FOR THOSE INTERESTED IN UNDERWATER READING

DO YOU LIKE READING about a fascinating, adventurous subject? Whether your interest in the world under water is as a professional, a trainee, a sportsman or a hobbyist, you will find many books to give you pleasure and information. The books listed below are among many available in your ship and station libraries.

Underwater Diving—Techniques

Handbook for Skin Divers—Bronson-Howard; 1958. Handy self-reference written for persons interested in skin diving.

The Science of Skin and Scuba Diving—Conference for National Co-operation in Aquatics; 1957. A valuable guide for adventuring with safety underwater.

Free Diving—Rebikoff; 1956. Describes self-contained underwater breathing apparatus, techniques and available equipment.

Shallow Water Diving and Spearfishing—Schenck & Kendall; 1954. A primer for the sportsman and hobbyist.

Skin Diving and Exploring Underwater—Sweeney; 1955. A professional diver and former Navy instructor's "how-to" book with detailed information on equipment and its use.

The Complete Manual of Free Diving—Tailliez; 1957. Authoritative technical manual by French naval underwater research group.

Underwater Sport—Vanderkogel & Lardner; 1955. Pointers on what you can and cannot do under water.

History, Exploration, and Adventure Below

Half Mile Down—Beebe; 1951. History of diving and underwater explorations.

Silent World — Cousteau; 1953. Fascinating account of the blue twilight seascape.

Danger is My Business — Craig; 1938. Autobiography of a deep sea diver.

Treasure-Diving Holidays — Grile; 1954. Underwater adventures in the West Indies and Mediterranean.

The Undersea Adventure — Diolé; 1953. A sea explorer's philosophical observations on marine life and psychology of diving.

4000 Years Under the Sea—Diolé; 1954. Diving for ancient treasures, mostly from Mediterranean civilizations.

Man Under the Sea—Dugan; 1956. Man's underwater exploits from primitive to present times.

Men Under the Sea — Ellsberg; 1939. Navy underwater rescue and diving experiences.

Deep Down Under — Floherty; 1953. Diving for salvage, construction, pearling, sport by frogmen, aqualungers and mask and finners.

Diving to Adventure—Hass; 1951. Water hunting and photographing underwater life.

2000 Fathoms Down — Huout & Willm; 1955. Story of two pioneers in a free moving bathyscaph.

Man and the Underwater World—Latil & Rivoire; 1956. History of man's attempts to penetrate the sea from the time of ancient Greeks to the bathyscaph.

Fathoms Below — Meier; 1943. Underwater salvage from sailing ships to *Normandie.*

Earth, Sky and Sea—Piccard; 1956. A scientist-adventurer in bathyscaph and balloon.

The Blue Continent—Quilici; 1954. Dangers and fascinations of aquatic big game hunting in the Red Sea.

The Underseas Navyman—World War II and After

Combat Beneath the Sea—Brou; 1957. Underseas war of all countries, describing swimmers, demolition teams and ordnance disposal squads.

Sea Devils—Borghese; 1954. True story of daring "human torpedoes" in Italian Navy's suicide corps.

The Big Dive—Crossen; 1959. A suspense novel based on the actual disappearance of a British frogman.

No Banners, No Bugles—Ellsberg; 1949. Salvage diving in the Med.

WAY BACK WHEN

Straight Down and Still Going

On a hot day in August 1913, the battleship USS *Nebraska* (BB 14) was holding torpedo practice in Guacanagabo Bay, Cuba. Instead of coming to a stop at the end of their run where they were supposed to float until recovered, most of the torpedoes kept right on going. One, it was noticed ran for a considerable distance, then sank in 120 feet of water.

In *Nebraska*'s recovery launch was the diving officer, Chief Gunner C. J. Miller, USN. With him were men dressed in diving gear whose job it was to locate sunken torpedoes. Within a short time the launch was over the spot and the Gunner sent a man down to survey the situation.

The diver came up on his own accord and informed Gunner Miller that "the torpedo was on its way to h---" (the mud being very soft), that he "could only see the tail and that the propellers were still turning over."

Armed with a shovel the diver went down after the torpedo. He worked for over an hour before he was hauled up, exhausted from his strenuous work. He informed the diving officer that he had dug a hole 20 feet deep and that the torpedo was still underway.

A relief diver went down. About a half-hour later he asked for a heavily weighted five-inch line to be sent down. This was made fast to the tail of the torpedo. The diver came up and informed Gunner Miller that he had put a timber hitch on her as he could only get one turn. The Gunner said that was enough.

Windlass and funnel were shipped and they hove the launch down to one inch freeboard. But it was no go. *Nebraska*, meanwhile, was maneuvering close by and the OOD suggested passing the hawser to the ship. It was rove through her hawsepipe and a turn taken around the winch.

The first few turns straightened the line out taut to such an extent that the ship's head was swung around by the tension. Another few turns and the torpedo shot out of the water 10 feet from the ship.

The elusive torpedo and the launch were taken aboard.

Under the Red Sea Sun—Ellsberg; 1946. Wartime underwater salvage in Africa.

The Naked Warriors — Fane & Moore; 1956. U.S. Navy frogmen from Tarawa to the present.

Ordeal by Water—Keeble; 1958. Salvage operations in the Mediterranean.

Epics of Salvage—Masters; 1954. Wartime feats of marine salvage men in World War II.

