MALE

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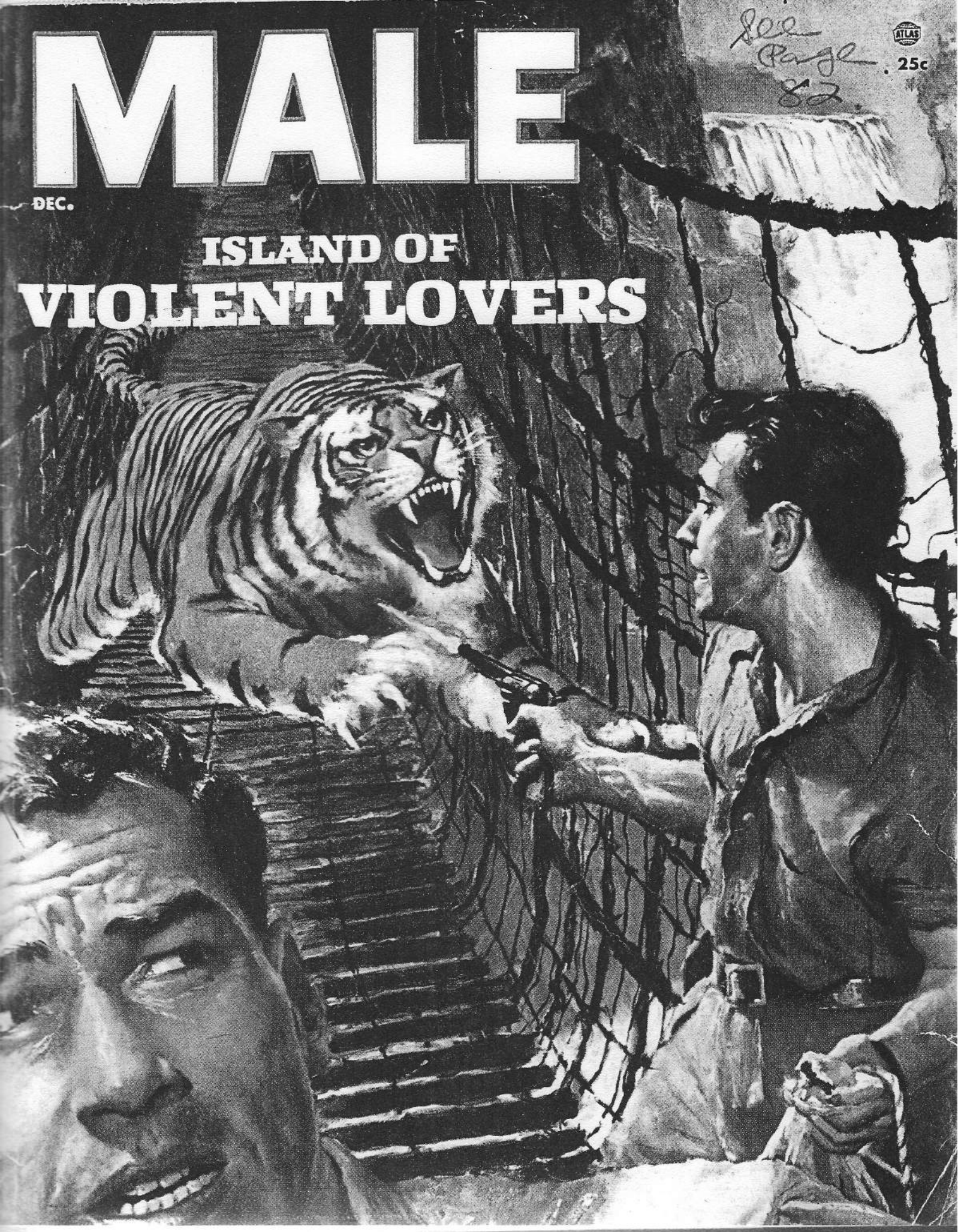

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by Bob Shulz

MALE

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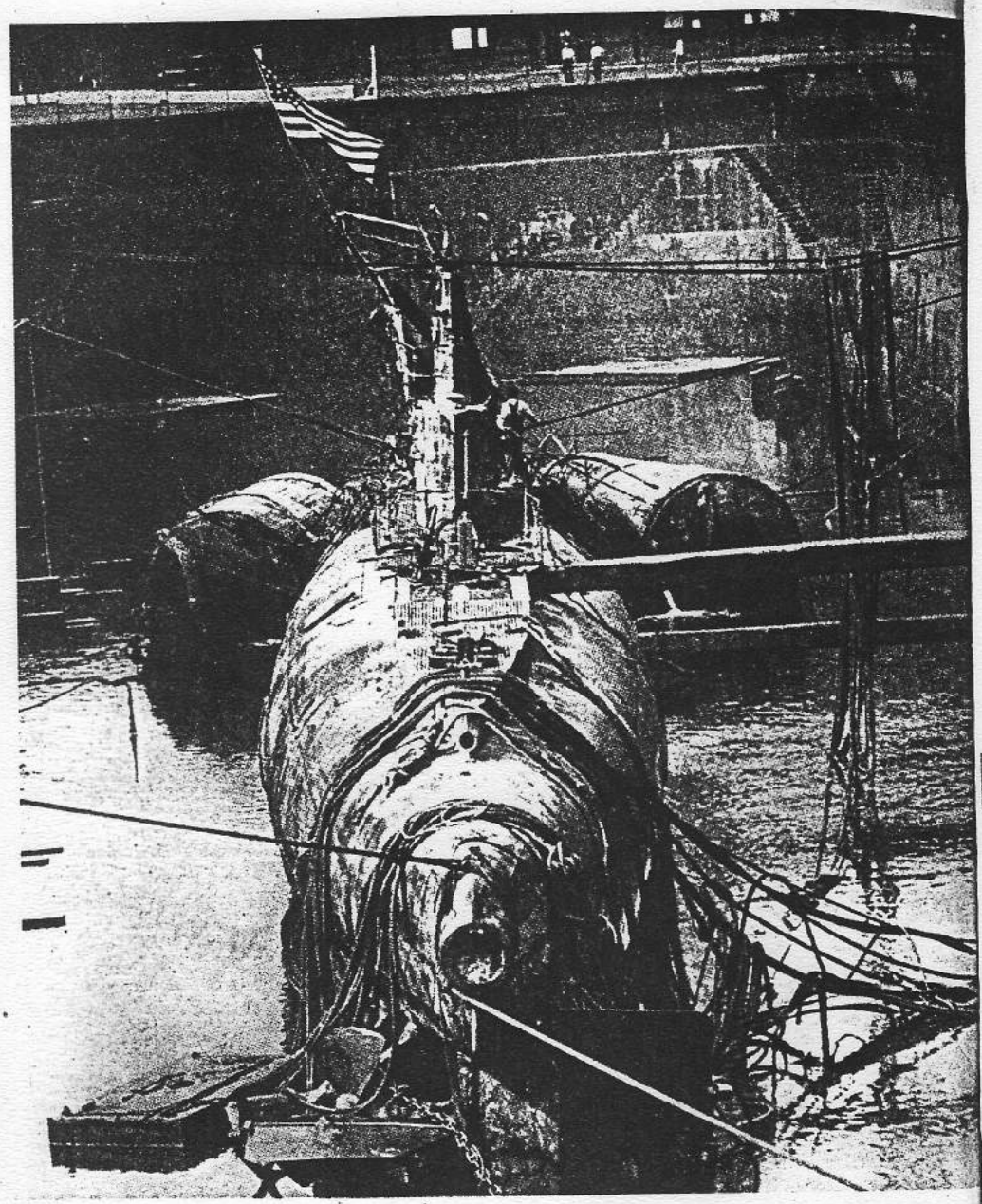
Book Bonus



It was a long, hard pull. But they finally got the S-51 in dry dock.

ABOUT THE AUTHOR... **The morning after Pearl Harbor found Rear Admiral Edward Ellsberg camped on a Washington doorstep waiting for a war assignment. That he was sent to the Red Sea salvage area was only natural—rescue is his business. Most fantastic of his ocean-floor salvage adventures are the two sunken sub incidents described here.**

MEN on the Bottom

By Edward Ellsberg

SHROUDED in a web of frayed hawsers and dripping air hoses, a battered submarine, with a ragged gash laying open her port side from deck to keel, rested in the drydock. With her diving fins cocked drunkenly in opposite planes, her conning tower half smashed in, her rudder jammed hard astarboard, and a trickle of mud and water oozing from her stern torpedo tube, that submarine was a dismal sight. Around her, crazily floating half awash in the nearly unwatered drydock, were the eight huge cylindrical pontoons which had floated that wreck in from her ocean bed at the bottom of the cold Atlantic off Block Island, 150 miles away.

Looking down on that submarine from the towering side of the drydock were the divers who had lifted her and brought her in. They were hardly able to believe that they actually saw her there, the submarine *S-51*, for whose hulk over nine endless months they had battled the fierce Atlantic.

They were a wan group of men, those staring divers—weather-beaten, with cracked lips, seamed faces, sunken eyes, and lean bodies from which had been burned every ounce of fat by long hours of breathing excessive oxygen in heavily compressed air forced down to them as they struggled on the ocean floor. For the hundredth time they leaned again over the drydock rails, gazing unbelievingly at the ship they had salvaged. Hopeless their task had seemed when, 22 fathoms down at the bottom of the icy ocean, they first had pitted their puny bodies against the powers of the sea, to lift that 1,200-ton wreck to the surface. Even more hopeless the task had seemed after months of fruitless struggling far offshore, when—in the minds of the divers groping in mud, in darkness, and in frigid cold—the ocean began to take on a definite personality, that of a malignant demon with superhuman cunning and unearthly strength fighting to hold from them what it had claimed as its own.

Relentless was the grip, formidable were the weapons of the sea—on the surface, fierce gales to batter and to scatter the salvage ships; on the bottom, icy cold water to freeze a man to the very marrow of his bones, the dark solitude of the weird depths to drive cold fear into a man's heart as he struggled alone in the mud and the blackness enfolding that wrecked submarine, a cold fear to paralyze the heart even more than the chilling water ever could paralyze the body, and last and worst of all the terrible pressure of the deep sea enveloping everything, ready instantly to crush a man into jelly under a load of 60 tons should he by any mischance lose the air pressure inflating his suit. Well, all that was over now and they had won.

In the drydock, safe on the keel blocks behind the massive caisson, rested the *S-51*. The salvage squadron could disband now—the *Falcon*, our diving ship, to rejoin the submarine flotilla at Panama, the other vessels, their fleet stations, and the divers (torpedomen and gunners' mates, most of them), after brief leaves ashore, to scatter again to the various ships from which they had hastily been gathered when the *S-51* had been rammed and sunk. For the men who fought through that heart-wrenching submarine campaign, nothing remained except to pack bags and hammocks and depart. The last order in the salvage squadron had shortly before been posted where the men returning aboard from the drydock would see it—the list of honors recommended for the men who had raised the *S-51*—Navy Crosses to six of the divers who had heroically distinguished themselves in extraordinary circumstances, promotions and letters of commendation to certain others whose services on the bottom had been only routine (if such a word can be used with regard to as perilous a job as diving).

