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" for 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.

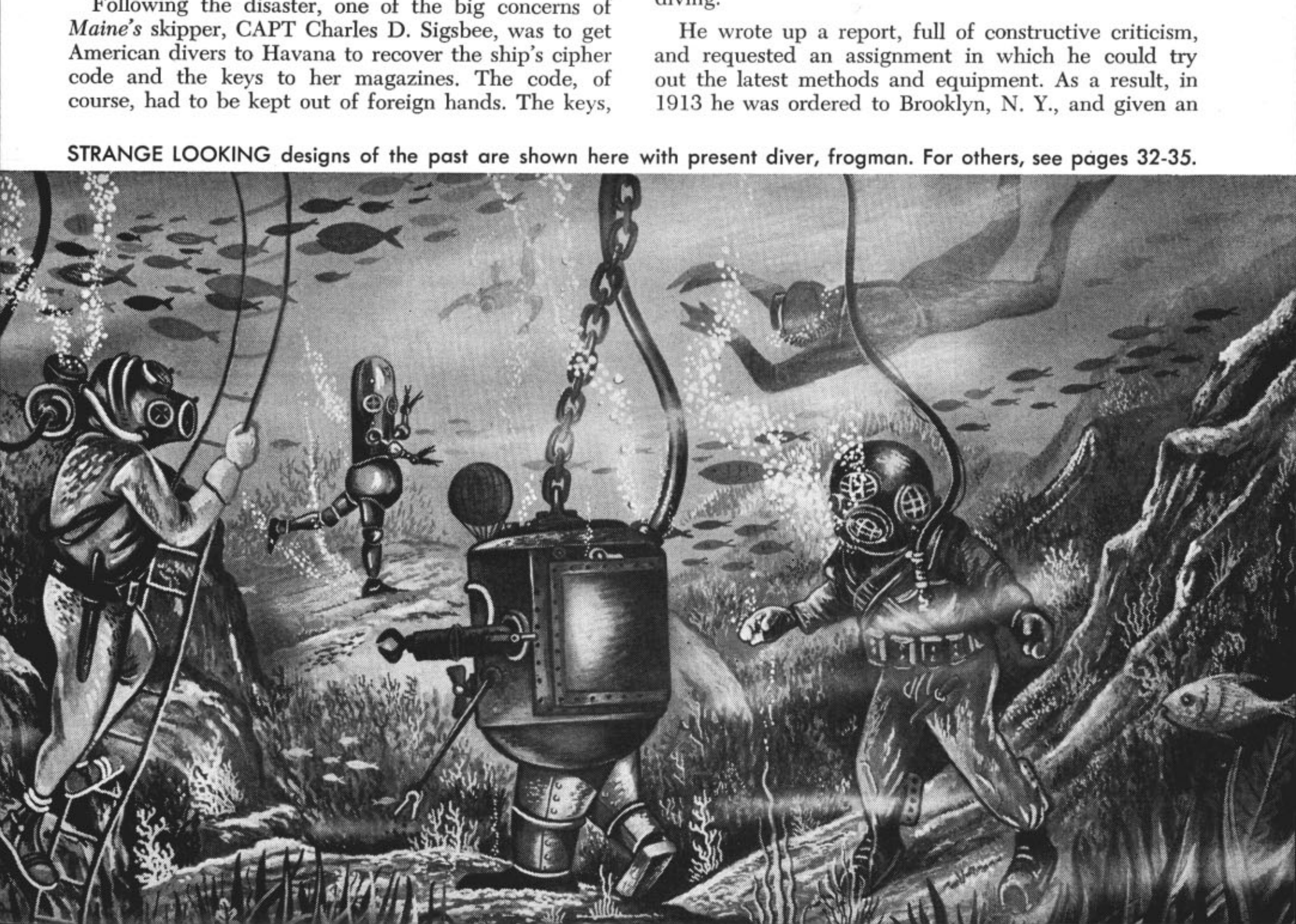
The divers proved helpful not only in finding the keys and the code, but also in trying to track down the causes of the explosion. Several of them, from USS *Iowa* and *New York*, were questioned about the condition of the wreckage by a court of inquiry which met in Havana shortly after the mystery blast.

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.

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 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.

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):

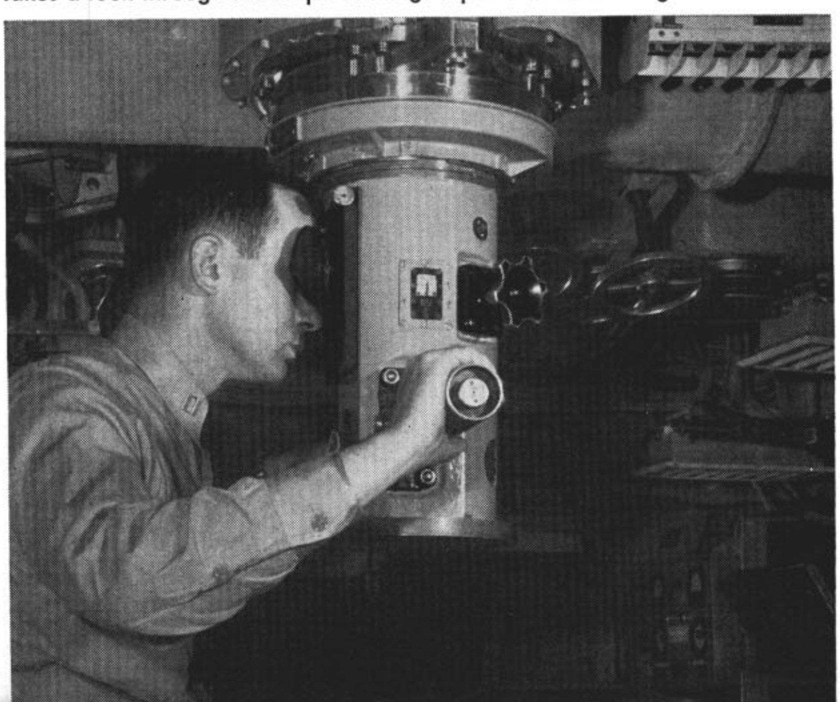
"I got into submarines back in 1930, when I was a yeoman striker in a submarine tender. One of the subs in the squadron needed a yeoman, so I just volunteered."

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

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



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.

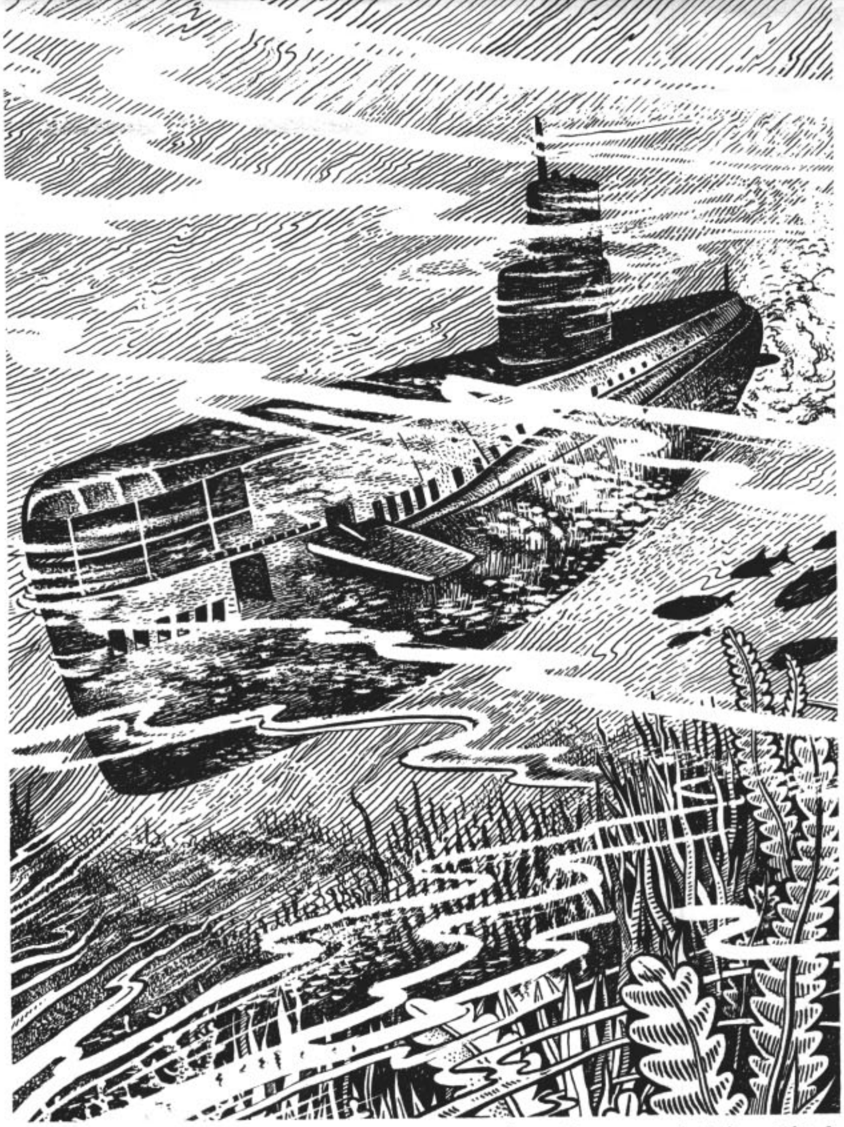
"Another thing that made me want submarine duty was a talk that CAPT Slade Cutter (now the Academy's athletic director) gave about the job submarines were doing in the war. It made quite an impression on me."