Frogman—Pugh; 1956. Story of famous British diver.

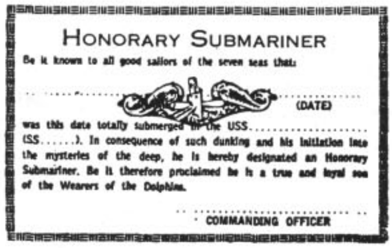
Frogmen — Waldron & Gleeson; 1950. The story of the wartime underwater operators.

By Sea and by Stealth—Wilkinson; 1956. Underwater exploits by miniature submarines, frogmen and "sneak craft."

The Midget Raiders — Warren; 1954. The wartime story of human torpedoes and midget submarines.

Ocean World

Oceanography and Marine Biology—Barnes; 1959. A technical account of instruments, methods and results of ocean exploration including marine life, properties of water, underwater noise, photography and TV.


HONORARY SUBMARINER

Be it known to all good sailors of the seven seas that:

.... (DATE)

was this date totally submerged in the USS.................... (SS......). In consequence of such dunking and his initiation into the mysteries of the deep, he is hereby designated an Honorary Submariner. Be it therefore proclaimed he is a true and loyal son of the Wearers of the Dolphins.

.... COMMANDING OFFICER

The Living Tide — Berrill; 1951. Animal and marine life in Atlantic tidal waters.

Edge of the Sea—Carson; 1954. The intertidal world of plants and animals.

The Sea Around Us—Carson; 1951. An authoritative and skillful story of the sea, its islands, mountains and depths; and man's efforts to solve its mystery.

The Ocean River—Chapin & Smith; 1952. Popular study of the Gulf Stream.

Story of the Oceans — Douglas; 1952. An informal introduction to oceanography.

The Atlantic—Outhwaite; 1957. A history of the ocean.

The Pacific Ocean — Reesenberg; 1940. On the world's largest ocean.

The Book of the Sea—Spectorsky; 1954. Anthology of writings about the wonder, majesty and mystery of the sea.

The Oceans — Sverdrup; 1942. Their physics, chemistry and general biology.

Wild Ocean—Villiers; 1957. North Atlantic and the men who sailed it.

Submariners

Nautilus 90 North — Anderson; 1959. Story of the epic transpolar voyage.

Submarine!—Beach; 1952. U. S. submarines in World War II.

The Atomic Submarine and Admiral Rickover—Blair; 1954.

The Hunters and the Hunted—Brennecke; 1958. German submarine warfare.

U-Boats at War—Busch; 1955.

Battle Submerged—Cope & Karig; 1951. Submarine fighters of World War II.

H. M. U-Boat—Drummond; 1958. Adventures of a German submarine captured by the British.

The Sea Wolves — Frank; 1955. The story of German U-Boats at War.

Twenty Million Tons Under the Sea—Gallery; 1956. Biography of the Nazi submarine U-505 captured by the U.S. Navy.

War Fish—Grider & Sims; 1958. Life of U.S. submarine crew in battle and on shore.

Sunk—Hashimoto; 1954. Story of the Japanese submarine fleet, 1942-1945.

Hellcats of the Sea—Lockwood; 1955. Submariners' "Operation Barney" when nine submarines invaded the Sea of Japan.

Sink 'Em All—Lockwood; 1951. Submarine warfare in the Pacific written by an expert.

Through Hell and Deep Water—Lockwood & Adamson; 1956. A biography of CDR Dealey, skipper of USS *Harder* and a history of his ship.

United States Submarine Operations in World War II—Roscoe; 1949. The big picture of subs in action.

The Complete Book of Submarines—Rush & others; 1958. Types of submarines and what goes into them.

U-Boat 977 — Schaeffer; 1953. Nazi skipper's version of his underseas operation.

Silversides—Trumbull; 1945. USS *Silversides'* adventures in the Pacific.

Undersea Patrol — Young; 1953. A first hand picture of World War II British submarine service.

Look Out for Synaceja

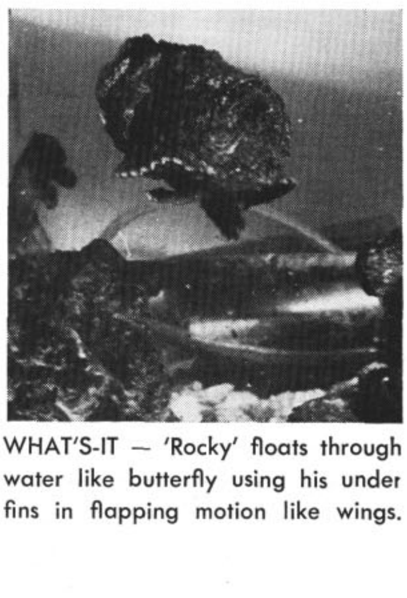
One of the most unusual passengers to travel aboard USNS *T-LST 618* was a *Synaceja horridis*. In plain English, that would be a stonefish.

This unusual MSTS passenger was captured by a former crew member who was netting tropical fish when *LST 618* was operating in the South Pacific. It was discovered when a fishing companion accidentally stepped on it in a tidal pool. Luckily the man was wearing shoes, for the poison secreted from the dorsal fins of the stonefish are so fatal that there is but one recorded incident of man' surviving its sting. South Sea natives claim that the only remedy to forestall death is immediate amputation. The sting of the stonefish is classed with the bite of the bushmaster snake.