IN A tiny cabin on the *Falcon*, the scene of many a heartache while working over the *S-51*, I listlessly gathered up my few belongings preparatory to going ashore myself. I was through, also, as Salvage Officer. Slowly I gathered up my blueprints, my instruments, my records, subconsciously as little able as any of my divers to realize that I should not again have to turn to over those designs of the submarine to figure out a way of untangling another knot that the sea had unexpectedly tied in our plans; that I should not again have to drape myself in that 200 pounds of lead and copper and wet canvas that made up a diving rig, and drop to the bottom of the cold sea to struggle on that submarine, while I mapped out their work, with the same dangers that my divers faced.

Never again should I go through that. Once in a lifetime was one time too many. Sixteen years of the Navy topped off with those nine months battling the depths off Block Island was enough of a naval career for me, and when my report was in the hands of the Navy Department, I was through with the sea forever.

The salvage squadron disbanded that day. With a heavy heart I said good-by to the divers on the *Falcon*. Never again would I see them, as I was leaving the Service and they were going back to ships scattered over the seven seas.

A YEAR and a half went by uneventfully and submarines and salvage had gradually faded out of my quiet suburban life in a little town in New Jersey, when, one cold Sunday morning in December, 1927, a week before Christmas, I opened my front door to reach for the Sunday paper lying on the steps, only to be frozen into immobility by a flaring headline screaming at me in large type:

SUBMARINE S-4 SUNK!
FORTY MEN TRAPPED!

About noon on December 17, 1927, the U.S.S. *S-4* had proceeded from inside Provincetown Harbor to the deep water trial course off the tip of Cape Cod for submerged standardization trials. For some months before, at her home Navy Yard, Portsmouth, New Hampshire, the submarine had been undergoing repairs and refitting; now she was to be run submerged under practically laboratory conditions to determine the effects on her submerged speed and maneuvering qualities.

From the near-by Coast Guard station at Wood End on the sandy tip of Cape Cod, overlooking the trial course and not half a mile away, were flying signals warning of an approaching northwest storm.

The day was cold, the sea already rising with white-caps everywhere and a force 4 wind whipping up a stiff chop over the whole bay, as the *S-4*, leaving her tender inside Provincetown Harbor, moved slowly out of the protected waters to the open bay, under the direction of Lieutenant Commander R. K. Jones, her captain for over two years.

The *S-4*, designed and built by the Navy, was a double-hulled submarine 231 feet long, 22 feet in the beam, and of 800 tons surface displacement. Of this special class, the S-type, built mainly during the World War and considered generally a very satisfactory size for all-around service, the Navy had about 50 boats. On the surface, the *S-4* was driven by two 8-cylinder Diesel engines; submerged, by two powerful electric motors from massive storage batteries.

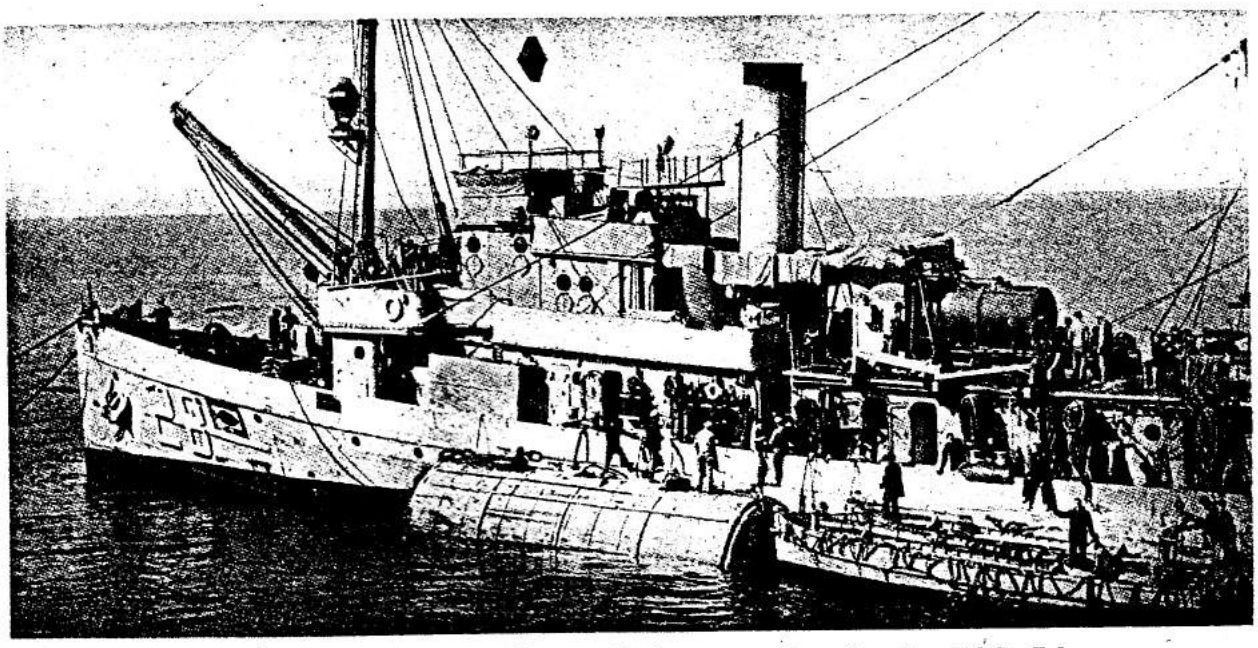
For safety in case of accident, four heavily reinforced transverse steel bulkheads divided the *S-4* into five main watertight compartments. These were, in order, starting from the bow, the torpedo room, the battery room, the control room, the engine room, and the motor room. Of these compartments, the battery room, owing to the space required to house the storage cells which fed the submerged propelling motors, was by far the largest. It extended practically from the conning tower amidships some 51 feet forward through the widest part of the vessel and provided living and sleeping quarters for the entire crew, both officers and men, except a few torpedomen whose berths were slung over the torpedo storage forward.

On this particular December day, in addition to her regular crew of four officers and 34 men, the *S-4* carried, to observe the trials as representative of the Navy Trial Board in Washington, Lieutenant Commander Callaway and his civilian assistant, Mr. Charles Ford, making a total of 40 aboard.

Meanwhile (it being still in the heyday of Prohibition), at 9 A.M. that morning, the Coast Guard Destroyer *Paulding*, one of a fleet of 25 such vessels transferred from the Navy to the Coast Guard mainly for the prevention of rum-running, steamed out of Boston Harbor for a sweep at high speed through Massachusetts Bay and outside Cape Cod. It was assumed that with the approach of the holidays increased activity of rum-runners known to be operating off that coast could be anticipated, and the presence in those waters of at least one "notorious offender" was suspected.

The *Paulding* had for three hours been speeding through the rising storm when about noon the *S-4* slowly nosed out of Provincetown, her interior especially crowded this day by the added equipment in the cramped control room for accurately registering the speed of the shafts during the trials. As she moved away from the tender, with the interior of the boat throbbing to the vibrations of the Diesels, the crew taking their stations shivered from the blasts of cold December air which swept through the control room and aft to be sucked into the intakes of the Diesels. Forward in the torpedo room were Lieutenant Fitch and his torpedomen, little concerned this day with the engine trials. Amidships in the control room and aft in the engine and motor rooms were the rest of the crew. Surrounding them in the control room on all sides was machinery.

A few miles out of Provincetown, the *S-4* approached the trial course, marked approximately by two white can buoys half a mile offshore. Inside the *S-4* the raucous note of electric horns cut through the clatter of the engines. The diving signal. All over the boat men sprang to diving stations. Another signal and the conning tower hatch slammed to, ventilation valves were closed outboard, Diesels hastily shut down and unclutched, kingston



Ellsberg-invented pontoons really upped the rescue time for the *U.S.S. Falcon*.

valves jerked open to flood the ballast tanks, and the *S-4*, driving ahead on her electric motors, planed smoothly down to periscope depth and commenced her trials.

Gone now were the roar and clatter of the Diesels, the slap of the waves against the rounded hull, the rolling of the ship in the seaway. Except for the clicking of the revolution counters, the slight whir of ventilation fans exhausting and circulating the battery gases to dissipate them, and the nearly imperceptible hum of the main propelling motors, silence filled the boat. With her deck 20 feet below the surface, she swam down the course, passed the first buoy close aboard and headed southwest with only her two periscopes showing a few feet above the surface, one periscope with its lens fixed on the range marks ashore, the other with its solitary eye sweeping the horizon as lookout for passing vessels.

During the next three hours, from the Coast Guard observation tower at Wood End, half a mile north of the course, Surfman Frank Simonds, lookout on watch, saw off and on the periscopes of the *S-4* swinging back and forth over the measured mile between the two can buoys.

At 2:46 P.M. the *Paulding* concluded her patrol in the open sea and, on a westerly course, headed in for a sweep past Provincetown Harbor and through Cape Cod Bay. Outside nothing of importance to her mission had been sighted. A few minutes later, Race Point Light was rounded and the destroyer started to skirt the fishhook tip of Cape Cod, heading southeast on a course which would take her well clear of the ranges off Wood End. A fishing vessel was swiftly overhauled, identified as the *William Langtry* of Boston, and passed without further notice. Wood End Light was drawing abeam; storm signals were flying there. The quarter-master swung his glass to read the flags, and at this time, 3:33 P.M., having followed the southeast course for over three miles, the *Paulding* passed a sea buoy off Wood End and abruptly changed course to port, heading 94° (practically east). For the first time she was pointing directly for the trial course which, to all eyes on the *Paulding*, seemed clear of shipping.

IN THE Coast Guard station ashore, Boatswain Gracie, in charge, climbed the tower, popped up through a trap door into the observation room.

"What's doing, Frank?" he asked of the lookout.

"Not much, sir," replied Simonds. "I've seen a submarine operating under the beach."

Gracie took the telescope, focused it on the *Paulding*, and, noting her easterly course, became suddenly alarmed.

"Frank, I wonder where that submarine is now? Have you seen her?"

"No, sir, not lately."

Hurriedly Gracie swung his telescope to the southeast on the can buoy marking the near end of the measured mile. There, centered in his glass, headed toward the destroyer, was the flash of the periscopes, a streak of spray flying in air! For a second only he watched, then lowered the telescope, looked again at the *Paulding*, and shouted:

"My God, Frank, there's going to be a collision!"

Gracie dropped his telescope, raced down the tower to get his lifeboat underway.

On the *Paulding*, the buoy off Wood End having been rounded, the course was set east to clear on the port hand the next can buoy (the one marking the end of the course) about a mile ahead. The captain dropped back to the chart house in the rear of the bridge to study the chart. The junior officer of the deck in the starboard wing of the bridge picked up in his glass, several miles off on the starboard bow and headed for them, the Nantucket Lightship, evidently off her station, and studied her to make sure before entering the fact in the log.

On the port side of the pilot house, the quartermaster searching for storm signals in Provincetown Harbor itself, looking off to port, saw suddenly, about one point on the port bow and not over 200 feet away, two periscopes. Simultaneously, Ensign Phanenmiller, officer of the deck, also picked them up and shouted:

"Hard astern! Full right rudder!"

As the *Paulding* during the next ten seconds strove desperately to reverse engines and swing to starboard, before the horrified eyes of her officers the two periscopes lifted from the water, half the conning tower of a submarine broke surface right under their port bow, and then came a terrific crash as the hurtling destroyer struck! The *Paulding's* bow rose as she drove on. For an instant the tapered stern of a submarine lifted drunkenly above the surface and drifted down the port side, visible a moment abreast the destroyer's smokestacks, then vanished. Except for bubbles and a little oil slick, nothing again showed on the surface as the quivering *Paulding* came to a stop, frantically lowered a lifeboat, dropped a buoy to mark the spot, and hastily took cross bearings of the lights ashore to determine her position.