Service

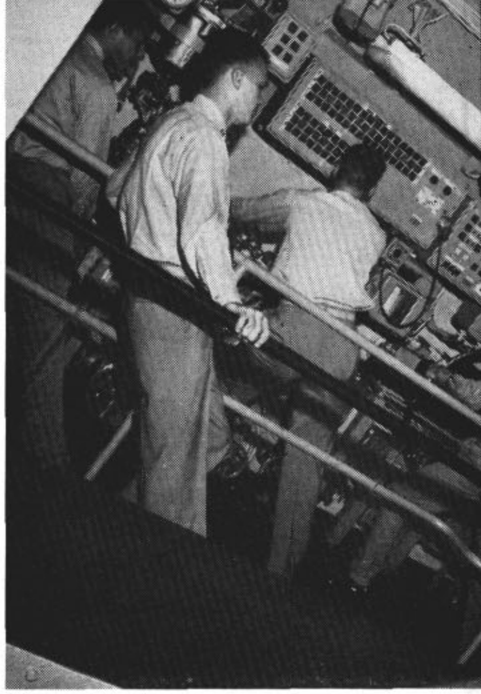
As you can see, there is no set pattern to the submariner's motivation. No matter what his reasons for volunteering are, nor how much he wants to become a submariner, it takes more than motivation to make him a good one.

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

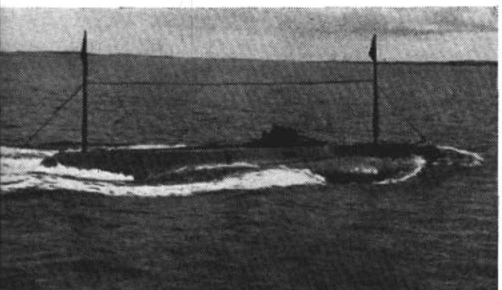
- He doesn't have to be a mental giant, but he has to be on the ball. He should have a minimum combined ARI and MAT, ARI and MECH or GCT and ARI score of 100. However, waivers of this requirement are granted if the man is a good prospect otherwise.
- He must be in good physical shape.
- He must be mature 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.



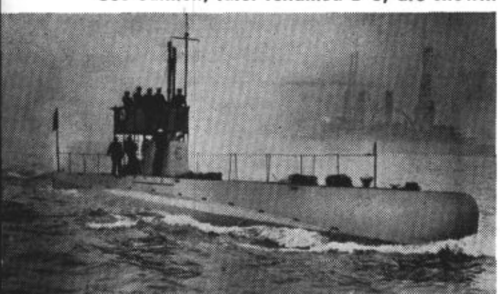
PICTURE THIS—Artist's drawing shows present-day sub on patrol. *Below:* Chief-of-the-Boat mans diving controls to take *USS Sea Owl* (SS 405) down under.



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.

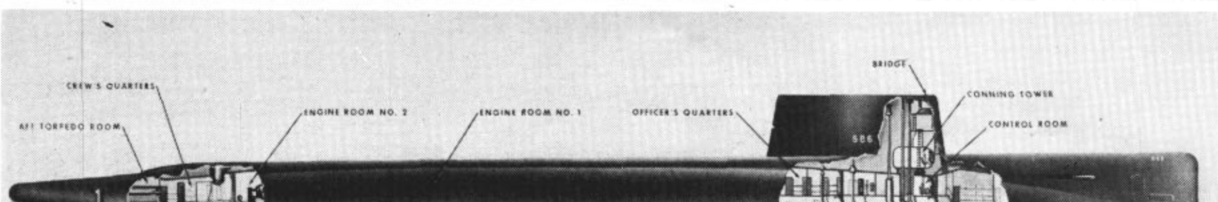
The basic course for enlisted men lasts eight weeks. During that time the embryo submariner gets his general indoctrination. This covers such subjects as submarine history; torpedoes; methods of escape from a disabled submarine; ballast, trim, air, hydraulic and other systems of a typical submarine; 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.

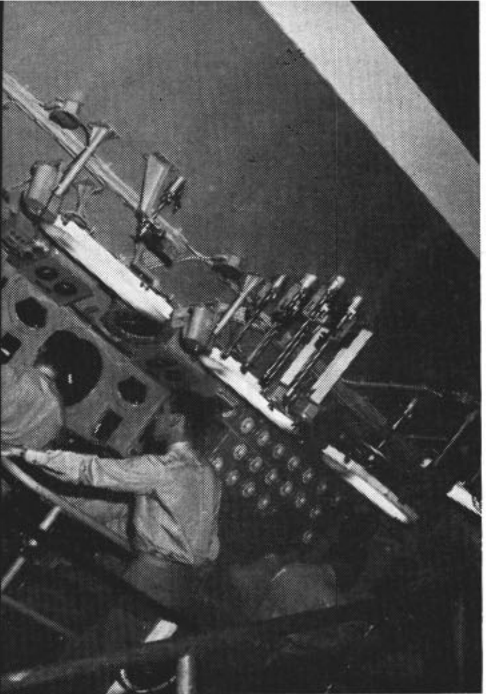
The officer's basic course is longer and even more complicated. It lasts six months and includes diving and surfacing, attack procedures, tactics, shiphandling, electronics, escape procedures, engineering electricity, fire control, sonar and everything else a submarine officer has to know just to get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

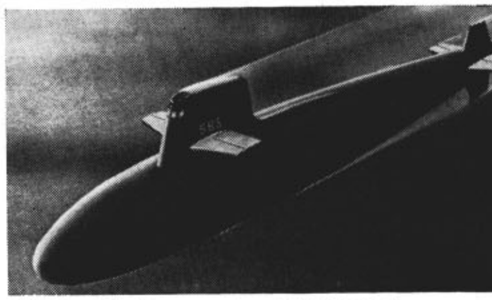
of the enlisted students can be assigned to a sub, they need more detailed instruction in the submarine aspects of their ratings. For instance, an electrician's mate who's had all his previous experience in surface ships, requires special training in the workings of a sub's electricial system. (In addition,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

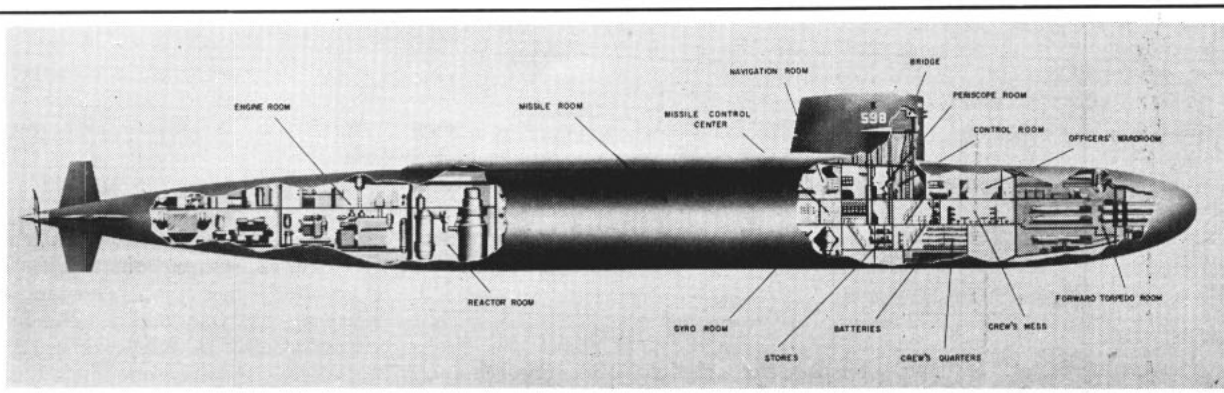
Normally, for the first six or seven months an enlisted man is on board, he's busy studying a variety of manuals and instruction books; sketching the layouts of all the important systems and the locations of valve, gages, switches and the like; taking notes; boning up for monthly examinations; and, generally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

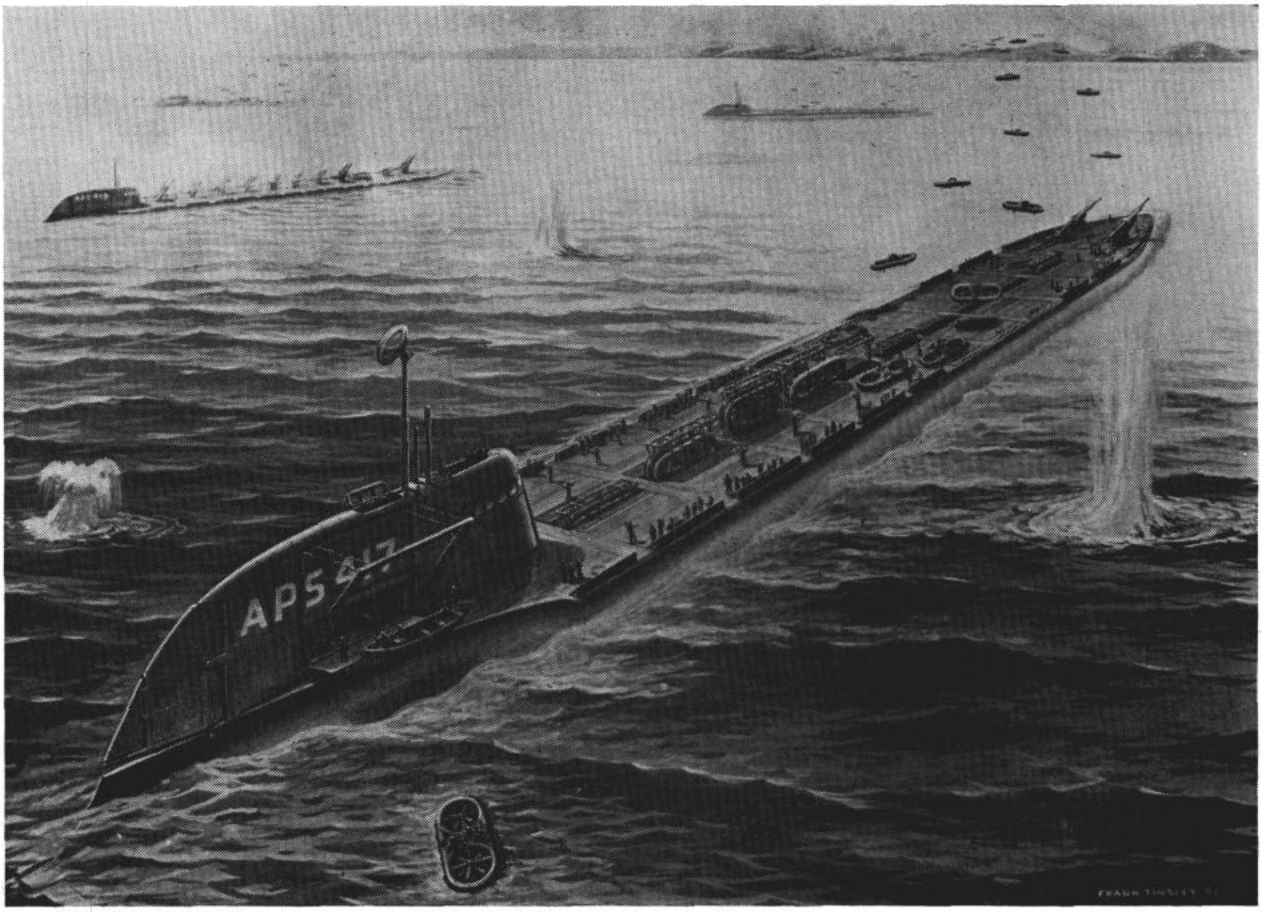
At the end of the seven months he is given a final examination by the Qualification Officer. If he passes that, he finally earns the right to wear dolphins and put an "(SS)" after his name. Usually, he also gets



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.