This is one more good reason for wearing swim shoes in tropical waters where coral abounds.

The stonefish is extremely ugly and has a funnel type mouth. Its eyes are vicious looking with white circles and are set on the top of the head very much in the same manner as those of a flounder or flatfish. They usually imbed themselves in small rocks or coral along the ocean floor and are just about invisible. They diet on fish and marine plant life.

Live specimens of this deadly fish were all but non-existent in the U.S., until "Rocky," as the *Synaceja horridis* was named by LST crew members, arrived in the States. He was donated to the Steinhart Aquarium in San Francisco's Golden Gate Park where he is now on display and under study.



WHAT'S-IT — 'Rocky' floats through water like butterfly using his under fins in flapping motion like wings.

ALL HANDS SPECIAL SUPPLEMENT

UP FROM THE BOTTOM

Few ships have been sunk for months, raised and recommissioned, then gone on to fight a war. *Squalus* did. Redesignated as *Sailfish,* she survived 12 war patrols during World War II, won a PUC for sinking an aircraft carrier.

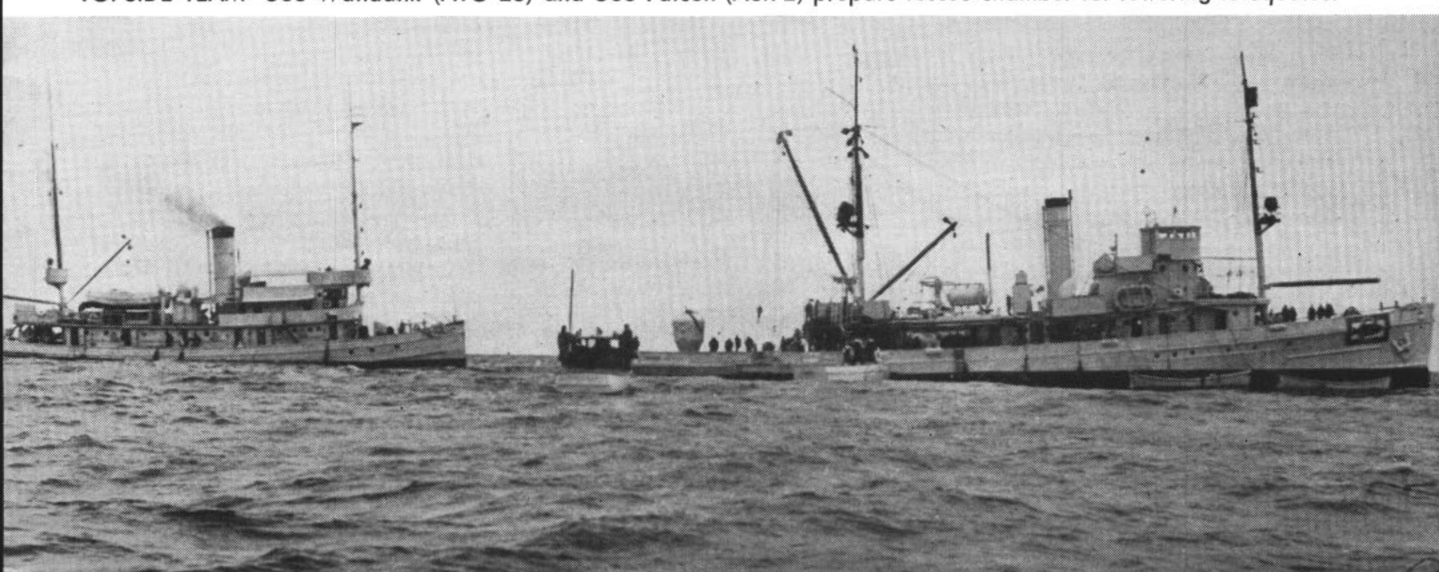
While on a practice run from her base at the Navy Yard, Portsmouth, N. H., USS Squalus *(SS 192, later designated as* Sailfish*), sank in the open sea on 23 May 1939. She went to the bottom because her high-induction valve failed to close, and through that 31-inch opening a great volume of water flooded the sub's after body.*

Squalus *had dived to 50 feet and was straightening out horizontally when the commanding officer, LT Oliver F. Naquin,* USN, *in the control room, was notified that water was coming into the ship. Ballast tanks were ordered blown instantly, but the boat could not obtain enough buoyancy to offset the dead weight of the water that flooded the four after compartments.*

The entire interior would have filled had not the door in the watertight bulkhead at the after end of the control room been closed through the quick and desperate work of one of the crew.

JUST BEFORE *Squalus* went under, her commander radioed Portsmouth that he was about to submerge for a run of an hour. When that time had passed by a considerable margin, and the boat had failed to report her return to the surface, USS *Sculpin,* (SS 191), a sister ship, was sent to investigate. She discovered a tell-tale

TOPSIDE TEAM—*USS Wandank* (ATO 26) and *USS Falcon* (ASR 2) prepare rescue chamber for lowering to *Squalus*.



BACK IN SERVICE—Extensively overhauled and recommissioned, *USS Sailfish* (SS 192) played big part in WW II.

smoke bomb floating on the surface, and then located a marker buoy that had been released from a well in the forward deck of *Squalus*.