THE *S-4*, which had been planing upward to surface, with her periscopes already half housed on their way down and useless for observation, reeled from the blow as if hit by a giant sledge, rolled heavily to port, and then, with her battery room torn open, began to sink bow first. A torrent of water poured through to flood the battery compartment. In the torpedo room forward, toward which the water ran first, Lieutenant Fitch and his five men found their path to the conning tower amidships and what chance of escape it offered, blocked off by that Niagara cascading into the room between them and the sole escape lock in the boat. With quick death staring them in the face, they slammed the torpedo room door shut against the water already pouring through it, hastily jammed down the dogs, and sealed themselves up, six men altogether, in the torpedo room.

In the control room, crowded with men and officers, conditions were worse. The forward periscope, hastily

The *Paulding's* keel went for scrap.

housed when collision was inevitable, came down with its training handles still rigged out and jammed itself in its housing well. Meanwhile, the hoisting wires, still slacking off as the motor continued to spin round, spread themselves in snaky coils helterskelter over the deck to tangle the feet of men, still reeling from the shock of collision.

"BLOW ALL BALLASTS!"

At the blowing manifolds, swift fingers traveled over the valves, frantically opening compressed air lines from high pressure air banks No. 1 and No. 2 to every main ballast tank in the boat—forward, amidships, aft—hurriedly to force out the water there, to lighten up, to float the boat to the surface before she went too deep. But the forward ballast tank of the *S-4* was now torn wide open. Uselessly the precious air, whistling through the blowing lines, escaped to the sea with-

out displacing any ballast, and, with fresh tons of water rushing in each moment, the *S-4* only accelerated her downward plunge!

Water rising in the battery room! Someone leaped forward along the narrow passage in the control room to close the forward door. There was room only for one man to work there. But Fitch and his five torpedomen were forward. For an instant, perhaps, the door was held open, but the missing men did not come aft. And then, in the face of the rising water, pouring through faster and faster as the boat sank and sea pressure increased, rising now to flood over the high sill, the steel door to the battery room was swung shut, a few dogs turned down to hold it. No more were necessary, for the water pressing that door against its seat would soon enough jam it tight.

Bow first, at a sickening angle, the *S-4* went down. For the moment, the sea had been shut out; the men in the control room struggled to free themselves of the tangling coils of periscope wire and man all the controls. With diving rudders at "RISE," air roaring through to blow ballasts, they had done everything possible in the emergency to start the boat up. Agonized eyes watched the depth gauge dials, but inexorably the needles went up the scales, continuously registering a greater and greater depth: 80 feet—90—100—

CRASH!

Again the boat reeled. Bow first she had struck bottom hard, plowed heavily along a few feet in the mud, then leveled off on an even keel.

THE *S-4* was on the bottom in 110 feet of water. To Lieutenant Commander Jones, to his men there in the control room, must have come an instant of hope. Things were not so bad. The sea was sealed out forward, most of the crew were safe aft, best of all they were in full possession of the control room with all its machinery, its controls, and the precious air still left in banks No. 3 and No. 4. By themselves they might raise at least the undamaged stern of the boat and escape that way. From even deeper water off the Delaware Capes, the crew of their sunken sister, the *S-5*, had done that very thing some six years before. So might they.

And then came disaster.

From overhead in the control room itself, a geyser of water burst suddenly forth, spraying directly on the live electric contacts of the switchboard to starboard! Wide eyes swept upward, seeking the source. Plain enough. A thin, sheetmetal ventilation duct overhead, intended to carry the exhaust gases from the storage batteries forward to the engine suctions aft, had burst wide open, rupturing, of all places, only in front of that switchboard, and now was deluging it with salt water!

"CLOSE THAT FORWARD VENTILATION VALVE!"

In the confined forward passage, where that ventilation duct came into the compartment through the bulkhead just over the door, was a lever-operated, quick-closing valve, intended when necessary to seal off that duct watertight at the bulkhead. The man at the forward door, who was turning down the securing dogs on the door, reached overhead for the valve lever and hastily pushed it closed.

But to the dismay of all those abaft him in the control room, the deadly spray of water only diminished somewhat but did not stop! On the switchboard, circuits began to short, vivid flashes leaped like lightning between the contacts, burned the man at the board. Forward, in the restricted space before the valve, the solitary man who could get in there to work struggled desperately to seal it tight, while astern of him, amidst the tangles of periscope wire, his shipmates fought even more desperately to protect the switchboard from the water spraying on the contacts, to prevent further damage. Obtained in that mass of machinery, from God knows where, a screen of canvas and cloth was hastily improvised and draped across the switchboard to shield it from the flood.

But through the ruptured duct the deadly stream of water under high pressure kept pouring in; the bulkhead valve would not swing home. Unknown to the men in the control room, beyond the bulkhead the ventilation duct in the battery room had collapsed under the sudden impact of the sea pressure and torn away from the valve body on the battery room side. The rising water in the battery room had floated up on its surface a green baize curtain draping the door of the captain's stateroom just forward of the control room bulkhead. When the water reached the valve which the collapsing duct had just exposed, it poured aft through the opening, picked up the curtain in the rushing stream, and washed it into the valve body, effectually preventing the valve disks from seating.

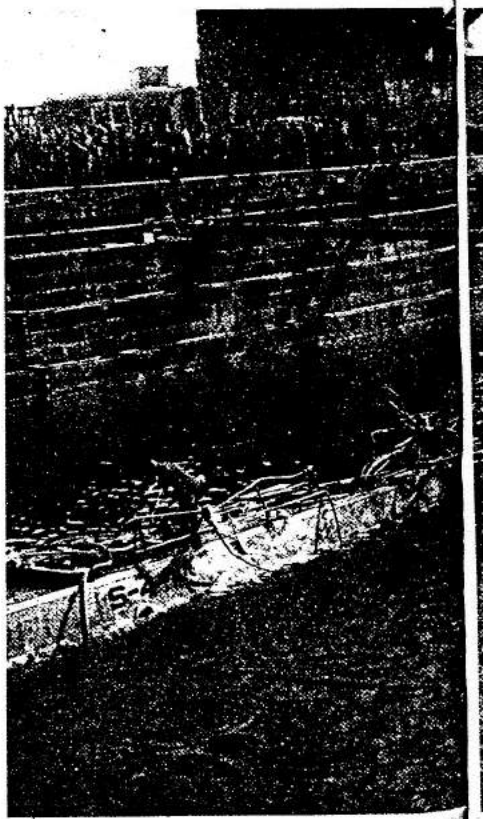
AROUND the valve the major battle inside the *S-4* was fought. Temporarily the switchboard was shielded, the short circuits stopped, but unless the valve was soon seated tight, the control room and all it meant to 34 desperate men was lost. In the narrow passage leading to the door only one man at a time could get to the valve. In the restricted space overhead, between partitions and piping, fumbling fingers and straining arms fought against despair to jam the valve lever home.

They failed. That harmless green baize drapery, clinging like a leech to the inside of that valve, was more deadly now to the crew of that submarine than depth bombs and TNT.

Beaten by that valve which would not close, the struggling officers and men were forced to abandon the control room with its escape lock, its compressed air, its controls, its chances of expelling fuel oil and enough ballast water from the undamaged after tanks at least, to float up the stern—to abandon everything that to a submarine sailor means anything, and flee into the engine room while yet there was a chance to flee.

The control room was abandoned; with its loss went all hope of doing anything for themselves. The last man squeezed through, the engine room door swung shut, the 16 heavy dogs on it were speedily twisted home. Soberly from its after side, 34 trapped men, helpless now to help themselves except to hold the sea out of their prison, regarded the door. That door swung closed against the after side of the bulkhead. The sea pressure on the other side would tend to spring the door and its rubber gasket away from its frame against which the dogs were clamping it. Would the dogs hold? Were they safe here from drowning?

Swiftly on the other side of the



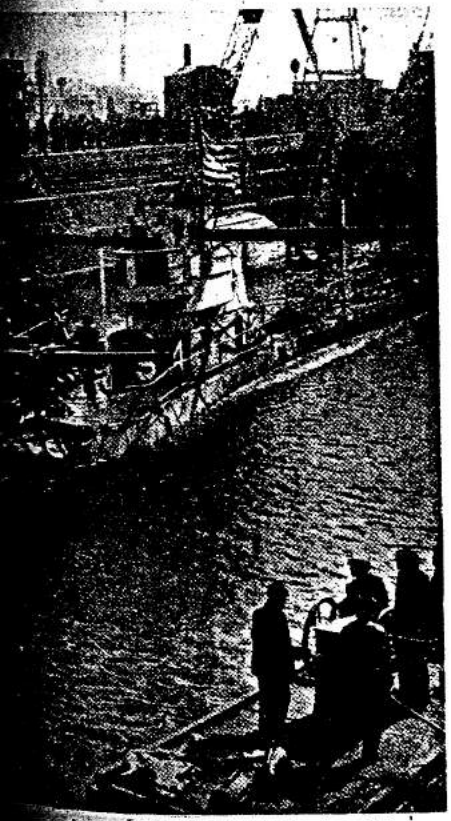
The *S-4*, sporting a new flag, re-

bulkhead the control room flooded, the pressure built up against that door. Then, before the horrified eyes of the crew, as the full sea pressure came at last against the bulkhead, on one side the door gave a little, and under heavy pressure a flat sheet of water sprayed on through into their last refuge!

Once more the battle to hold out the sea commenced. Overwrought men sledged down the dogs over the tapered brass wedges on the door till the dogs brought up against their stops and would go no further. But still some water gushed on through. Again the clang of the hammers rang out through the sea in a frenzied attempt, stops or no stops, to tighten the dogs still more, only to have five brass wedges shear off under the hammer blows, releasing completely all hold on those dogs! Before the dazed eyes of the men fighting to hold back the sea, the leak suddenly increased!

Hurriedly the engine room was ransacked for emergency securing gear. A bit of planking two inches thick, once used somewhere as staging, was dragged up and, with other improvised material, jammed in against the door. The leak was at last reduced to an insignificant trickle.

For the first time since the *Paulding*, only a few minutes before, had crashed into the *S-4*, the panting men aft were safe from immediate death. But what faced them? Thirty-four men in two small compartments with hardly space to stand comfortably between the engines, with no place except wet and oily steel plates to lie down, no air except that fouled already from three hours submerged operation, with the steel shell forming their prison firmly gripped in the freezing water of the deep sea, soon chilling the engine room to 34° F., began their weary wait for help from the world above. But long before the first sign of that help came, in the foul air inside the crowded stern, they had all lapsed into unconsciousness.



turns to the land of the living.

ON THE surface, from the *Paulding*, down by the head now and seemingly in danger of sinking herself, the radio began to crackle:

COMMANDMENT NAVY YARD BOSTON.
RAMMED AND SANK UNKNOWN SUBMARINE OFF WOOD END LIGHT PROVINCETOWN.
PAULDING.

From Boston to the Submarine Base in New London, the Navy Yard at Portsmouth, and the Navy Yard at New York almost immediately went identical telegrams:

SUBMARINE REPORTED SUNK AT WOOD END NEAR PROVINCETOWN BY COAST GUARD DESTROYER. SEND ANY LIFTING APPARATUS. RUSH.