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, businesslike 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 oldtimers 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.

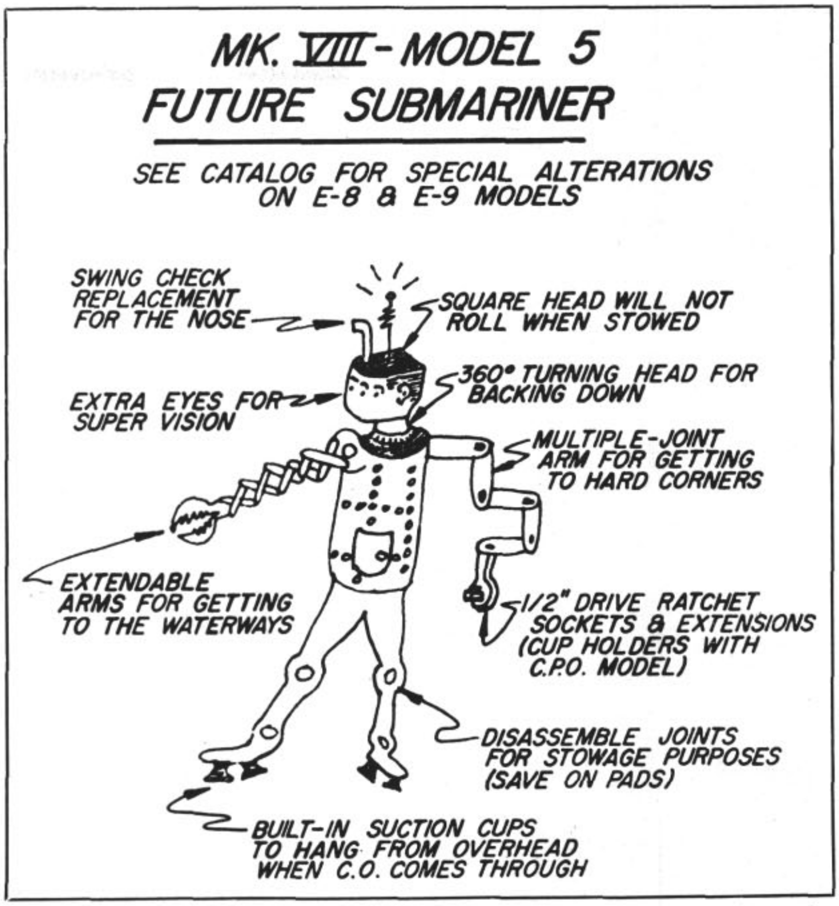
"Words fail me when I try to give a true picture of those early submarines.

"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 oldtimer 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).

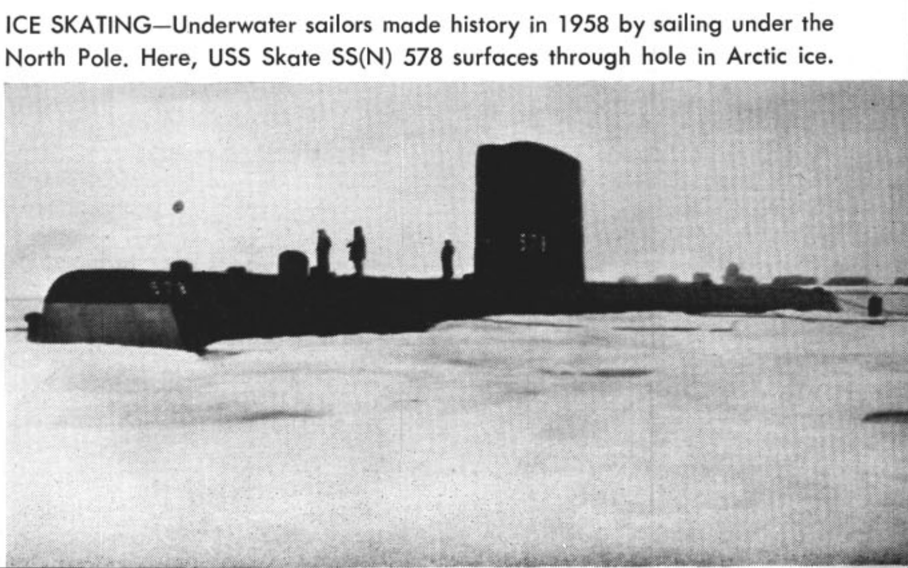
THROUGH TRAINING and life on board his sub, the submariner comes to realize that there's no such thing as an unimportant job in a sub. He knows the Navy has done everything possible to make sure he and his shipmates are men who will know what to do in just about any situation they might encounter.

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

USN Frogmen &

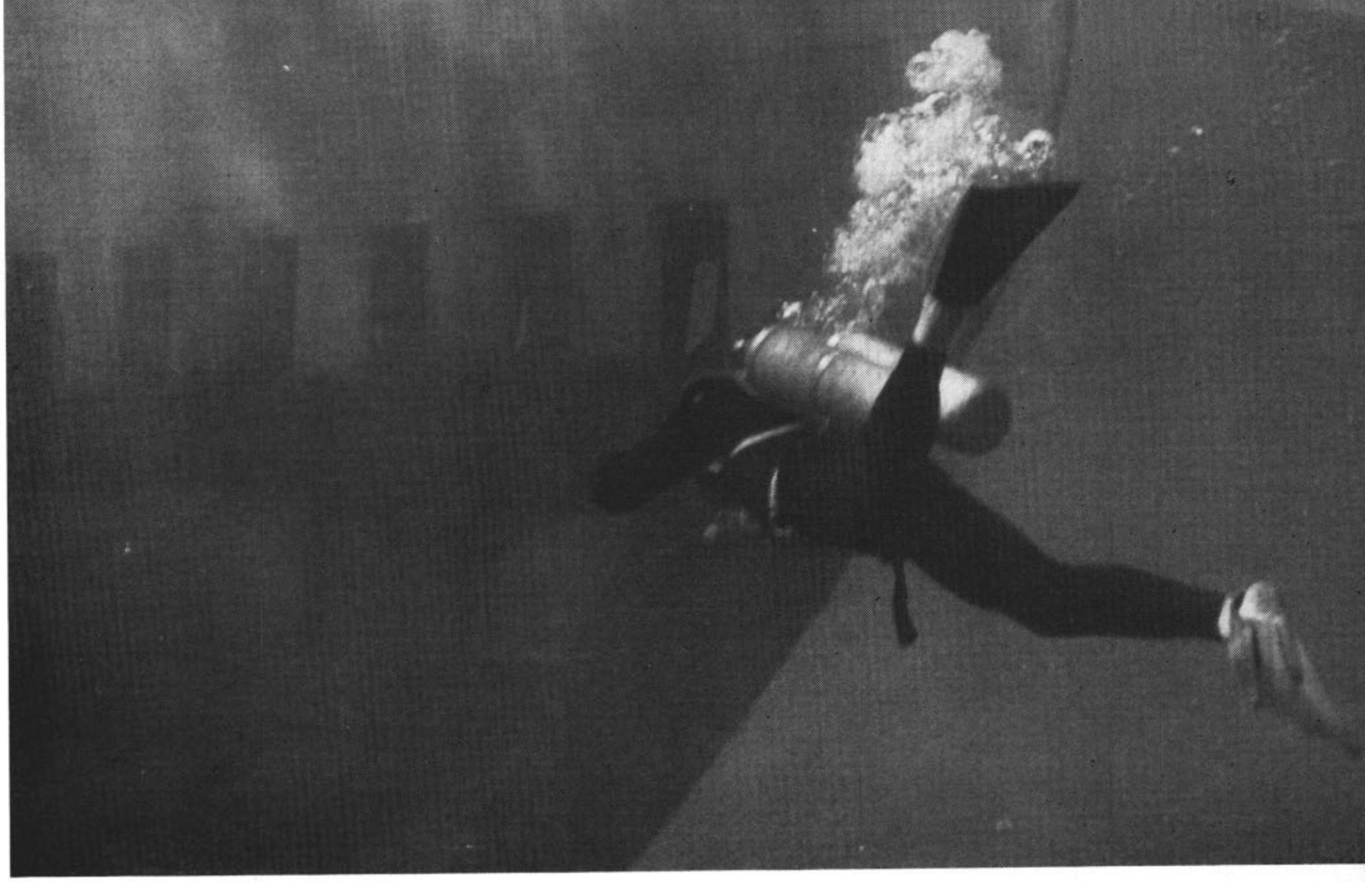
themselves to "skin diving" (without breathing apparatus), additional thousands have acquired self-contained gear and are able to make dives which only professional divers could even consider a few years ago. The Navy's interest is not concerned with the sporting aspect of Scuba diving. It is interested 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-

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.