That buoy carried a telephone circuit in the cable which linked it with the submarine; and the commanding officer of *Sculpin* was thus able to communicate with the survivors in the forward compartments of *Squalus*. The buoy cable parted within minutes after contact was made, but it was still possible for *Sculpin* and *Squalus* to maintain communications by tapping in Morse code with a hammer on the hull of *Sculpin* and hearing similar messages from *Squalus*.

USS *Falcon* (ASR 2, ex-AM 28) reached the scene of the disaster early the following day. She laid out four point moorings and divers from *Falcon* went aboard *Sculpin* to familiarize themselves with the layout and equipment to be found aboard *Squalus,* her sister ship.

SLIGHTLY LESS THAN 26 hours after *Squalus* sank, Martin Sibitzky, BM1, made the first dive and a few minutes later telephoned that he had landed on the forward deck of *Squalus* and that men inside her were tapping on her hull as they heard him walking overhead.

Sibitzky shackled the downhaul line of the rescue chamber to the forward escape hatch, and a little more than an hour later the chamber pulled itself down to the hatch. Adjustments were made and the two operators of the chamber descended through the lower compartment to open the exposed hatch to the torpedo room. LT Naquin named seven men to make the first trip—LT Nichols to inform *Falcon* of conditions inside *Squalus,* a test engineer and five enlisted men who were the weakest of the survivors.

Twice more that afternoon the bell repeated its journey, removing all but eight of the crew. In darkness the last trip was started, the last contact made with *Squalus* and the last eight men, including LT Naquin, taken aboard.

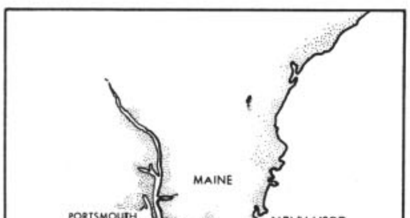
On this last ascent, the downhaul wire jammed when the chamber was 150 feet below the surface. Those inside could do nothing to release it nor could the chamber be pulled free by *Falcon*. Three divers successively went down into the dark and frigid deep and the last one finally succeeded in cutting the cable.

However, the chamber could not be allowed to rise free lest, with increasing speed, it should strike *Falcon* in its rise, to the disaster of the men in the chamber. The crew was ordered to give the chamber just enough dead weight by admitting water ballast to make it barely float—a dangerously difficult operation under the best of circumstances. Unfortunately, the chamber lost all buoyancy and sank back to the sea bed not far from the *Squalus* it had left only a short time before.

There, after juggling with the ballast, the chamber was given moderate dead weight and was then pulled to the surface, hand over hand, by the crew of *Falcon*. The chamber had started its fourth trip about 2050, 24 May, and was pulled alongside *Falcon* three hours and 48 minutes later. The emotions of the 10 men inside, as they stepped on the deck of *Falcon,* have not been recorded.

A FIFTH DESCENT was made the following day to the after escape hatch to determine whether or not anybody was alive in that flooded section. This, too, was a delicate business. After the chamber was secured to the escape hatch, the chamber was made to serve as a diving bell so that the escape-hatch cover could be eased open just enough to release a small volume either of pent-up air or water. Without first equalizing the pressure in the chamber with that of the sea the hatch cover would have been thrown open violently when released, which would have meant sudden death. *Falcon* could have given them no help.

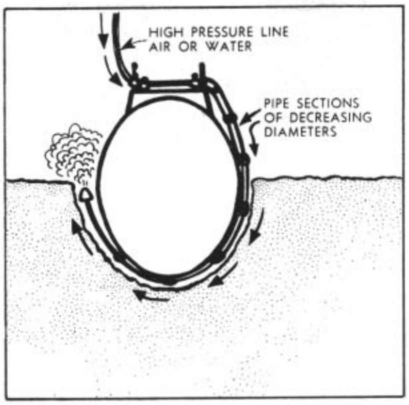
Fortunately, the rescue crew met the situation with coolness and skill. When the hatch cover was slightly unseated, water oozed out—conclusive evidence that the 26 men trapped in the after section of *Squalus* were dead.



Submarine salvage was beginning to be a familiar story to Falcon, *then based at the naval submarine base, New London, Conn. She had been used to raise* USS S-51 *which had sunk off Block Island in 132 feet of water in September 1925, and in recovering* USS S-4 *which went down off Provincetown, Mass., in 102 feet of water in December 1927. (See* ALL HANDS, *May 1950, pp. 59-63 for excerpts of Tom Eadie's personal story of the rescue attempts of* S-4).

Commissioned in 1918, Falcon *operated off the East Coast of the United States during World War I and, at the end of hostilities, was sent overseas to help in lifting the North Sea Mine Barrage. (See "Taking Up The Mines,"* ALL HANDS, *May 1956,* *pp. 59-63). Designated AM 28 in 1920,* Falcon *was converted to a submarine rescue ship and redesignated ASR 2 in 1936. She was stricken from the Naval Register 19 Jul 1946.*

At the time of the Squalus *rescue,* Falcon *was, perhaps, the best-equipped ship and her men the best qualified in the country to do her job. With an over-all length of 187 feet, extreme beam of 36 feet and standard displacement of 1060 tons, she was equipped for rescue and salvage work by powerful wrecking pumps, an extensive compressor plant, steam-driven winches, mooring and towing bitts, and the like. She could make 14 knots, had a complement of 74 men. Her commanding officer at the time was LT George A. Sharp,* USN.