The collision occurred at 3:37 P.M. By a few minutes after 4 P.M., in New London, Portsmouth, and New York, action had started. In New London lay the *Falcon*, the only salvage ship the Navy had in the Atlantic. At 6:10 P.M., with her crew gathered from far and near around the town, the *Falcon*, carrying Rear Admiral Brumby, flag officer of the squadron to which the *S-4* belonged, sailed for Provincetown, 120 miles away. From Portsmouth, at 7:30 sailed the *Bushnell*, mother ship of the *S-4* and her sisters; from Boston, several destroyers and tugs; a few hours later, from New York, six pontoons in tow of other tugs—the same pontoons used two years before to lift the *S-51;* while, from Norfolk, sailed the U.S.S. *Wright*, carrying on her deck four more pontoons, the remainder of the single lot of 10 that the Navy owned.

Meanwhile, during the night, over the road by automobile from Newport to Provincetown went the most important help of all—all the divers in the vicinity—three men, Eadie, Carr, and Michels, veterans of the *S-51* salvage, with eight others of less experience.

BOATSWAIN Gracie of the Coast Guard, on the scene with his surfboat promptly after the collision, dropped a grapnel and commenced to sweep the bottom over the spot indicated by the bubbles of air and traces of oil escaping from the *S-4*.

At 7 A.M. on Sunday morning, the *Falcon* steamed up from the Cape Cod Canal, took aboard the divers already in Provincetown, and stood by outside prepared to dive. But until a line was hooked into the *S-4* to guide the divers down to her, putting men over the side was out of the question. Men and officers eager to go into action had to stand by chafing idly, while Boatswain Gracie, who since eight the previous evening and all through the long December night had clung to the wreck, swept now endlessly back and forth across it in his surfboat, trying to hook it.

Finally at 11 A.M. his grapnel caught. Carefully, so as not to lose that precious grip, he buoyed off his line with an empty gasoline drum, while the *Falcon*, with something to work to at last, maneuvered to windward, dropped anchor, then veered cable to bring herself over the spot and took aboard the buoyed-off line. For proper work the *Falcon* required from four to six heavy mooring buoys laid out in a circle to hold her in position against wind and sea, but there was no time to lay out the buoys or to plant the anchors. Instead, two minesweepers, the *Lark* and the *Mallard*, anchored one off each quarter of the *Falcon*, and to each of them the *Falcon* ran a hawser to hold herself over the wreck as best she might.

AT 1:38 P.M., twenty-two hours after the collision, Tom Eadie, chief gunner's mate, was hoisted over the *Falcon's* side as she yawed and pitched to the head seas, dropped into the water, and slid swiftly down the grappling line. Within a minute his lead-soled shoes landed with a clang high on the chariot bridge of the *S-4* between the two periscopes where the grappling hook had caught. The water was murky, the light dim, the cross current bad. As Eadie clambered down, the quiet of the deep sea broken now by the banging of his weights against the steel hull, he thought he caught coming through the water from forward a signal. As he landed on the deck, he was sure of it. Over the slewed gun, across the torn deck, Eadie went forward, following the sounds. They came from the torpedo room. At the torpedo room hatch he stooped and banged the cover. Immediately from within, strong and distinct, came six raps. Six men alive in the torpedo room! Promptly the diver reported this over his telephone.

With a final rap for encouragement, Eadie went forward to check conditions at the bow, then aft over the wrecked deck to the conning tower. He rapped there. No answer. Aft again along the undamaged deck as far as the steel hatch over the engine room where he then rapped again. But there was

no response from anyone astern.

On the *Falcon's* deck, listening to the diver's reports, was Rear Admiral Brumby, in whose hands lay the final decision.

Brumby knew from the *Paulding*, confirmed now by Eadie's report, that the damage was in way of the battery room; he knew that six men were alive forward in the torpedo room; and he knew that from aft, where most of the rest of the crew must have been, there was no answer to signals.

BELOW, built into the *S-4*, were two entirely separate emergency air lines with connections outside her conning tower, intended only for use in disaster—a salvage air line leading only to all the ballast tanks, and a compartment air line opening only into the crew compartments on the boat. To which of these two emergency connections should the next diver hook the first air line—to the crew compartments, or to the ballast tanks?

Carefully the situation was canvassed. If only one compartment was flooded, blowing ballasts with external air ought to float up the boat; if two or more compartments were flooded, that was hopeless. Still, if the men forward, with the boat going down by the bow and the water therefore tending to rush into the torpedo room first, had succeeded in closing the forward door of the damaged battery room, there was no apparent reason why the rest of the crew had not been able to do the same with the after battery room door, thus confining the water to one compartment.

That no sounds came from aft more probably indicated not that the stern was flooded, but that so many men crowded in a small space aft were, after twenty-two hours, either unconscious or so weak from bad air that they could not answer. If so, prompt lifting of the stern was all that would ever save those aft; the men forward seemed strong enough to last till that was tried first.

At 3 P.M., Bill Carr, chief boatswain's mate, went over the side carrying the salvage air hose for the ballast tanks. He passed Eadie who was on his way up. Connecting up the hose proved difficult; Carr spent 90 minutes in icy water on the bottom working through the little hatch in the side of the superstructure before the hose was finally coupled and some air blown through to test the job.

Then, with Carr off the boat, the *Falcon* was hauled a little to one side to avoid being struck by the rising *S-4*, and blowing commenced. At full speed for an hour the compressors on the *Falcon* rammed down air through the hose into the ballast tanks of the *S-4* while on the surface hopeful eyes watched and waited. Then air began bubbling up, in quantity increasing till it equaled what the compressors were sending down, and sounded the knell of that hope. What water could be expelled from the ballasts evidently was gone, the air was now simply blowing out somewhere as fast as it went down.

The *S-4* did not rise. Apparently more than one compartment was flooded. If that were so, presumably then the crew aft, for some reason or other, had not succeeded in closing any doors, and their silence meant that they had all drowned. There was no longer any hope except for the six men forward.

MEANWHILE, as night drew on, conditions on the surface had changed for the worse. The long-expected northwest storm finally broke and kept on increasing, with the wind blowing a gale. The *Falcon*, swinging from her flimsy moor, was yawing erratically from side to side and pitching heavily. It was evident now that the *S-4* could not be quickly raised by anything within the power of men; that diving, which was fast becoming impracticable in that sea, would soon for days be wholly impossible; that, to keep the men in the torpedo room alive till the storm blew over and diving could be resumed, a hose would have to be connected immediately to the compartment air line to feed air into the torpedo room.

Hastily the *Falcon* was hauled back into diving position, centered as well as possible over the *S-4*. At 8 P.M., in the darkness, with heavy spray breaking over the *Falcon's* rail and freezing immediately on the decks, Fred Michels—chief torpedoman and most experienced of the divers left on the *Falcon*—went over the side, carrying with him the air hose and a powerful submarine light.

Michels, sliding down the rope to the *S-4*, hit bottom, not on the submarine but in deep mud somewhere off to one side of her, and immediately found himself buried to his waist and wholly unable to extricate himself. He phoned up his difficulty. On the *Falcon* it took 13 men hauling on his lifelines to drag him clear of the mud and up into the water once more.

A second attempt to land him on the submarine was more successful, but unfortunately, instead of landing near the conning tower where the descending line was attached and where he was to connect the hose, he was dropped this time in the midst of the wreckage left by the *Paulding* where the slack of his own air hose promptly fouled. Before Michels could clear it, he felt himself irresistibly dragged to the deck by the tightening coils across his back and in a moment found himself sprawled out face down on the steel hull of the *S-4* with his own lifelines tangling above him on the wreckage in a web from which there was no escape!

Helpless, unable to signal, unable to talk intelligently with the air roaring through his helmet, Michels managed after nearly an hour on the bottom to get a message through indicating his plight. With the weather even worse, Tom Eadie was dressed again and in the middle of a December gale went overboard to try to save Michels. Disregarding the descending line now, he slid down on Michels' own air hose as a guide. Somehow between luck and skill, those on the *Falcon* managed to land Eadie directly on the submarine the first time without fouling him. Working there in that ice water for nearly two hours with a hacksaw, Eadie cut away part of the wreckage and untangled Michels. Finally, near midnight, Michels, after three hours and twenty minutes on the bottom, went up, unconscious, perhaps dead, and literally frozen as stiff as a board.

WHEN I read the news of the *S-4* I immediately volunteered my services. After some red tape, I finally arranged with the Coast Guard for transportation to the *Falcon*.

The storm was raging as our surfboat headed up the port side of the yawing *Falcon*. With engine slowed and with only speed enough to keep steerage way and avoid broaching, the lifeboat edged up past the stern, past the quarter, and then sheered gradually in till we were not over eight feet away from the *Falcon's* side. Poised on the lifeboat's gunwale, clutching the engine house, I clung precariously, watching the lifeboat crazily rise and fall.

We dropped dizzily into another trough as the *Falcon* started rolling toward us. I braced myself, looked aft at the bosun, nodded. Along came the inevitable crest, the bow of the boat heaved up, the bosun sheered in a little. For an instant only, poised on that wave, I could see the *Falcon's* glistening side below me in the darkness and the black water gap between ice-coated ship and ice-coated lifeboat narrowing. Then head first, with arms outstretched, I leaped in a wild dive from boat to ship, shot over the gunwale, and felt myself sliding spread-eagled on my stomach down the *Falcon's* icy deck!

While I was still sliding, my bag, heaved across by the engineer, came hurtling over the rail to land with a crash astern of me. By the time I had regained my feet, the lifeboat, with her engine at full speed once more, was already several boat lengths away and headed about, disappearing in the

black night toward Provincetown.

"Thanks!" I shouted across the water, but in the storm I doubt that I was heard.

A little shaken by my leap, I clung an instant to a nearby superstructure stanchion to steady myself, then started forward along the deserted deck. Near the bridge, a quartermaster hastily descending from the chart house met me, apparently recognized me from my last cruise on the *Falcon*, and filled me in on details of the *S-4*.

I scrambled across the deck to the starboard side where, built into the ship, lay the recompression tank, a huge steel cylinder for treating divers under air pressure. I shouldered through into the inner chamber. My heart sank at what I saw.

On the deck, naked, stiff, unconscious, lay Fred Michels whom I had last seen at the Navy Yard in New York. Working over him, one on each side, chafing his muscles, rubbing him with hot towels, were Tom Eadie and Bill Carr, striving desperately to bring him to. For over two hours now they had been at it. Without a word, I dropped to my knees alongside to help. Neither Carr nor Eadie showed any surprise at my sudden appearance at that unearthly hour. Nothing in connection with the *S-4* would ever surprise them again.

Chafe and rub, rub and chafe—we kept endlessly at it. Then at 3:30 A.M., Michels, whose last conscious moment had been passed at the bottom of the cold sea with his helmet pressed tightly down against the *S-4*'s broken hull, came suddenly to, blinked his eyes questioningly, unable to believe at first whom he saw bending over him, and then mumbled in surprise:

"Why, hello, Mr. Ellsberg!"

THE GALE blew on. Monday morning came; no chance of diving.

Soon after the first dive, communication had been established with the men in the *S-4* by Morse code. Signals were sent on an oscillator from the *Falcon* or a sister submarine, the *S-8*, and answered by hammer taps from the torpedo room, one rap a dot, two raps a dash. With the exception of the first taps on the hull by Eadie, all succeeding communication was from ships on the surface.