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.

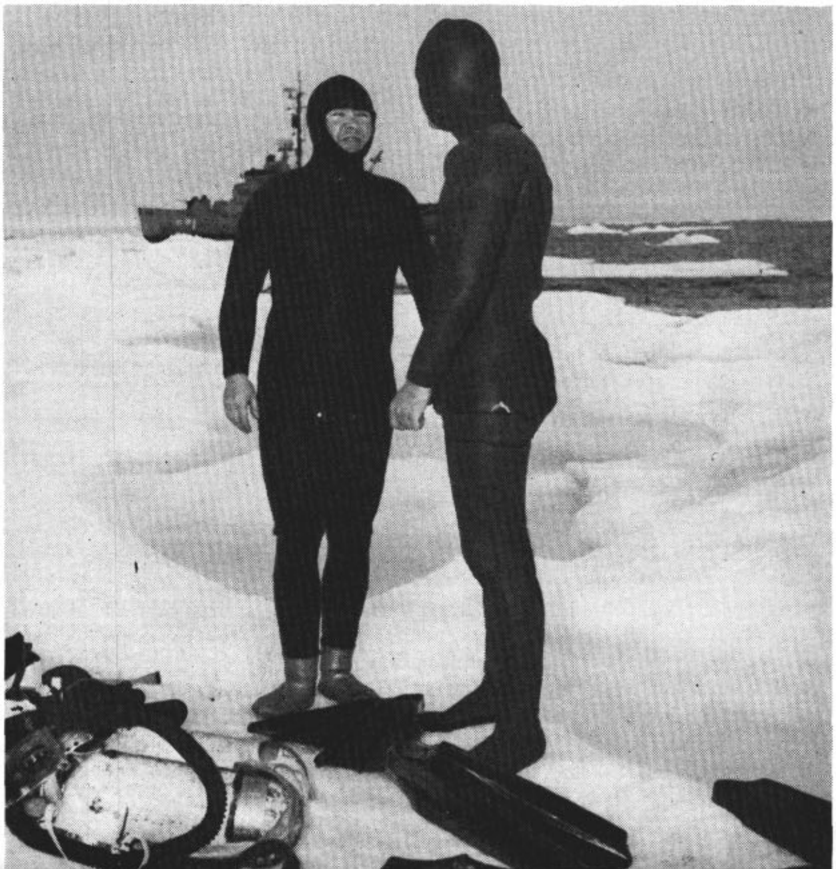
Next comes practical training at the demolition firing area of Stump Neck Annex, Naval Propellant Plant. Here the student is given a thorough course in demolition with special emphasis placed on safety precautions. This is followed by a course in EOD tools and methods. Then he goes to a study of the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

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 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."

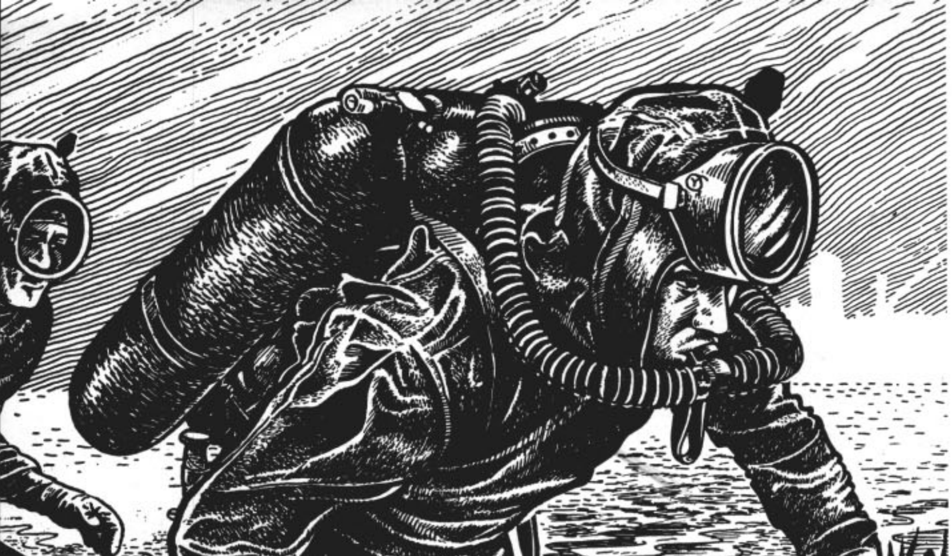
Graduates of the EOD School are spread throughout the services. Naval personnel are sent to minesweepers, carriers, ammunition depots, harbor defense units, and to the two EOD units maintained by the Navy in Charleston, S.C., and Pearl Harbor, T.H. Marines are responsible for their own bases.

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.

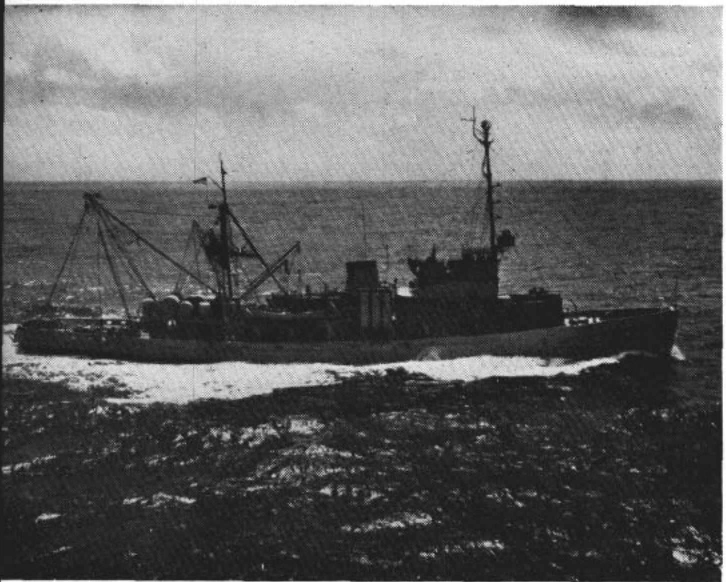
Underwater Demolition Team personnel, both officer and enlisted, are all volunteers. And they must have a specific and valid reason for requesting UDT duty. Individuals who can give only vague, indefinite, or general reasons for volunteering are not wanted. Those who simply desire a change of duty or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

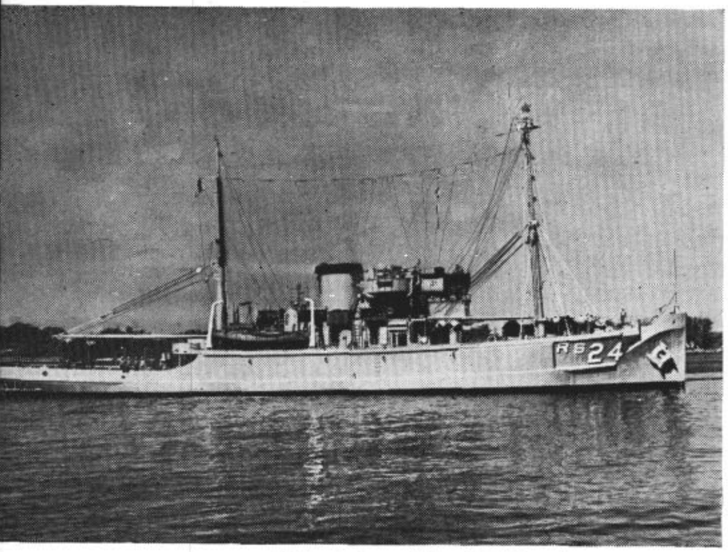
- Be physically qualified in accordance with the *Manual of the Medical Department* requirements.
- Be able to swim easily a distance of 300 yards in less than 15 minutes using at least three distinct strokes, such as crawl, back, side and breast.
- Possess an education of at least two years of high 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.

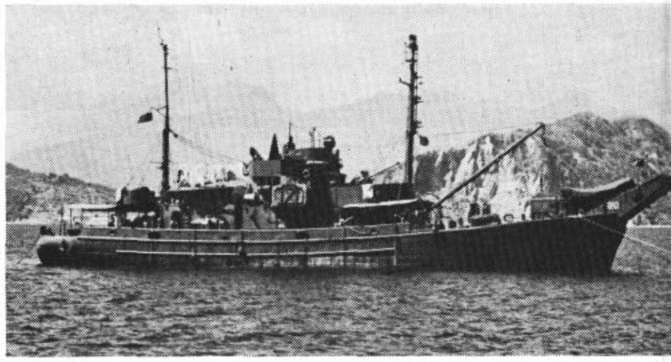


ASR—Submarine Rescue Vessel (USS *Chanticleer*)



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.

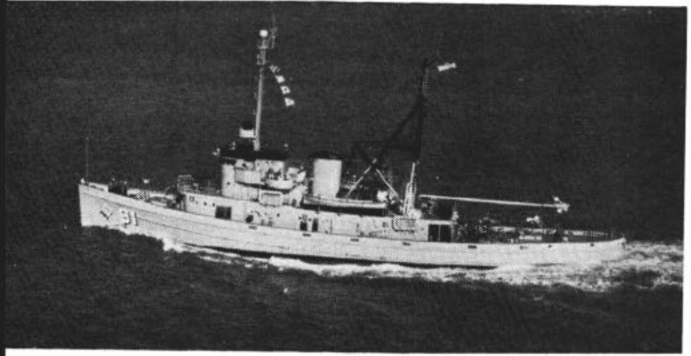
All "diving type" ships have an allowance for qualified diving personnel and carry deep sea, lightweight or Scuba diving equipment aboard.

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.