DIG THIS—Drawing shows how tunneling lance was used to excavate mud to get chains around ship's stern.

ON PAGE 53 of this issue, reference is made to the study of the helium-oxygen formula for diving. Here's the way it worked on the *Squalus* job:

In her main deckhouse, readily accessible, *Falcon* had a recompression chamber with an internal diameter of six and one-half feet and a length of 14 and one-half feet. The chamber had an air lock at the outer end and was large enough to accommodate 20 men. The "iron doctor" had plenty to do in the case of *Squalus*.

Ordinarily two divers went down at a time; but only one man descended when an oxygen-helium mixture was substituted for air. The helium and oxygen were combined in definite proportions at the Portsmouth Navy Yard, and the mixture was delivered to *Falcon* in flasks at 1100 pounds pressure. This artificial atmosphere was supplied when divers were working at depths between 240 and 160 feet; but at lesser depths they were provided with straight air.

The average time of decompression for an ascending diver was only 20 minutes. When a diver had been brought up to about 50 feet below the surface, he was quickly lifted aboard *Falcon* and placed in the iron doctor where the pressure was immediately raised to correspond with that at a 50-foot submergence and the diver, with his cumbersome suit removed, breathed oxygen to speed up his decompression.

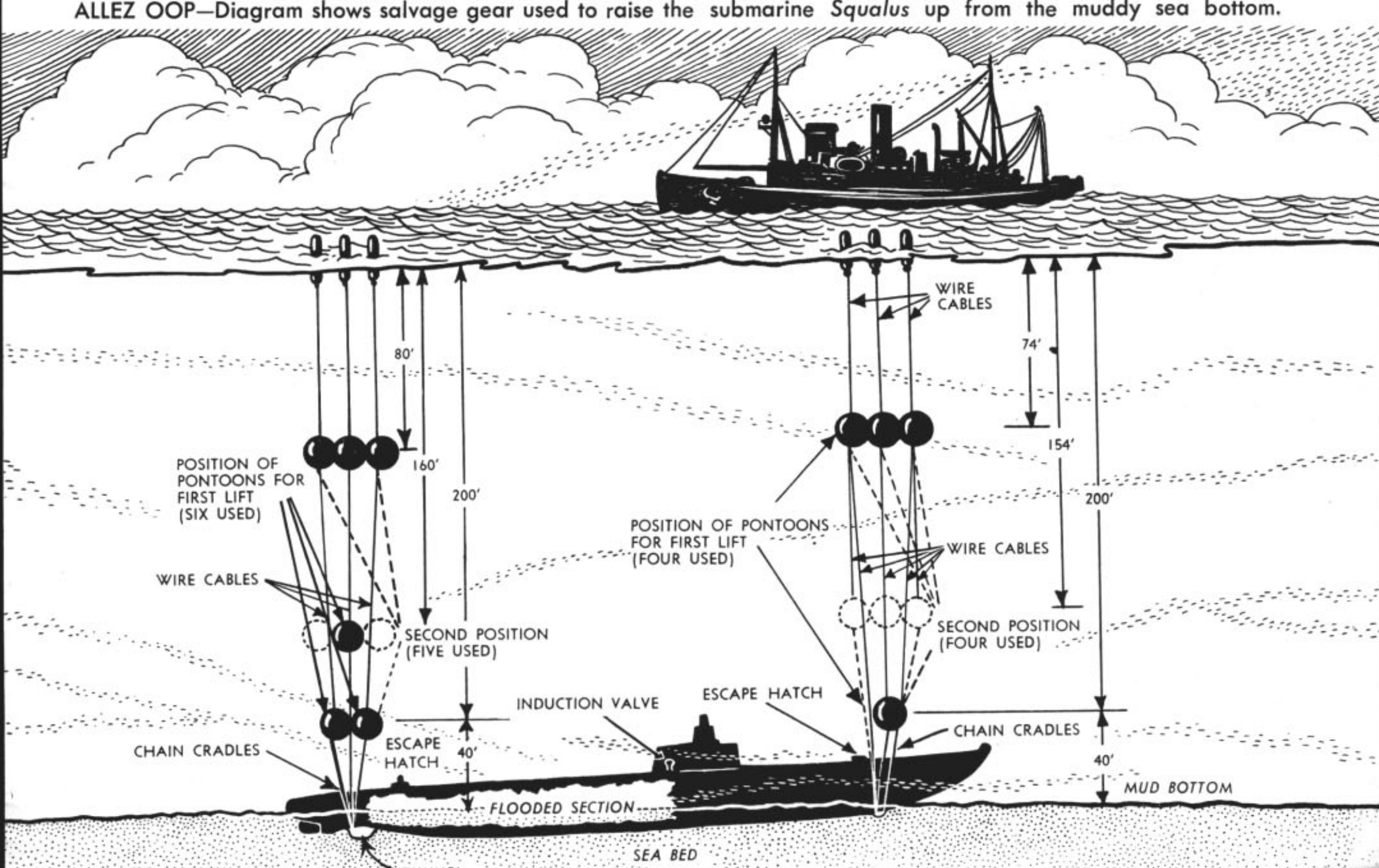
This shortened the time the men were held in the cold sea water and helped make life more comfortable for them. For instance, after a stay of 20 minutes on the bottom, 95 minutes would be required for decompression when air was used; but decompression with the oxygen-helium mixture took only 63 minutes.