Just before Michels went down, the *Falcon* signaled:

"Is there any gas?" To which, in dots and dashes picked up by the *Falcon's* receivers, came the answer:

"No, but the air is bad. How long will you be now?"

To this the *Falcon*, about to lower Michels over the side in the teeth of the gale, replied:

"Compartment salvage line now being hooked up."

But the connection was never made.

FOR THE NEXT two days, the gale blew on and no diving was possible. To save Michels's life, in the face of weather which made a transfer at sea impossible, early Monday the *Falcon* ran for Boston to put him in the hospital.

The storm blew all day Tuesday.

Wednesday at last the sea moderated and the *Falcon* moored for diving. The sounds from the *S-4* had long since ceased. And then another blow: Both the manila descending line the divers had used and the ballast tank air hose, buoyed off at the surface, had chafed through during the long storm. When picked up in the waves on Wednesday, the last remaining threads parted, and there was no line to the *S-4*. Moored as exactly over the spot as bearings could place her, divers went overboard and floundered impotently in deep mud on the bottom searching for the *S-4*. Though unquestionably within 50 feet of the submarine, they never saw her.

Precious hours were lost till Boatswain Hawes of the *Falcon* hooked her again in the afternoon with a grapnel. Hurriedly then, divers Wilson and Eiben connected an air hose directly to the torpedo room through a fitting improvised to go over a listening tube on the submarine's bow, and we started alternately to pump in and vent out the air below. The first sample tested of the air coming up from the torpedo room showed it was hopeless—the amount of carbon dioxide was so high, seven percent, that the men could not live long in such an atmosphere.

In spite of that, the ventilation was continued for hours till the air inside the submarine was purified, but inside the torpedo room no one ever revived. The tragedy of the *S-4* was over.

What injuries had the *S-4* suffered in that collision with the onrushing *Paulding?* To determine that, while the ventilation of the forward compartment went on, I got dressed for my first dive. Cased from ankles to neck in three suits of heavy blue north woods, woolen underwear and wearing three pairs of thick woolen socks, I went aft to the dressing bench looking decidedly rotund.

I seated myself on the bench on the *Falcon's* fantail—for all my clothing, chilled in the cold wind—and the dressers went expertly to work on me. First came the diving dress, a canvas-covered rubber suit. Into this stiff garment I slid thankfully, for at least its impervious texture made it an excellent windbreaker. While the dressers lifted me and the suit by its rubber collar, unceremoniously shaking me down inside, I slipped my padded toes into the feet and my bulky gloved hands down into the water-tight gloves forming the ends of the diving sleeves. With a final wiggle of fingers and toes to slide everything home, I settled back again on the bench, and the rest of my ponderous regalia was hastily put on.

A pair of 30-pound lead shoes were strapped over my feet, an 80-pound lead belt draped round my waist, a copper breastplate tightly bolted to the rubber collar of my dress to make a waterproof seal, a telephone headset buckled on over my ears, a massive diving knife hooked to my belt, and I was ready to test out. Hurriedly my telephone was checked, my air hose tried. Both worked satisfactorily, and down over my head came the helmet. A quick twist on it from the tender to lock the screw joint, and I was ready. Completely shut inside my suit, I opened the valve on my air hose a trifle to get some air to breathe, and immediately my rig ballooned out under the slight pressure.

Two husky dressers seized me, one by each shoulder, and helped me rise. Staggering under a load of 200 pounds of lead and copper, I walked unsteadily, supported by the dressers, to the *Falcon's* rail. With an effort, I lifted my bulky shoes a few inches onto a steel stage dangling from a boom overhead and gripped the steel bails of the stage to steady myself. Then the tenders let go.

A BOSUN'S pipe shrilled, a winch rattled into action, up went the stage, out swung the boom, and the next instant I was swaying erratically, with the stage outboard of the bulwark and only the sea beneath me. Again, muffled by the noise of the air whistling through my helmet, I heard the bosun piping, and down into the sea splashed the stage. Instantly my canvas suit, which had in the air been grotesquely swelled out, collapsed like a punctured balloon, the folds of canvas-covered rubber now pressing in tightly against my frame, leaving only a little air space inside over my chest where the breastplate held it out.

Down a few feet, and the stage stopped. Peering out of my faceplate through the water, I could see alongside me the rounded red hull of the *Falcon* sloping away to her keel, with here and there a few barnacles and some moss. Over me was the surface, undulating like a silver sheet, sharply dividing the world I was now in from the normal world of men.

Completely immersed in the sea, I was now buoyed by it, and the lift on my helmet as it tended to float up in the water took from my shoulder the burden of my bulky belt. Quickly I adjusted my air valve and the exhaust

valve on my helmet to give me some negative buoyancy, enough to prevent my floating upward off the stage, and then through the telephone transmitter I sang out:

"Topside, there! All ready! Lower away!"

I felt the lifeline and air hose tied to my suit at the breastplate tauten up as my tender took in the slack, then a far-away voice sounded through the transmitters over my ears:

"O.K. Step off the stage!"

I stepped off, the stage was promptly hoisted, and there I hung, dangling on my lifelines with nothing below me now but the bottom of the sea, and in front of me only a manila line tied somewhere below to the *S-4*. I grabbed the line and wound my canvas-covered legs round it. The tenders started to lower.

The light quickly faded as I sank. A few fathoms down, the *Falcon* disappeared from view, the surface faded away, and around me was nothing but water. A little above me, the manila line down which I slid seemed to dissolve, and beneath my feet, more line seemed to materialize constantly out of nothing.

Down I slid endlessly. The pressure increased, breathing became harder, my eardrums dilated painfully. I swallowed hard continuously to relieve them. The cold water started to strike through to my skin in spite of my many layers of protective wool.

And still down I went through the seemingly bottomless depths, through an unearthly quiet broken only by the air whistling through my helmet and then out, leaving behind me a trail of air bubbles streaming from my exhaust valve.

But I had no time for watching bubbles. My eyes were down now, always down, peering through my faceplate at the manila descending line which was my guide. The line started to slope away more sharply toward the horizontal; I took a firmer grip with my legs to hang on to it. And then vaguely forming out of the water below me was the *S-4*. A few more fathoms down the line, and I stopped, shouted into my telephone, "On the bottom!"

THERE she lay before me, silent, motionless, huge in mass as I stared at her, her bulk strangely magnified by the water. I was standing on her very bow, in the thin triangle where sides and deck met stem, a precarious perch with no railing for support. A little dizzy from the pressure, I paused a moment, clinging tightly to my guide line, while I readjusted air valves to suit conditions on the bottom. Then, checking my lifelines to make sure they were not fouled round the descending line but were floating clear, I let go the manila rope which had been my guide till now. Signaling on my lifelines for more slack, I cautiously walked aft. The deck was level, the submarine had neither heel nor trim. The visibility was fair; I could see perhaps 10 feet.

Aft I went, pushing slowly through the water. The deck widened still further. I was perhaps 70 feet aft and increasing my pace, when before me the deck suddenly vanished, torn completely away! In a ragged tangle of torn steel, the deck ended where the *Paulding*, evidently riding across, had ripped the superstructure and the deck clean off the submarine. Peering over the edge of the broken deck, I could see below me the cylindrical hull. Cautiously, so as not to cut open my diving suit on any of those jagged plates, I clambered down to the hull below, then continued aft again, eyes glued now on that round steel hull, searching for the rupture which had flooded the inside of the submarine. But there was no opening, no gash in it anywhere, just that smooth, round hull beneath my feet with the superstructure wiped clean off.

Puzzled, I stopped. Where was the *hole* in the submarine which had sunk her? That hole I was supposed to find, to examine carefully before the salvage operation proceeded. Certainly it must be forward of me; somehow I had missed seeing it. Signaling on my lifelines to start taking in slack, I turned, retraced my steps to look for it again.

Once more I clambered over the slewed gun, dropped down over the broken deck edge onto the cylindrical hull.

A few steps forward, and then, as if a fog had suddenly rolled in, the submarine disappeared — from my waist down I stood in a cloud of mud; in no direction was any part of the *S-4* visible!

I STOPPED instantly, all sense of direction lost, fearful that if I took a single step the wrong way, I should go sliding overboard from the rounding cylinder on which I stood. Where was the fore and aft line now along the hull of the sub that I must follow if I were to stay aboard her? Perplexed, I looked around. The gun and the conning tower astern of me had faded away, dissolved so to speak in the translucent water. They could not serve as guides.

I was completely lost. I looked down at the clouds of mud billowing there in the water, like clouds in the sky, blotting out my legs, blanketing the submarine. What had happened? Apparently in my passage aft along the sub I must have stirred up a fine layer of mud with which the sea had coated the *S-4*. Now going forward again, I was caught in the resulting fog. Somewhere to port of me was the wreckage in which Michels had been trapped, to starboard the curving side of the hull. A step in any direction but the right one would land me in trouble, but which way in that mud-shrouded water was right?

And then it came. On the surface, the *Falcon* took a wide yaw among the waves, my lifelines suddenly tautened, jerked my breastplate, threw me off balance, and I felt myself going over sideways, in another instant to be sprawled face down on the submarine, sliding helplessly through the water over the curving hull of the *S-4!* Faster and faster I went, lead weights clattering, copper helmet banging against the submarine's shell, while involuntarily I tried to dig my gloved fingers into the steel plates beneath me, to get a grip on something, anything, to stop my fall. Useless. The

Divers get "decompressed" on way up.

plates were smooth and slippery, there were no projections. With increasing speed, I shot overboard and started to drop vertically, still clawing wildly. No use. Down I went.

Then suddenly in the water a projection flashed before my faceplate! Out shot my right hand, grasped it. I stopped with a jolt that nearly jerked my arm from its socket, to find that there, before my face, was what I had made that dive to find. Through the faceplate of my copper helmet I was staring straight into the hole punched through the *S-4's* side into her battery room! And the projection I was clinging to was part of the *Paulding's* steel stem, still jammed like a broken lance into the *S-4's* death wound!

DANGLING there in the water by one arm, completely forgetful of my own plight, I swiftly examined that hole where it pierced the inner hull. It was a surprisingly small gash—hardly a foot across—to have sunk that ship and killed her crew, but still, aided by the increasing pressure of the sea as the sub went down, it had been more than enough to pour into the battery room a torrent which quickly spelled complete disaster.

A second look into that hole finished my examination. The damage was insignificant as affecting the strength of the ship to stand a lift—no danger of that trifling hole causing it to break in two when our lifting gear took a strain.

With that, I swiftly forgot all about the submarine's troubles and came back to my own. We could lift the submarine all right, but how about myself? I had broken my fall; what could I now do to lift myself up on deck? I tilted back my head and looked out through the top part of my helmet. Then cold fear suddenly gripped me. A stream of bubbles was pouring upward through the water from my hand! The jagged steel to which I clung had cut open my watertight glove, and from the highest point in my suit I was rapidly losing all my air!

Frantically my lead-soled shoes beat the sides of the *S-4*, trying to get a foothold on something to support me, to allow me to drop that arm below my helmet and save my air. It was useless. On the sheer side of the submarine there wasn't the slightest toehold. I felt the sea pressing in on my chest as the air went out, and breathing became more difficult. Despairingly as I dangled there I glanced up again at my cut glove, at the air bubbling away. I couldn't climb up and I couldn't hang there much longer or the sea pressure would finish me. There was nothing to do but to let go while still I had a little air left in my suit, and take my chances on the sea floor. I let go, and hoped for the best.