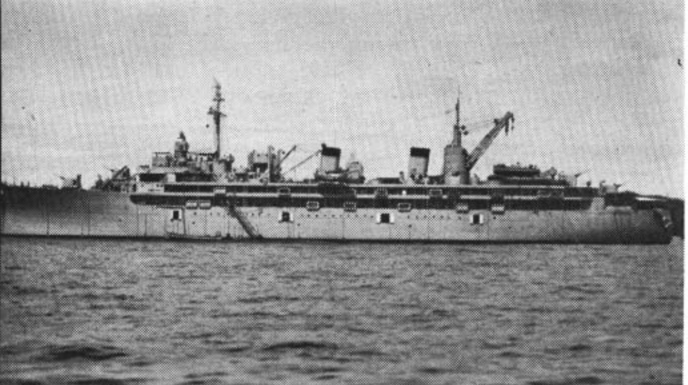
Much repair work on underwater parts of ships or other floating equipment can be accomplished by the use of divers, thus eliminating the expense and loss of time necessary for drydocking.

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

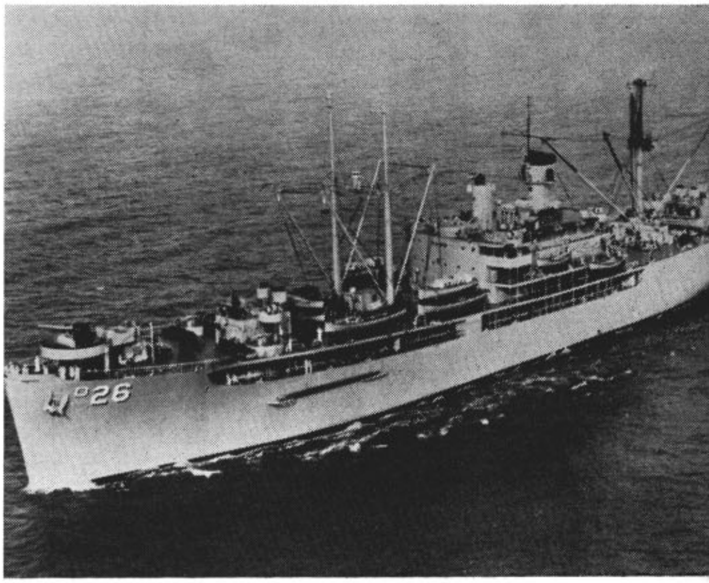
The only other member missing from this group is the divingest one of them all—the submarine—which, incidentally, is in the "non-diving type" category.

—H. George Baker, JOC, USN.

AS—Submarine Tender *(USS Orion)*

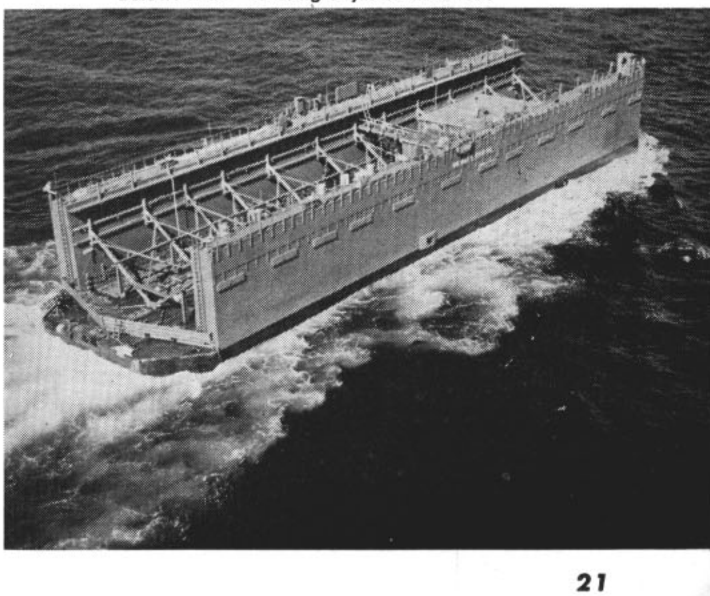


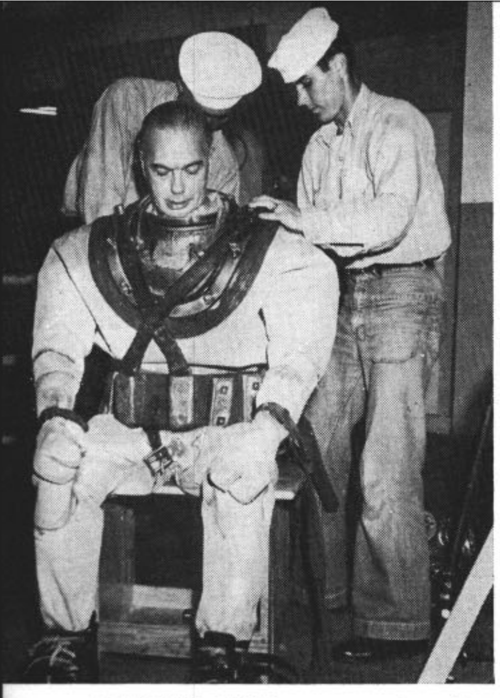
AV—Seaplane Tender *(USS Kenneth Whiting)*



AD—Destroyer Tender *(USS Shenandoah)*

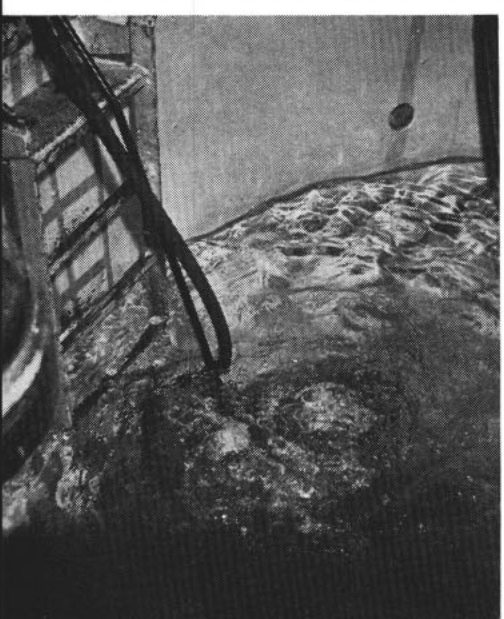
Below: ARD—Floating Drydock (ARD 32)





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.

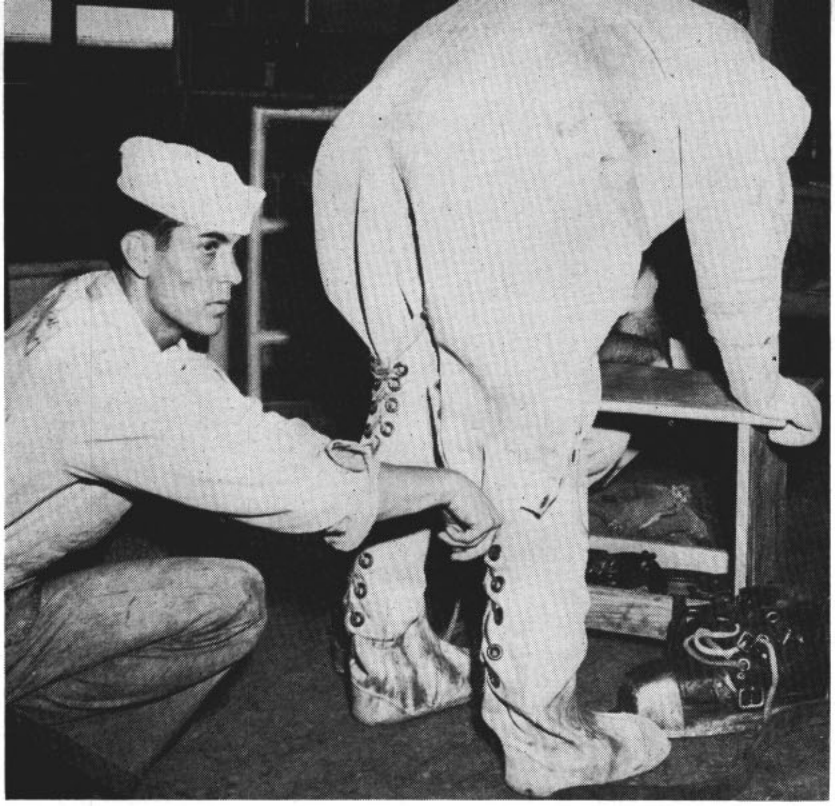
I did pay attention however, when Fuentes and Jackson moved downstage and picked up the belt which, just like every other item of gear, had already been very carefully laid out. I had noticed that fumbling, or wandering about the tank area looking for stray gear while the diver waited, half-dressed, 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 straight-jacket.

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?"

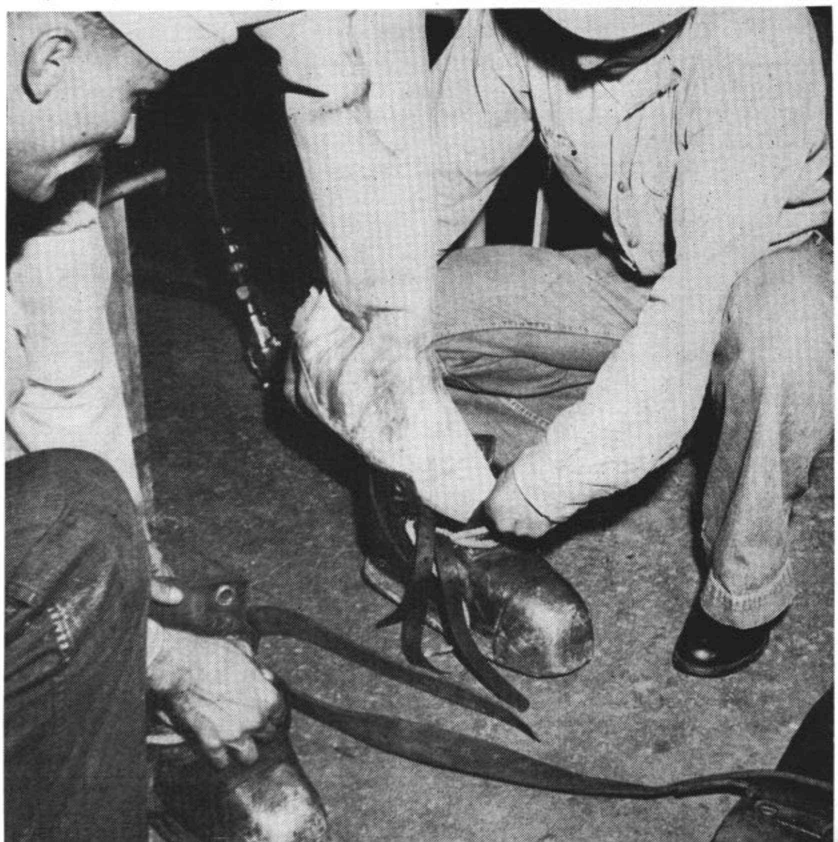
I didn't, but it would be easier to go than explain why I didn't. So I took the next step.