THE OXYGEN-HELIUM MIXTURE, especially in cold weather, had a chilling effect on the diver; and those on *Squalus* were hampered at first by frosting of the water vapor inside the helmet. (In plain English, this meant that the water was so cold it froze the diver's breath on the glass of his helmet.)

The diver was clothed in an undersuit that enveloped every part of him but his face and was heated by current from a storage battery. At the height of salvage operations, *Falcon* had on board 49 of the Navy's best divers.

The first step toward salvage of *Squalus* was to place her forward compartments, from which the men had been rescued, under compressed air so as to prevent

ALLEZ OOP—Diagram shows salvage gear used to raise the submarine *Squalus* up from the muddy sea bottom.



FIRST NINE survivors to be rescued by diving bell from sunken *Squalus* are shown on board Coast Guard cutter.

water in the flooded after part from finding its way through the hull and the separating bulkhead into the fore part of the craft. Later, some of the forward ballast tanks were filled with water to help break the after body of *Squalus* free from the grip of the mud.

SQUALUS had an over-all length of 310 feet, beam of 27 feet, and a standard surface displacement of 1450 tons. Her submerged displacement exceeded 2000 tons. The difference between the two trims was the weight of water admitted to her ballast tanks so that she would be responsive to the diving rudders at her stern and the two diving planes at her bow.

Underwater, she was driven by electric motors which drew their energy from storage batteries. She could change from surface condition to complete submergence in about one minute.

In order to submerge, air must be allowed to escape from empty ballast tanks as sea water rushes into them. Furthermore, all hatches must be closed, as well as other air intakes, and many valves must be manipulated rapidly and in a closely ordered routine—every man at his station and doing his work at the right instant.

The air-venting valves are at the top of the ballast tanks; and while they are manipulated from within the main pressure hall, still they can be reached from the deck of the vessel and opened or closed for salvage purposes.

It is also possible from outside to make air connections with fuel-oil tanks to blow them. Both the oil and ballast tanks lie between the pressure-resisting hull and the nonpressure-resisting hull that gives the submarine her ship-shaped external form. Likewise from the deck can be made hose connections with the main compartments either to pump water out of them or to force it out with the aid of compressed air.

Twelve such connections were used to give *Squalus* buoyancy when raising her and when moving her shoreward. The remainder of the buoyancy was supplied by pontoons that both lifted the submarine and held her suspended at different depths while making the 15-mile journey to the drydock.

SUBMERGIBLE PONTOONS were first used by the Navy in 1915 to recover USS *F-4* from water 46 feet deep near the channel entrance to Honolulu Harbor, and later in raising S-51 and S-4. Some of the pontoons used for S-4 were also used in the far more difficult task of recovering *Squalus*. A total of 10 pontoons were used with *Squalus*—two with a buoyancy of 60 tons and eight were 80-ton units. The smaller ones weighed 30 tons apiece and the larger ones 42 tons each.

After the deck of *Squalus* was cleared of all hampering rigging and stray lines, the next step was to get under her the half lengths of the 90 feet of chain of each of six slings. This was not too difficult at the bow, where much of the keel was clear of the mud for about 100 feet; but the deeply embedded stern presented a pretty problem in tunneling.

Usually, such work is done by a diver guiding a high-pressure water line; but there is always the danger that the excavation will fill in and bury him. In the case of *Squalus,* a self-propelled nozzle, called a "lance," was used. This was fitted with sections of pipe from eight to 18 feet long, curved, and increasing in size from one inch to two and one-half inches. The ends of adjoining sections telescoped and were locked together at the joint with a toggle pin.

The diver guided the lance down from the deck of *Squalus* and kept the curved pipe close to and conforming to the hull. Water pressure up to 300 pounds per square inch was supplied by *Falcon's* fire pump; and the nozzle was designed to discharge rearward enough water to force the apparatus onward as the stream excavated the mud ahead. Small holes at intervals throughout its length allowed some of the water to escape and prevented the mud from filling in rearward and blocking the tube.

When the lance had made a circuit of the hull, a small wire cable was pulled through it and the tubing withdrawn. The receiving wire, progressively enlarged, served eventually to pull into place an entire sling which had been assembled aboard *Falcon*. Each sling was pulled into position beneath the sub by the winches aboard *Falcon* and the two ends of each sling were run through the two hawsepipes of a pontoon before it was sunk.

WHEN A PONTOON was alongside *Falcon* ready for sinking, an eight-inch manila hawser was attached at each end for lowering. At regular intervals, the hawsers were painted with colored bands which guided the men at the bitts and enabled them to pay out their lines in unison. To carry it down, the end compartments were flooded until the pontoon had a negative buoyancy between four and five tons. This made it easy to handle when sinking and made it sink rapidly.

When a pontoon reached its proper depth, it was moored to its two lifting slings by a cable clamp, known as a "flower pot," set on the top lift of each hawsepipe. The flower pot was a massive casting hollow from top to bottom, with its sloping interior fitted with roller bearings. Between the bearings and the steel cable were tapered wedges which dropped and jammed against the cable. When the pontoon tried to rise and pulled on the slings, the grip tightened.