Down I went again through the water, faster than ever now, with little air to buoy me up and that 200 pounds of lead and copper dragging me into the depths. I got one last glimpse of the side of the *S-4* shooting by my faceplate and then—the light went out!

I had hit bottom, but instead of stopping I shot completely through it to find myself buried in soft mud, engulfed in total darkness, and still sinking helplessly, dragged down by my weights!

I came to rest at last, sprawled out sideways in utter blackness, to feel mud pressing in on me from all directions while the water which had leaked into my suit from my cut glove now all poured into my helmet and half strangled me. Convulsively I tried to straighten myself, to get my feet down and my head up, but with each desperate flailing of my arms and legs I could feel myself only sinking deeper through that clinging mud.

Then at last I struck something hard, quit sinking, came to rest still sprawled out on my right side. With a gasp of relief; I thrust my arm down hard, intent on getting my head up, getting that water out of my helmet, only to feel my arm go full length down again into unresisting mud. There was nothing solid under my shoulders, only under my body.

Instinctively I began to wiggle myself along that supporting shelf, to get wholly on it so that I might work myself erect, but after the first motion, I immediately quit moving and lay still, terror gripping me completely. All along beneath me I felt sharp points jabbing upward into my diving suit, sawtoothed steel protruding everywhere from the support beneath me. What I had come to rest on there in the mud was twisted wreckage torn from the *Paulding's* keel as she raked over the *S-4*, wreckage now sunk alongside her victim. And if I moved, those razor-edged steel plates would cut my suit wide open in a dozen places as the *Paulding's* bow had already ripped apart my glove.

I LAY still. No more struggling, no more efforts to rise. In the blackness, in the cold, in the mud 20 fathoms down, I lay quietly, not daring to move a muscle, desperately wondering what to do.

Then the answer came to me. All I had to do to get clear of my trouble was to call my tenders on the surface and tell them to pull on my lifeline.

Carefully I twisted my head round to bring my mouth opposite the telephone transmitter in the roof of my helmet, fortunately clear of the water lapping round my neck, and gasped out, "Topside there!" Then I waited with straining ears for a reply. Had the water already short-circuited my telephone? With infinite relief I heard the answer from the *Falcon* in the world above me:

"Topside. What is it?"

"Heave in on my lifeline!"

"Aye, aye. Right away!"

My head dropped back thankfully. All my troubles were over. With muscles tensed and stiffened legs, I waited for the tug on my breastplate. But the tug never came, and after what seemed to me an endless wait with not the slightest pull on my lines that I could feel, in anxious tones I sang out again, "Topside there! Are you heaving yet?"

The answer fell like a sledge hammer blow on my strained nerves.

"Yes! Four men are heaving hard on your lines but they can't get an inch of slack. What's the matter down there?"

FOUR men heaving on my lines and I couldn't feel even a slight pull! And they were getting no slack at all on deck. Then my lines must be afoul of something above me, probably tangled in the *Paulding's* broken stem which had already pierced my glove! The strain that four men heaving hard on deck could put on my air hose fouled on the sharp edges of that jagged stem projecting from the *S-4's* side could easily cut my rubber air hose in two, leave me there in the mud to be asphyxiated! In a strangled voice, I screamed, "Topside there! Avast heaving! Slack off! Slack off for God's sake!"

An agonized moment passed while I waited in suspense. Would they get that message in time, would they obey it? Then almost with a sob of relief I heard, "We're slacking away! Do you want any help down there?"

Did I want any help? Heaven knew I needed it badly enough, but I could waste no more breath in talking. My head sagged back, I didn't bother to answer, and I heard nothing further. On the topside, I knew that they would do what they could anyway, probably dress a relief diver and send him down. But in my position, I gave up expecting any further aid from the *Falcon*. I must rely on myself. Despair, black as the blinding night around, gripped me.

THEN gradually I became vaguely aware, in the utter silence and blackness of that grave beneath the ocean floor, of a persistent murmur in my helmet, of a murmur to which long familiarity had made me oblivious. A small current of air was still flowing through my helmet, escaping with a gurgle through the exhaust valve somewhere near my chin. I still had air

coming through my hose from above. Suddenly, across my dazed brain, that brought an idea. That air could save me!

Slowly, cautiously, not to let any movement of my body saw through my suit, I dragged my left arm through the clinging mud to my breast, fumbled with frozen fingers encumbered by mittens and stiff diving glove till I found the handle of the air control valve bolted to my breastplate. Through that valve, the air from the *Falcon's* compressors, coming down my air hose, entered my helmet.

CONVULSIVELY my fingers closed on that valve handle, twisted it wide open. Immediately a suddenly increased stream of compressed air roared into my helmet, started to inflate my suit. I could feel the canvas which had been pressing in on my chest ease off as if a heavy weight had been removed and began to swell. Under the increasing buoyancy, my helmet lifted a trifle, then, as if a giant hand had seized me by the shoulders, my body started to float upward through the mud, to come erect as my suit swelled more and more. Another moment and I was free of that bed of torn steel plates and could feel myself dragged vertically upward through the mud by my over-inflated diving suit!

A little further and my helmet burst through the ooze of the ocean floor into the water. Light! After the terrifying darkness of the mud, that dim half-twilight of the depths seemed to me as dazzling as if the sun had suddenly risen inside my helmet!

But my dangers were not yet over. Under the pull of my partially ballooned-out rig, I was still rising from the mud, excessively buoyant. If, when I tore free of that clinging ooze, I was still so light, I would go shooting upward through the water with ever-increasing speed as the sea pressure decreased, and perhaps crash at high speed into the *Falcon* above and kill myself. Or, if I missed her, I might be an immediate victim to "the bends," having risen from the heavy pressure of the depth to the surface without the slow decompression which alone could avoid it.

Instantly, when my helmet popped out into the water, my still-buried fingers were clawing again through the mud for my control valve, shutting off the air before it was too late. When the excess air had blown itself off through the exhaust, and my ballooned-out rig had shrunk back to more normal proportions so that I ceased rising, I found myself still buried to my waist in mud with only the upper half of my body in the water. But I dared not float myself any further up for fear of not stopping. And there, in equilibrium, half in water, half in mud, I stood suspended in the ocean floor.

I looked up. To my pleased surprise, my lifeline and my air hose were floating vertically above me with no tangles in sight. Were they still fouled, or had my rise from below permitted them to slack off and to come clear of trouble? I could quickly find out. Once more I called the *Falcon*.

"Topside there!" Take an easy pull on my lines!"

A brief moment, and then I felt a gentle tug on my breastplate. My lines were free! Swiftly I bled more air from my rig to make sure I was heavy enough not to float and then:

"Topside there! Pull me up 10 feet!"

My lines promptly tautened and up I went, legs tearing free of the mud.

Step by step, I was lifted. Halfway up I clambered aboard the little steel stage lowered into the sea alongside me. Then up again till waving over my helmet I could once more see through my faceplate that foam-flecked undulating sheet, the surface, with the familiar red underwater hull of the *Falcon* nestling in it. One more last stop, and then at last the welcome message: "Coming aboard!"

With a final heave, the stage rose and I burst through the surface, clinging tightly to the bails of the stage again to avoid collapse as my buoyancy vanished and the unsupported load of all my lead and copper ballast came suddenly down on my shoulders. Swaying violently, the stage rose over the bulwark, swung inboard, dropped with a bang on the deck. Dripping mud and water, I was seized by the tenders and dragged to a bench. My belt, shoes, and helmet were hastily stripped off, and then, without a pause, still clad in my dripping suit, I was rushed across the deck, up the passage and unceremoniously jammed through the outer door of the decompression chamber into the first lock. Slam! went the door. A tender with me twisted open an air valve and in roared a stream of compressed air, once more to get me under pressure, to make sure that no bubbles of air formed in my veins to give me "the bends."

WHEN I had recovered I made my report to Captain King, carefully outlining the condition of the submarine and the lack of structural damage, and salvage operations began.

Admiral Brumby left to resume command of his forces afloat, Captain King was put in complete command, and I, with nothing further possible in the way of rescue, said good-by to my shipmates and, on New Year's Day, steamed back across Massachusetts Bay in a dead calm, bound for home. Commander Saunders became Salvage Officer, the job I had had on the *S-51* operations, and Lieutenant Hartley, skipper of the *Falcon,* took general charge of the divers.

Luck was with them. Fate, as if satisfied with what it had already dealt in the way of death and disaster, sent no more storms. Only the cold and the cold water remained as unusual obstacles. Fighting these, the divers clung to the task. Using the same equipment and the same general methods by which, two years before, the *S-51* had been raised, they sealed up the inside of the submarine, expelled the flood waters from the undamaged compartments, tunneled under to pass lifting chains and sank and attached pontoons. Finally, on March 17, 1928, three months to a day from the time the *Paulding* sank her, the *S-4* rose from the depths, burst through the surface, and was towed to the drydock in Boston.

Fate dogged the *S-4*. First, in the unfortunate combination of circumstances, never wholly explained, which brought her up in the *Paulding's* path; next, in the fouling of the ventilation valve which drove her crew from the control room; and last, in the occurrence of the accident just before a three-day gale, the worst of the whole winter, which, except for the initial dives, held the rescuers off till it was too late to save a single life. Now, 12 years later, I am still convinced that, with the men and means then at hand, except for that long-continued gale, we would have saved Fitch and his five companions in the torpedo room. We might even have revived and finally rescued at least the stronger members, if not all, of Jones's party in the stern.

Except for that long-continued gale—

THERE is but one consolation. In the future we shall not have to make that exception. As in every great disaster, the deaths of the *S-4's* crew drove home vividly to the nation, as no accident before had ever done, the perils and the needs of the submarine service. Money and men were for the first time freely made available by Congress to allow experimentation and improvement—more rescue ships were provided to cover more closely the areas in which submarines work, more pontoons, more divers, improvements in the submarines themselves. But most important of all, a submarine escape device, originally conceived abroad, was, with the funds provided and in the hands of the captain of one of the *S-4's* sister submarines, developed into a usable appliance, the Momsen "lung." With this apparatus, now issued to every submarine, the crew may escape from any compart-

ment of the boat and rise to the surface, wholly without aid from other vessels, wholly independent of the state of the weather.

ANOTHER important development has been the underwater torch. Probably of all paradoxes in human experience, not one seems crazier or more unbelievable to the average mind than the practice of lighting a torch at the bottom of the sea and then proceeding with that torch to burn through steel wreckage immersed in water. Yet that miracle is now as everyday a fact as radio.

Something workable simply *had* to be produced to insure success in salvaging the *S-51,* where I first came into forcible contact with both the problem and the need.

Wrecks are always a mess, and each one is different. However well-ordered a ship normally operating on the surface may be, let her be rammed in a collision or ruptured by an internal explosion, and then dropped heavily to the sea floor—badly heeled over on her side, perhaps capsized completely, or sometimes broken in two—it is always a sickening sight to those who must work on her. Decks slope so steeply that no man can walk on them; they may be even vertical. Corridors and passages are no longer normal; a man may have to crawl along the bulkheads on hands and knees because he can no longer stand erect in a passage lying on its side. Wreckage is everywhere, barring progress. The slightest task for the diver often becomes an almost insuperable problem.

I learned all these things while attempting to salvage the submarine *S-51.* That was a vessel of some 1,200 tons, smashed open in a collision, lying badly heeled over to port in 22 fathoms of water about 14 miles out in the wild Atlantic. The salvage job looked fairly hopeless, but, because of peculiar circumstances surrounding the loss of the ship and her crew, the Navy was going to try.