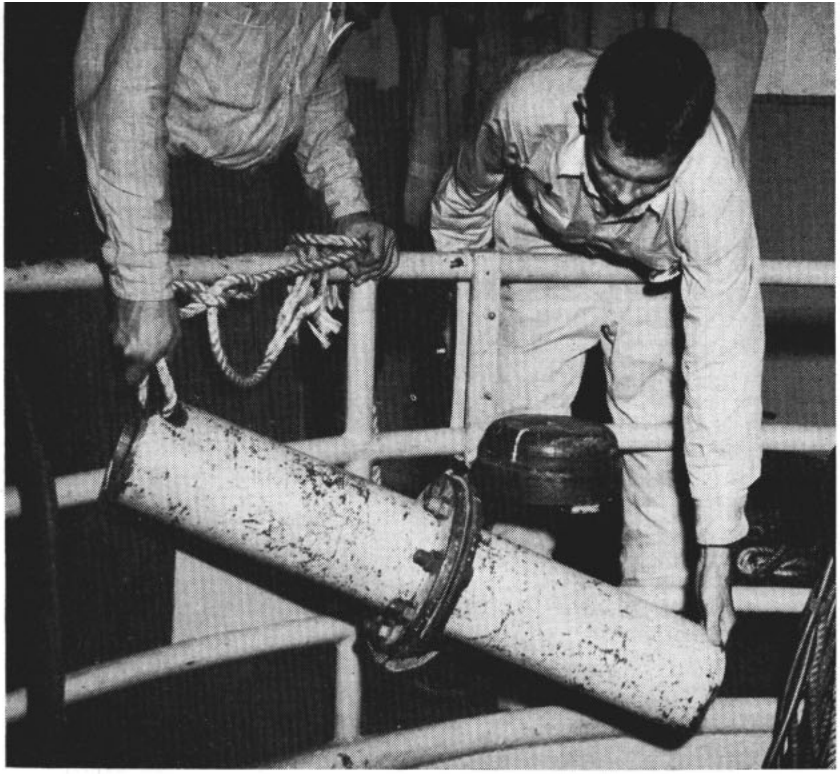
If the rush of air was strong before, it was now a torrent. I kept on going down until my feet wouldn't go any further. As soon as I let go of the ladder, I found I couldn't stay on the bottom. I started to float upward.

"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.

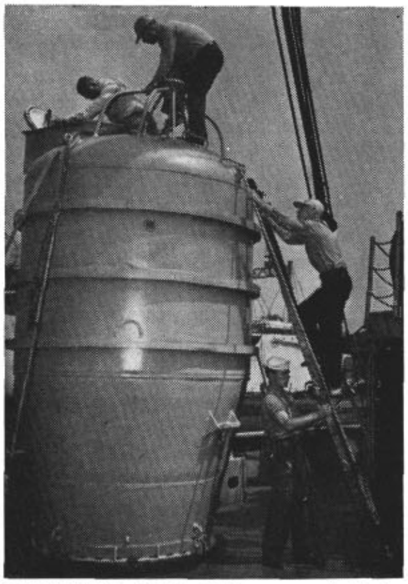
I have an indistinct recollection of Jackson trying to relieve me of my wrench bag but I had one major problem to whip before I dared let go the ladder on his side.

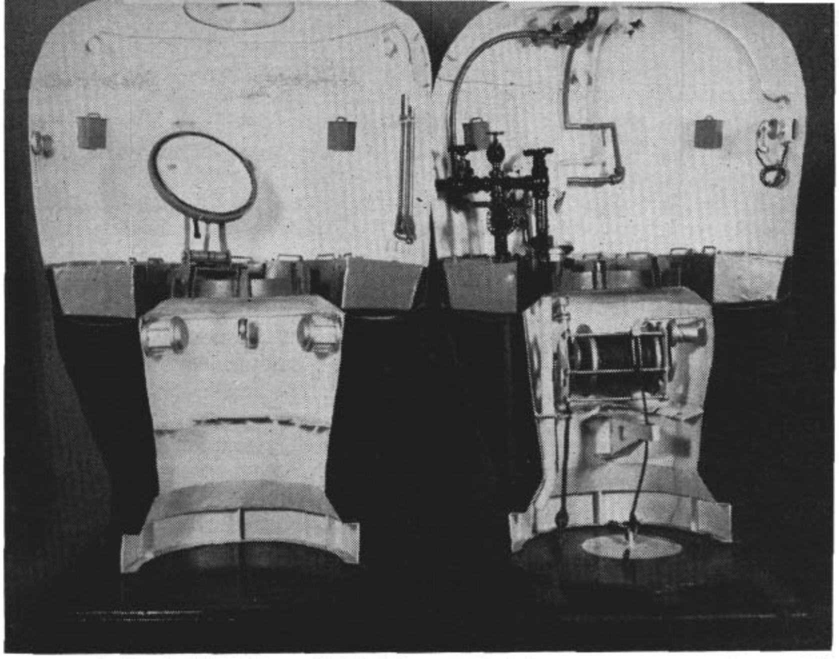
Around the rim of the tank there is a four-inch steel coaming. I can't imagine what purpose it serves, other than to trip tired divers. I could feel it with the end of my boot but I could not, under any circumstances, lift my foot over it. This was the end of the line, and as far as I was going.

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.

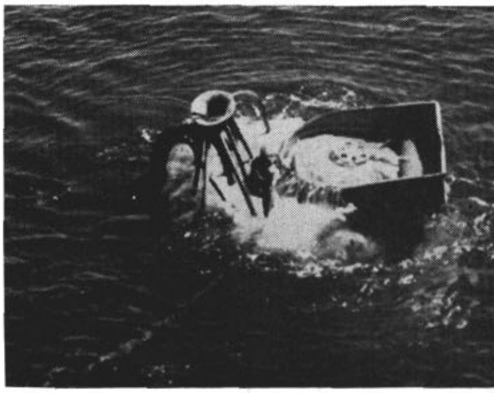
In the lower is an air-powered winch, and along its sides are ballast tanks for taking in and expelling sea water as necessary.

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.

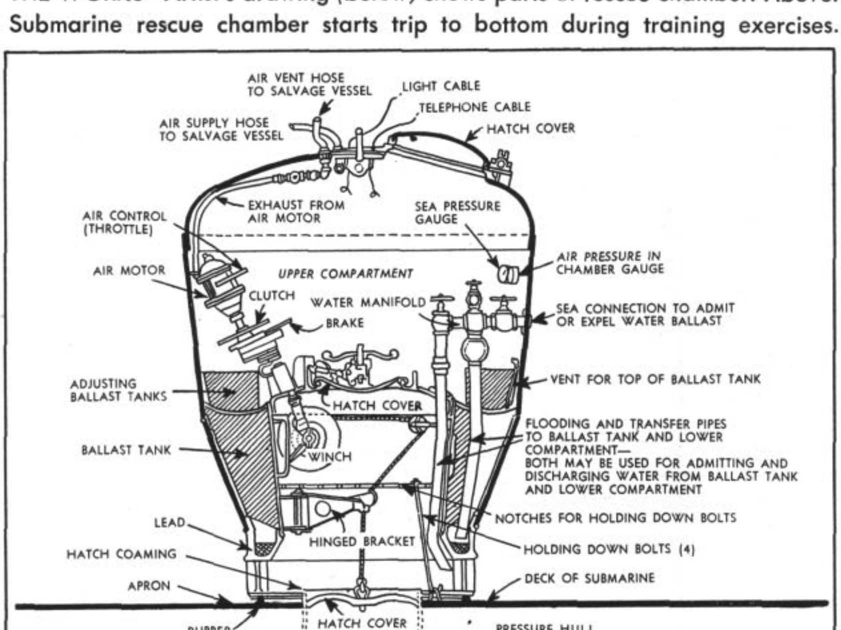
When the chamber rests directly over the sub's escape hatch, the operators flood the ballast tanks to increase its weight and hold it in place. Then, using air pressure, they blow all water from under its skirt and then vent excess air from the lower compartment into the bell. Gravity, plus undersea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