At the start, the plan was to lift *Squalus* in three stages and to ground her twice on her journey back to the Navy Yard. As first arranged, the pontoons were set at three levels on the slings and when the topmost pontoons reached the surface, the sub was to be towed shoreward until she grounded.

On 13 July, the first lift was attempted. It didn't work. Here's the report:

"Lifted stern of *Squalus* with five pontoons about 85 feet clear of bottom. Then lifted bow with two pontoons, blowing ballast tanks forward. Both pontoons came to the surface, followed by the bow. Forward sling carried away and bow sank. One sling aft and two lower pontoons on sling surfaced. Stern sank with remaining pontoons, possibly in a damaged condition. Think *Squalus* on even keel on bottom. Two chains still remain under the stern."

In other words, the bow of the sub came up so fast that the sub literally stood on end, then slid out of the arrangement of slings, and went to the bottom again.

IT TOOK A MONTH of hard work before she was again ready to be raised.

On 12 August, early in the morning, *Falcon* again began blowing air down into the ballast tanks of *Squalus,* as well as into the pontoons arranged in three levels above the sub—each given a positive buoyancy of 10 tons. The object was to give the pontoons their full buoyancy, applying the air first to the topmost pontoons and then downward.

Ten pontoons were used—six above the stern and four above the bow—with a total lifting capacity of some 760 tons. The theory was that the stern would rise higher than the bow and, as the boat was towed stern first toward shallower water, that the bow would be the first to ground.

In the midst of a wide area of water seething with escaping air bubbles, the topmost pontoons broke above the surface and, after bobbing about for a time, settled down. Tired men on board *Falcon* grinned and shook hands. The toughest part of their job was done.

USS *Wandank* (AT 26), with a line down to the stern of *Squalus* and to the surface pontoons above the stern, led the procession toward shallower water near the Isle of Shoals, while *Falcon,* with a line to the bow of the submarine and hawsers to the trailing pontoons, took up her station at the rear. Over the bow of *Falcon* leading to the pontoons and to the suspended *Squalus* there were as many as 37 lengths of one-and-one-quarter-inch pneumatic hoses distributing compressed air. All went well until the stern of *Squalus* struck an uncharted ridge of mud and the whole procession came to an abrupt halt.

Five days later, after readjustments and with four pontoons at the bow and five at the stern, *Squalus* was raised again—without a hitch—and towed another five miles where she was again grounded—purposely, this time—some two miles west of the Isle of Shoals.

Here, in 90 feet of water, she was prepared for her final lift and for the long tow to the Navy Yard. The pontoons were rearranged again; this time, two were placed at the bow and two at the stern on opposite sides, and were held close to the deck and lengthwise with the submarine.

This meant a lot of work for the divers and for *Falcon.* Shallow water added to the difficulties. Stormy weather twice drove the salvage flotilla to port. Finally, on 13 September, *Squalus* was brought to the surface a fifth time and held there by her pontoons with only a small part of her body visible above water. In that condition, after twice touching bottom on the last long lap of her journey, the submarine was moored at the Portsmouth Navy Yard—just 113 days after she had left the station for her submerged sea run.

During much of the salvage work, Squalus' sister sub, *Sculpin,* stood by to aid the divers to familiarize themselves with the external details of the sunken craft.

In spite of the hazards faced by the divers and the men on board *Falcon,* no one was injured. During two of the lifting operations some 20,000 feet of air hose were used; and the deck of *Falcon* was often buried deep with thousands of feet of cables, hawsers and miscellaneous gear.

As might be expected, Squalus *was in somewhat disheveled condition upon her arrival at Portsmouth. Nevertheless, it was obvious in 1939 that every ship and every type of craft was soon going to be needed. Thus,* Squalus *was decommissioned and after six months of extensive overhaul she was recommissioned in May 1940 as* USS Sailfish *(SS 192) with then LCDR M. C. Mumma, Jr.,* USN., *as commanding officer.*

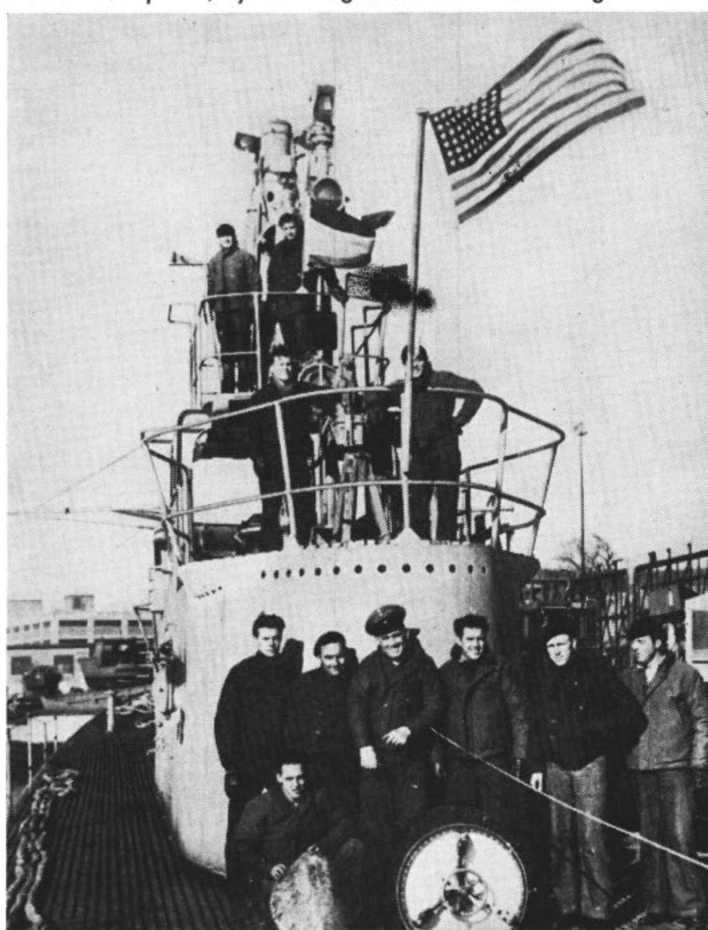
At the outbreak of the war, Sailfish *was at Manila and, on the following day, she steamed out along the west coast of Luzon to begin the first of her 12 war patrols. Five days later she was able to lay claim (officially unconfirmed, however), to the distinction of sinking one of the first enemy destroyers to be accounted for by a U. S. Navy sub in World War II.*