I managed to get myself designated as salvage officer. I was a naval officer, a naval constructor, and a naval engineer, quite confident that certain engineering apparatus I intended to bring to the task would soon lift that hulk to the surface. Nor was I wholly wrong. The engineering apparatus I used was quite adequate to make the lift, but I quickly saw that it was highly doubtful that it would do it *soon* or indeed *ever,* for getting that apparatus attached to the hulk was proving a Sisyphean task, and I concluded that I unfortunately had rushed in where angels fear to tread.

The difficulty was, of course, the divers. I had had no previous experience either with diving or divers, and, having checked the fact that men could work in 22 fathoms of water, had taken it for granted that what a mechanic could do on the surface, he could still do fairly well encased in a diving rig. Sad to relate for me, it turned out not to be so. I quickly learned that most divers then were very poor mechanics, and that it was not possible to put a good mechanic into a diving rig and have a good diver —at least not till after months and perhaps years of training him to feel somewhere at home in the water.

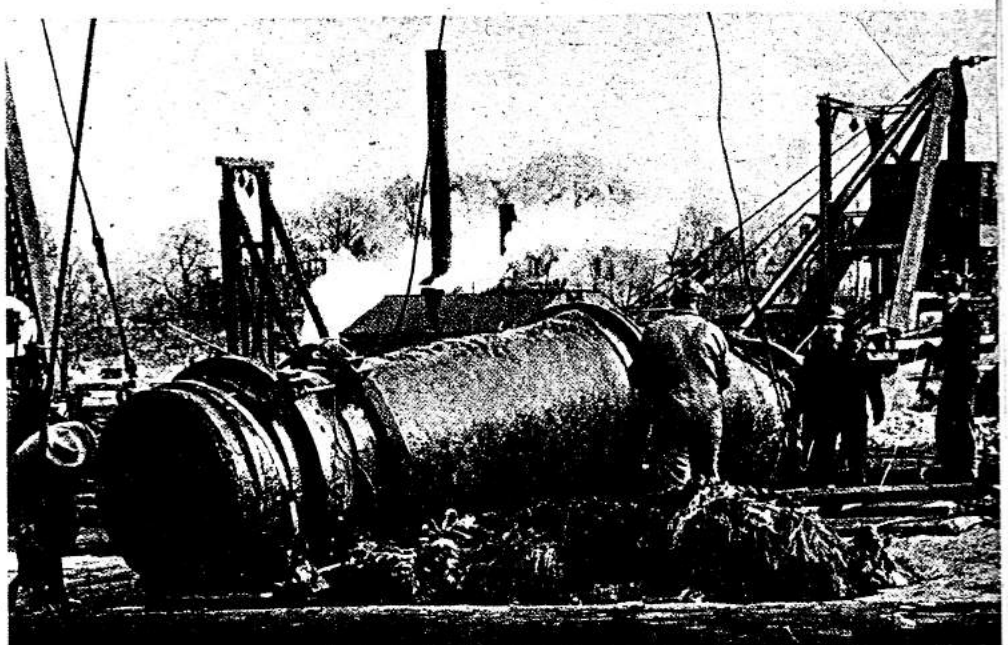
I struggled along for some weeks, getting sickeningly little done on the bottom compared to what was necessary to attach the lifting gear and raise the submarine, though I quickly came to have a deep respect for the divers for what they were accomplishing under terrible handicaps.

In the midst of this situation, we had a mishap. When we attempted to lower our first pontoon alongside the stern of the submarine, the lowering hawsers broke, dropping the pontoon (a weight of some 40 tons) about 80 feet to the bottom of the sea, where it landed happily clear of the submarine, but with the two lifting chains and wire hawsers attached to that pontoon and intended to go under the sub, a dismal tangle of snarled wire and chain about the *S-51.* Before we could proceed, it was necessary to get that pontoon to the surface again and get that mess of wire and chain clear of the sub's stern.

One massive chain (its links weighed about 100 pounds each) and wire hawser we managed to drag clear by having a diver with a sledge hammer drive out the 2½-inch thick anchor cable link or a one-inch thick steel wire, both buried in the sand on the ocean floor, prudence suggested trying to cut the wire, even though the anchor link was made of soft wrought iron while the wire was of hardened plow steel.

We had with us what then amounted to practically a laboratory curiosity—the Navy design for an underwater torch. In addition, we had as its operator a young diver from the Brooklyn Navy Yard, George Anderson, who had worked with its designers in the Naval Laboratory, and of all people knew most about its use. Here was a job just made for that torch. All George Anderson had to do was to go down, light off the torch, burn that wire in two, and our troubles were over.

We dressed Anderson, and, to help in holding the wire while Anderson burned it we also sent down another diver, John Kelley, a chief torpedoman and a naval diver of long experience.



Underwater torch, 50 feet below surface, did a job on this cast iron water main.

Having rigged up the torch and the igniter and tested out both diving telephones, we clapped the helmets down on the men and one by one lifted them over the side. They slid down the descending line to cut that wire.

On deck, I waited and just listened.

"Hello, John!" I sang out into his transmitter. "How's Anderson making out with the torch?"

Immediately Kelley shut off his air to make himself heard better, then answered:

"Mr. Ellsberg, if I could only take my helmet off and get my teeth on that wire, I could chew it in half faster than that damned torch is burning it!"

A loud roar echoed in my receivers as Kelley turned on his air again, abruptly ending the conversation.

Then came a welcome call from the bottom: "On deck! The last strand's cut! Take us up!"

But that didn't quite end the matter. Kelley, too chilled to decompress properly, developed a bad case of "the bends" and we had to keep him under treatment all night long in the recompression chamber to relieve him.

That ended any dreams of expediting the job by slicing wreckage with the torch. A man with a hacksaw could have cut that wire much faster.

WHEN, in December, bitter cold and continuous Atlantic gales drove us off the job till spring, I decided that if only I could invent a torch that would work, my chances of successful completion would be measurably improved, and I turned to on the task. A major reason for previous failures to produce such an instrument seemed to me to be self-evident—that the laboratory engineers who formerly had worked on the problem were not divers, and no divers were engineers enough to work it out.

I was not a diver either, but I was an engineer, and if only I became a diver, I might not only solve the torch problem but be able also actually to supervise and direct the rest of the salvage work on that submarine from the bottom of the sea. So I became a diver.

John Kelley, Bill Carr, and Jim Frazer were my instructors, and a tougher lot of teachers a man never had in anything. But they knew their stuff, and what they knew they taught me.

Working in a narrow, 16-foot-deep tank in the Navy Yard, I soon learned enough diving to start my torch experiments, and all through the winter I worked at the bottom of that tank with innumerable torch designs, developing the basis for a practical one.

Much of the work I did myself on the bottom of that tank, but not all. Often Kelley or Frazer manned the torch, while, through the glass ports outside, I watched carefully to see how each torch design worked. Working with a huge torch one day, the biggest I have ever seen anywhere, we came near disaster.

Frazer was in the tank. His deep sea diving days were definitely over on account of his heart, but he objected strenuously to giving up diving altogether, and 16 feet was practically no depth at all.

Torpedoman James Frazer (rear) chews the rag with co-worker John Kelley as he gets dressed for a dive.

Through a small glass port in the side of the tank, giving a sort of aquarium view, I watched while Frazer worked inside. Before him in the water were a couple of wooden sawhorses of the kind ordinarily used by carpenters, but heavily weighted down with lead to keep them from floating up. Spread across the top of the horses was a steel plate, perhaps an inch in thickness, on which he was to try the new torch. The water inside the tank, while clear, was quite dark, for very little light came down from above, and the glass ports below were so small as to pass only a negligible quantity through them. Still that made no difference, for the operator would have light enough as soon as he ignited his torch.

And so it was. The moment Frazer, cased in his diving rig, flashed an electric spark from the igniter across the tip of that torch, it lighted off with a terrific bang and commenced burning with a beautiful blue conical flame, much larger than any we had had before. It brightly illuminated the steel plate beneath it and Frazer's grotesquely helmeted figure above it, casting a gigantic black shadow through the water behind him against the inside walls of the constricted tank.

I looked through the port, glowing with elation. With a flame as big as that, we should get heat enough to produce startling results; and so we immediately did, but not in the way I had anticipated.

AS Frazer bent forward to bring the torch down on the steel plate, there was a slight puff, and the flame at the tip vanished as if sucked up inside the torch, leaving the interior of the tank as vaguely lighted as before. Through the dark water, I could see Frazer's body straightening slightly as he lifted the torch close before his helmet, his surprised eyes staring at it through his faceplate evidently unable to make out what had happened. And then, convulsively, Frazer's fingers suddenly opened, as if he had just discovered he was holding a rattlesnake, and he flung the torch from him violently, hurling it as far away as he could—which was, however, not very far, as the tank was only about four feet across one way and not over eight feet the other.

Almost instantaneously, a radiant ball of fire, indescribably dazzling, at least two feet in diameter, blazed out there in the water inside the tank, flaming with all the fierce brilliance of the noonday sun! Immediately, as if under illumination of a thousand searchlights, the water lighted up, outlining Frazer in his diving rig spasmodically throwing his huge figure against the far side of the confined tank as if struggling to break through the steel plates and get away. It was hopeless, of course, but with the very flames of hell licking toward him, threatening, immersed though he was in water, to incinerate him, who could blame him for trying to smash through that steel side?

Half blinded by the tremendous light, and horror-stricken by Frazer's danger, I staggered back from the port, ran sideways a few yards till I could see the tender on the platform atop the tank, shouted wildly, "Pull up the torch, Bill! Yank it up!" Then I ran back again to the port.

Bill Carr started to heave up on the torch hoses and I watched that terrifying mass of flame rise through the tank past Frazer's huddled figure till, thank God, it cleared his helmet, leaving him again surrounded only by water. Then I scrambled madly up the ladder to the tank top to lend Bill Carr a hand with the fire.

My bosun's mate, when I got up there, was hesitating over what to do. Each time he dragged the burning torch near the surface, the flames billowed out over the tank top and threatened to burn him; when he lowered it a little, the fire, instead of being quenched by the water, only caused the water to boil furiously so that it looked as if Frazer in the tank below might well soon be cooked. In this dilemma, Kelley, who was still on the ground below, helped matters by running over to the gas bottles and shutting off the valves. This promptly reduced the size of the blaze enough so that Carr, with one wild heave, pulled the flaming torch out of the tank and sent it sailing like a fiery comet far out into the air, to land well clear of everything. When the gases in the hoses were exhausted, the blaze sputtered out at last. And then, hand over hand, we pulled Frazer up through water already far too hot for comfort, to find him deathly white and dripping perspiration as if he had been in a Turkish bath.

WHAT happened? So far as I could learn from our quivering diver, he had thought the torch had simply gone out on him and was looking at it to see why, when suddenly it seemed to him he had hold of a red-hot iron. Instinctively he dropped the torch, and a moment later saw it burst into a Vesuvius erupting flame and scorching steam at his feet. As nearly as I could ever determine, the flame at the tip must have flashed back through the unusually large gas ports into the handle of the torch, there to burn invisibly a moment till it made the metal handle too hot to hold, as Frazer's burned fingers mutely testified. Then going back a little farther, the flame had burned through the rubber hoses carrying the gases, thus loosing under high pressure the two streams of hydrogen and oxygen with startling results.