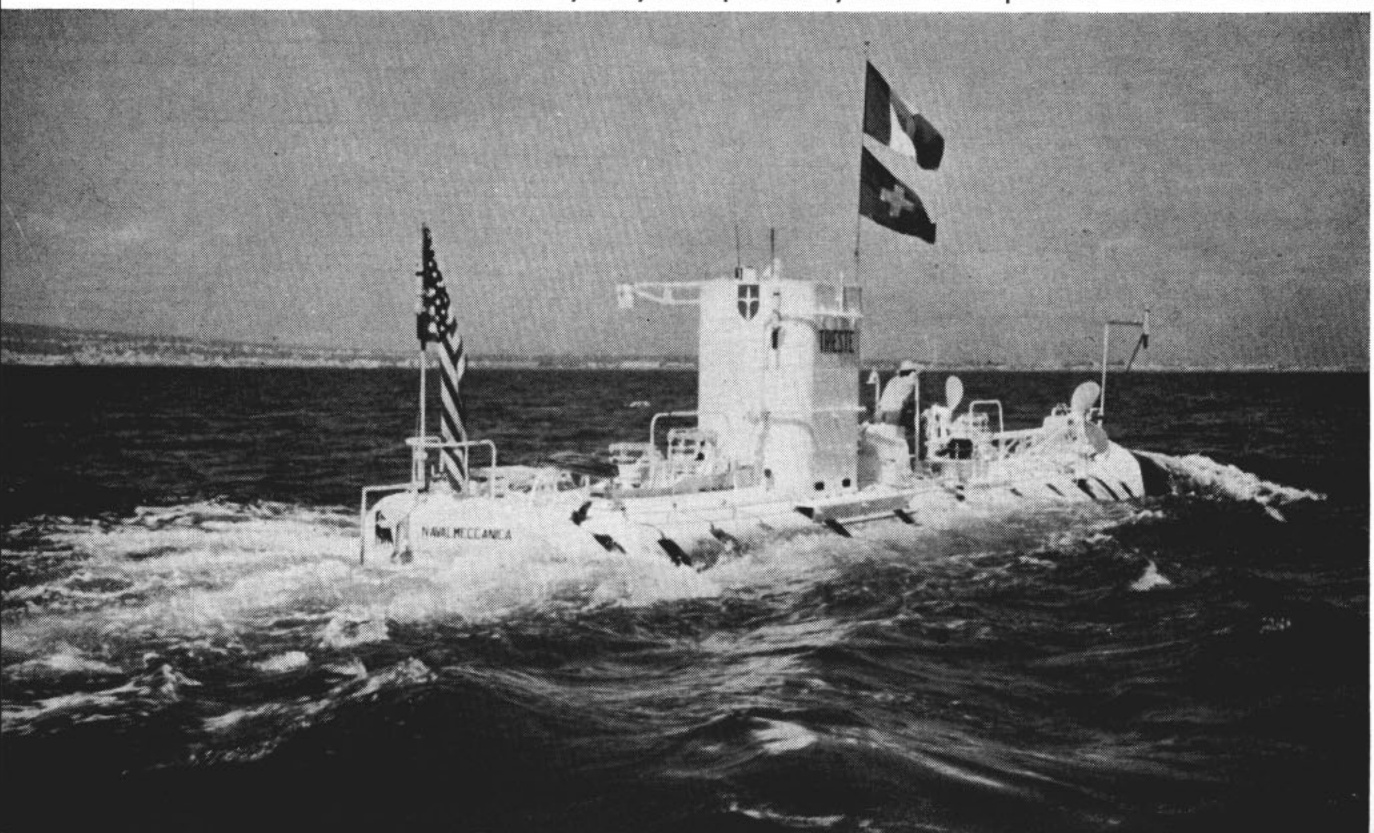
Between June and October of 1956, Navy scientists made a series of 26 dives in the Mediterranean with *Trieste.*

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.

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.

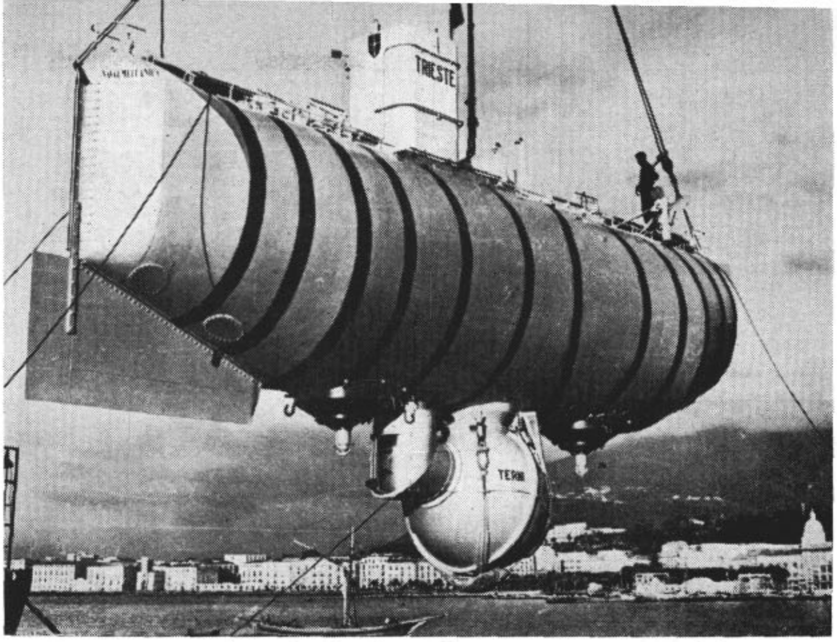
Most of the bottom fish that live below the penetration of sunlight showed little concern for the strong artificial illumination of the three mercury vapor lamps that lit up the ocean for the observers, although species of isopods accumulated in the light zone by the hundreds.

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.

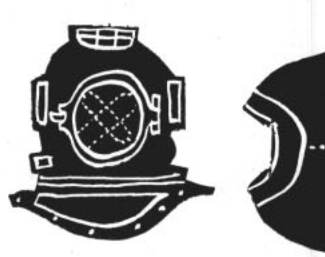
Photographs were taken with a special camera and flash designed and built by the famed Dr. Harold Edgerton. The camera and flash were located about 15 feet from the sphere near the bow where it could photograph objects illuminated by the mercury lamp. The Edgerton camera is capable of taking 800 35-mm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

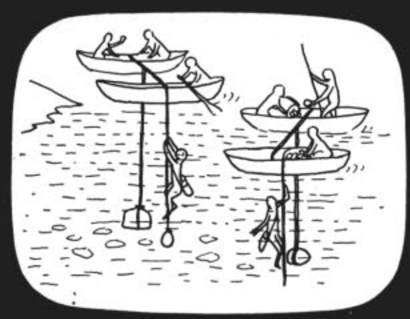


ON THE BALL—Gasoline-filled bathyscaph, now operating out of San Diego, can lower its sphere and Navy scientists to a depth as great as three miles.

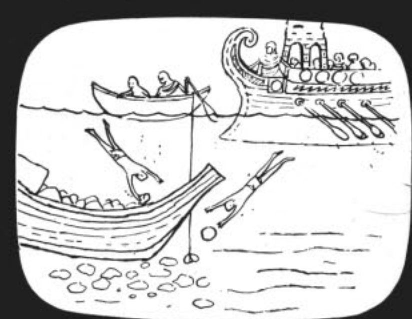
NAVYMEN IN THE UNDERSEAS WORLD



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

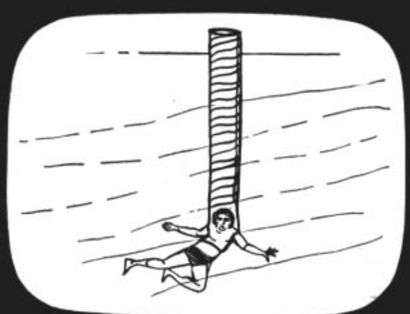


EARLY MAN probed the depths to obtain food, shells and coral, learning techniques still used in sponge-gathering.

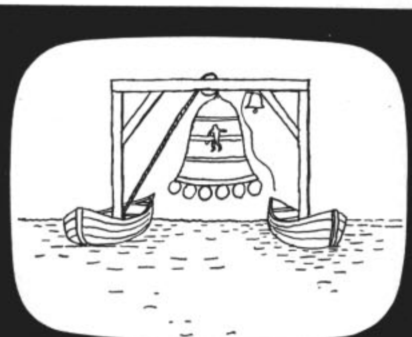


ROMAN NAVY divers foiled enemy plan for blocking harbor with sunken ships. Stones removed, ships refloated.

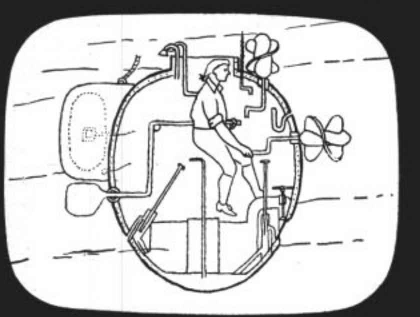
FIRST DIVING BELL on record was successfully used in 1531 for one hour by inventor Lorena to hunt sunken treasure.



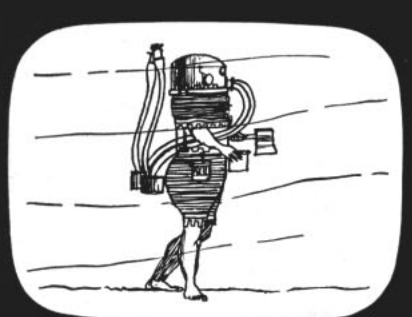
SEVENTEENTH CENTURY theorist Borelli recommended a large breathing tube; seemed logical but did not work.



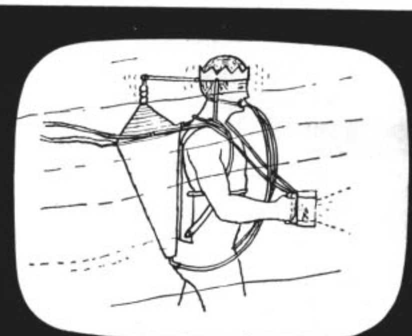
WOOD AND IRON diving bell lowered between boats to recover Spanish treasure in 1677. Dives lasted two hours.



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

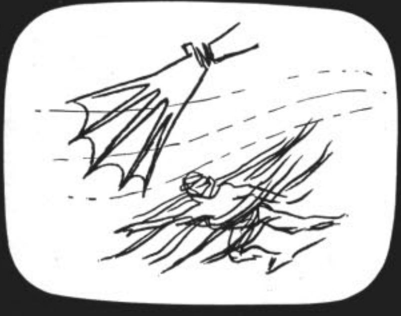


DIVING SUIT takes modern shape in 1797 in Klingert's metal helmet, belt, leather jacket, trousers (Germany).