Her official record consisted of seven vessels—four cargo ships, one passenger-cargo ship, an aircraft ferry and a 20,000-ton escort aircraft carrier.

It was on her 10th war patrol that she sank the carrier Chuyo *and, in doing so, earned her Presidential Unit Citation "for outstanding performance in combat against strongly escorted enemy task forces and convoys in Japanese-controlled waters."*

She was decommissioned 27 Oct 1945 at Portsmouth, her "home" yard which she had not seen for years. This ship with two lives was finally stricken from the U. S. Naval Vessel Registry in April 1948.

SHIPSHAPE—Crew members of *USS Sailfish* (SS 192), the former *Squalus,* fly PUC flag won for carrier sinking.



TAFFRAIL TALK

THIS ISSUE on the Underseas Navy barely goes skin deep. It's a vast subject and there are many aspects of it that we have merely touched upon. For example, Navy's pioneering work in the field of submarine development, and the proud achievement of the world's first nuclear ship. But we have discussed these subjects before on different anniversaries of the Submarine Navy (ALL HANDS April 1955, April 1956, April 1958), and so the space in this issue went to other subjects.

We have tried to look at the subject from the individual's point of view—that is, what this strange world looks like and how it affects the salvage diver, the frogman, the ordnance disposaleer, the diving corpsman, the submariner and the scientist. There was a lot more that we wish we could have included, but you'll be hearing about those subjects in future issues. Meanwhile, if you can add to this subject, let's hear from *you*.

★ ★ ★

Just as we were going to press we received an interesting letter from Will Jacobs of Hartford, Conn., who had some queries about the Underseas Navy.

"I have been asked the same question many times," he says, "but I cannot find the answer. Maybe you can help.

"As you know, all qualified Navy deep sea divers wear an emblem on their uniform showing that they are a Master, First and Second Class Diver. Why don't Scuba divers or UDT personnel have a distinguishing patch? I feel that a qualified Scuba man is as important as a deep sea diver and should be shown some recognition. How do you feel about this?"

Those were good questions, but we didn't have the answers ourselves, so we went to the sources—the Training people and the Naval Uniform Board. Here's their answer:

"All qualified deep sea divers are trained to use all types of diving equipment including the self-contained breathing apparatus used by the free swimmer or Scuba diver. But Scuba divers are not qualified or trained in the use of surface supplied or deep sea diving gear.

"All graduates of the Navy's Underwater Swimmers School at Key West, Fla., are designated Scuba divers. However, upon completion of the school, the majority of them go on to EOD (Explosive Ordnance Disposal) or UDT (Underwater Demolition Team) training. When they complete this more advanced and highly specialized training, they drop their basic Scuba designator in favor of the higher qualifications and designations.

"Although the Navy uses Scuba divers quite extensively, there's only a limited number of billets for Scuba divers. When Scuba diving is required and authorized, it is generally done by qualified deep sea divers, EOD technicians and UDT men.

"EOD technicians, who are qualified Scuba as well as Divers Second Class, are authorized to wear an EOD distinguishing mark on their right sleeves. However, this mark does not indicate that the individual is a qualified diver. It consists of a mine superimposed on a crossed torpedo that points down to the right, and a bomb that points down to the left.

"As yet, UDT personnel, who are also qualified Scuba divers, do not have an authorized distinguishing mark."

That's the answer—for the present.

The All Hands Staff

The United States Navy

Guardian of Our Country

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends. The United States Navy exists to make it so.

We Serve with Honor

Tradition, valor and victory are the Navy's heritage from the past. To these may be added dedication, discipline and vigilance as the watchwords of the present and future. At home or on distant stations, we serve with pride, confident in the respect of our country, our shipmates, and our families. Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

The Future of the Navy

The Navy will always employ new weapons, new techniques and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war. Mobility, surprise, dispersal and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past. Never have our opportunities and our responsibilities been greater.

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• **AT RIGHT: LOOKING AFT along her fish-shaped body, USS *Albacore* (AGS 569) cuts a narrow wake as undersea sailors cruise topside off Florida Keys.** ➧

★ TRAINING
★ SAFETY
★ ADVENTURE
IN YOUR NAVY