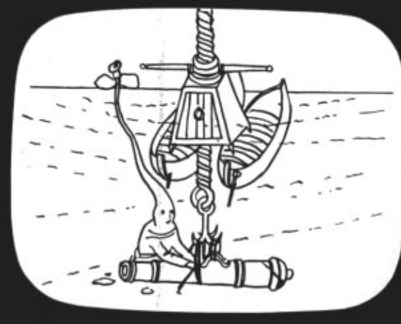
1808 "TRITON" was bellows strapped to diver's back, designed to operate by nodding head to and fro to pump air.

Prepared by ALL HANDS Magazine



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

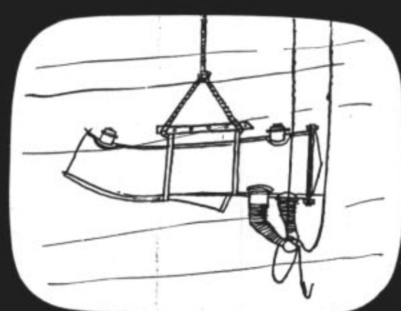
DA VINCI'S leather underwater mask with rigid hoop reenforcement and breathing tube was along right track.



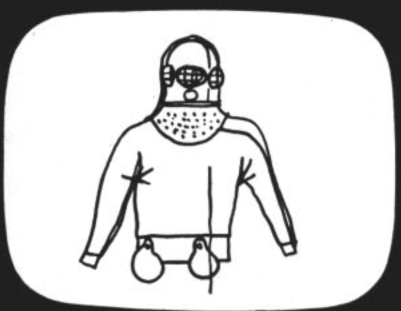
GREASED COWHIDE hood, carefully stitched, with tube floating on surface, was plan of Ufano to salvage cannon.

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.

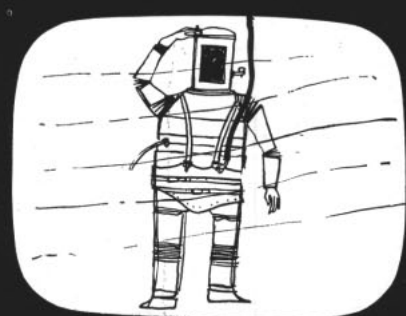


PRESSURE PROTECTION in watertight barrel, 1715 attempt to provide rigid dress and air at atmospheric pressure.



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

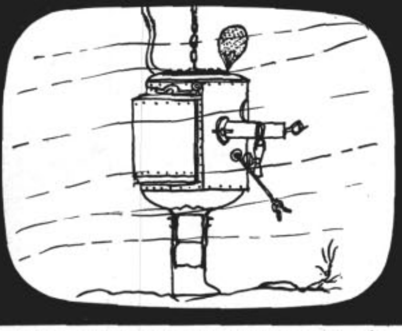
SIEBE'S "CLOSED DRESS" of 1819, waist-length "open dress," developed into the full-length suit used today.



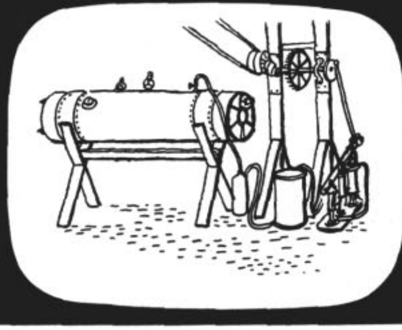
1838 ARMORED ATTEMPT by Taylor to design deep-water diving gear was on right track, had dangerous defects.

continued on next page

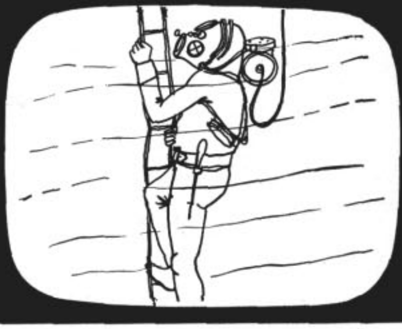
NAVYMEN IN THE UNDERSEAS WORLD continued



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.

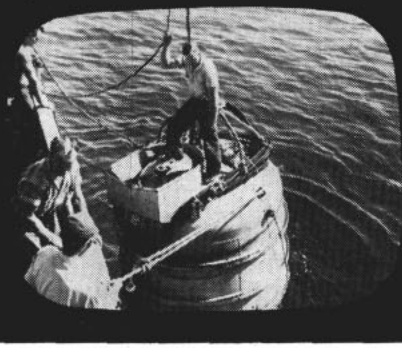


1872 FACE MASK and compressed air apparatus by Rouquayrol-Denayrouze introduced the equalized air pressure.

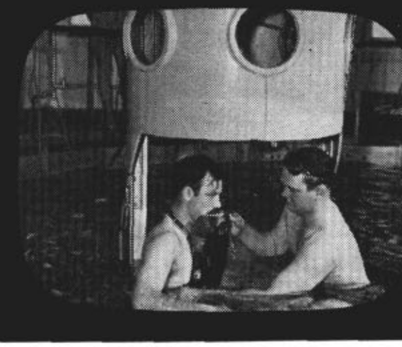
PERSISTENT CHIEF Gunner's Mate Stillson brought success to Navy with British Haldane safety tables in 1912.

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.

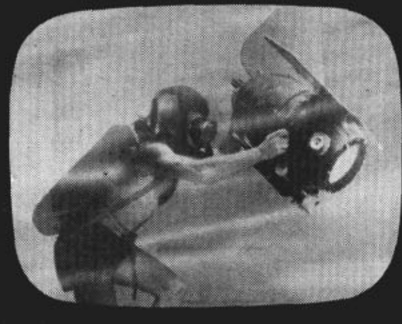


MOMSEN LUNG qualification was a must for all Navy under-the-sea men. Replaced by "blow and go!" method.

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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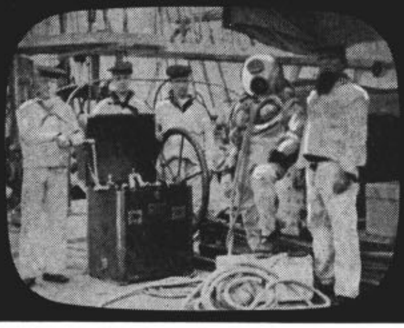
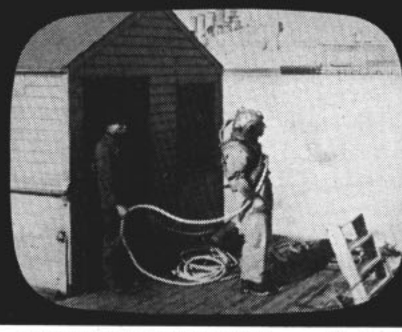
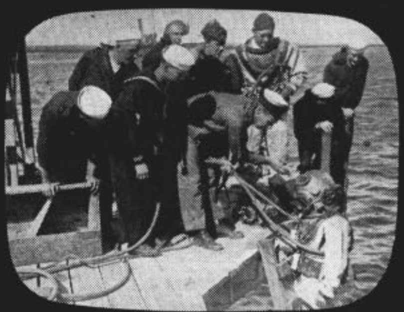


USS HARTFORD had "diving school for enlisted boys" in 1877. A hand pump on the deck supplied the air.

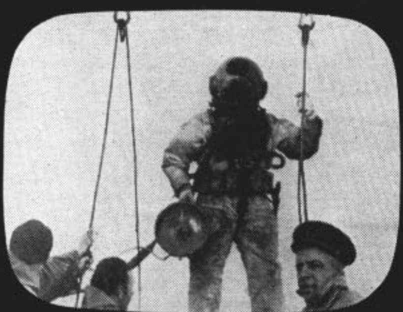
NEWPORT, R.I., 1900. Young officers learned to dive at the Torpedo Station under Master Diver Caleb West.



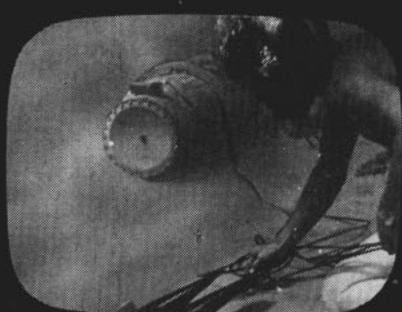
1909 NAVY DEEP DIVES were limited because of the lack of facilities to iron out the decompression problems.



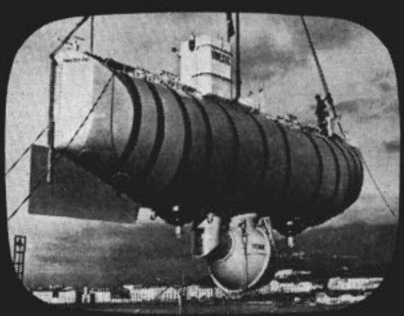
WORLD WAR I U.S. Navy Diving Unit performed invaluable salvage operations off the French Coast.



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.

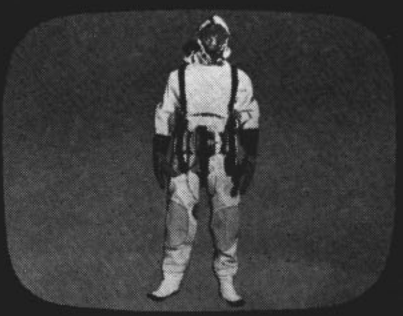


DEEP-WATER RESEARCH continues with ONR bathyscaph *Trieste* designed by Auguste and Jacques Piccard.

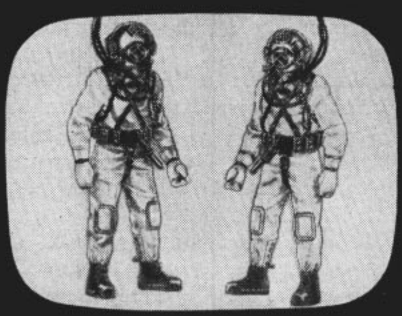
"BLOW AND GO!" is latest recommended method of submarine escape. Inflate jacket, exhale, and up you go!

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.