The condition of that huge torch bore out this theory. When it had cooled enough to be examined, we found it a ruin, with its brass interior a mass of melted metal, while only the compressed air hose remained attached to its handle, the two gas hoses being completely burned away.

That ended all experiments with such monster models. I concluded that I had better stick to smaller torches and less likelihood of flashbacks, while I strove to get a hot enough flame some other way than through mere size. Meanwhile, I could only be grimly thankful the shock of that accident had not proved too much for Frazer's already weakened heart.

We lost a day while we emptied the diving tank of its steaming contents and filled it with colder water from the city mains, after which we turned to one of my previous smaller designs.

THE weeks dragged along, the winter wore away, and we obtained some real results. I worked out a design that seemed satisfactory and taught my divers to adjust for a certain blueness of the flame which indicated maximum combustion temperature. With such a combination we got some amazing results in slicing through inch-thick steel plate.

In April, we sailed once more on the *Falcon* for the spot in the Atlantic where our submarine lay. Work on her —once we had buoyed her off again for our moorings and tied to her new descending lines forward, amidships and aft—started with a rush. And very soon after came the first opportunity to try out the torch on a job, which, if successful, meant a radical reduction in diving labor—the task of securing the pontoons to the cradle of lifting chains threaded under the submarine.

The first dive I ever made in the deep sea was for that purpose. With the veteran Kelley for a helper on the bottom, I was rigged out in diving armor, and, following Kelley, for the first time I went overboard to slide myself down the thin manila descending line to the bottom of the sea where so many divers had preceded me to struggle with that wreck.

INDELIBLY engraved on my memory is that first dive—the unearthly sense of loneliness as the sea swallowed me up; the dizziness as the pressure increased and the water flowed upward by me endlessly as I sank, always dropping, dropping into what seemed bottomless depths.

When the submarine itself finally loomed up beneath me against the dull background of the ocean floor, a silent

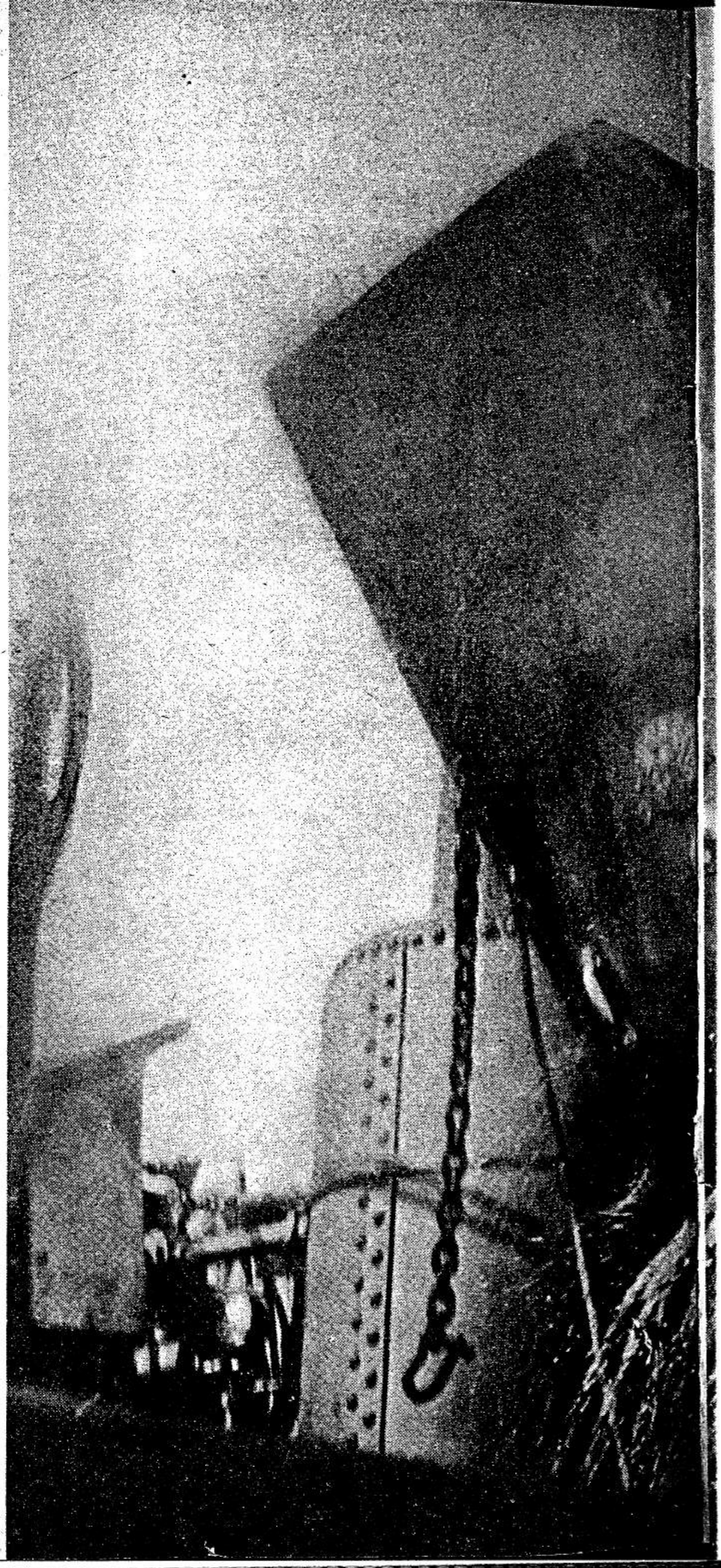
hulk, massive and immobile, I lost all hope. Considerably magnified by the water through which I peered, she looked colossal in size, far beyond the power of human hands ever to raise. I had tackled the impossible.

But I had little time to speculate on that. The line to which I clung led not to the submarine itself but to a pontoon alongside its starboard quarter, and I slid on down past the *S-51's* conning tower to land in another moment atop the end of that pontoon, a gigantic cylinder as large almost as a section of the submarine itself. It was one of eight similar pontoons which, when attached to that submarine by chains beneath her keel, should tear her from her bed in the depths and drag her back to us on the surface.

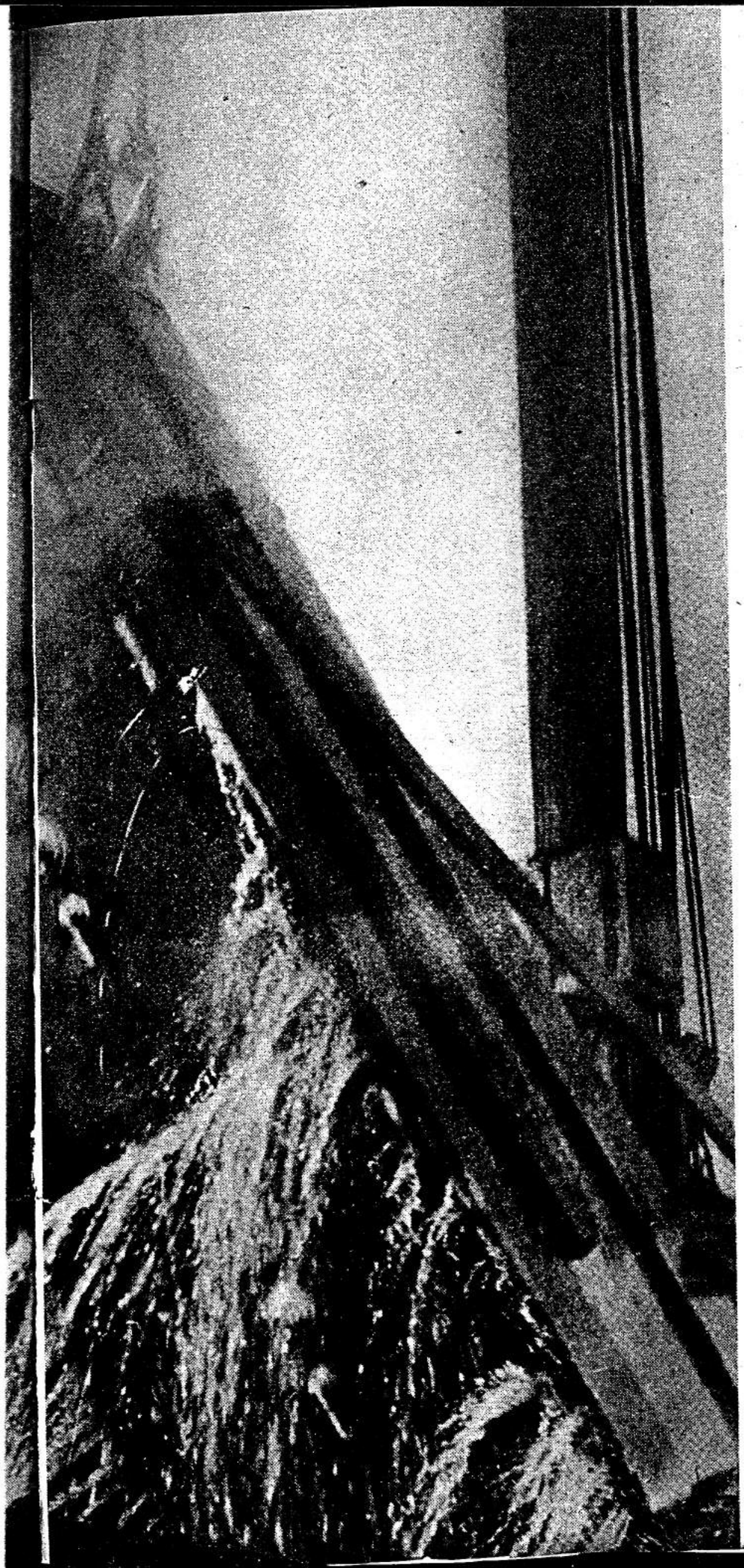
I CLUNG tightly to the descending line for support as I tried to balance myself on top of the pontoon, so dazed from the pressure that I felt each instant I would collapse, while a little distance away, Kelley's beckoning figure, magnified to at least twice life size, danced before my unsteady eyes. Falteringly I walked over to him, feeling that when I crumpled up I was safer at his feet than where I was. But Kelley, to whom all this was an old story, completely unaware of how close I was to unconsciousness, simply knelt on the pontoon and pointed to the link lying across the pontoon hawsepipe. He had twisted it slightly so I could get at the iron stud which I was to burn out. Since my quivering knees seemed likely to buckle under me at any moment, I knelt beside him, my befuddled brain noting gratefully that now I should have less distance to drop when I folded up.

Again Kelley pointed to the stud in the middle of the chain link between us. Since I was still conscious, I concluded I might as well pass out working as idle, and, like an automaton, I dragged up the torch and its hoses, which were trailing behind me by a loop fastened to my wrist. I adjusted the flow of gases, and flashed a spark across the tip. The torch lighted instantly and continued to burn with a staccato roar like a machine gun firing, setting up a pulsation in the water beating against my body which must violently have accelerated my circulation, for immediately my head began to clear.

I PRESSED the torch tip close to the two-inch-thick square iron stud set in the middle of the chain link before me, held it there while the orange flame blazed against the metal. A few



Over the side comes a salvaged safe.



brief seconds, and then, glorious sight for my dizzy eyes, a spot on that iron stud glowed first a dull red, then brightened quickly into a limpid yellow. I pressed a trigger on the torch. A stream of pure oxygen shot out through the middle of the flame and hit the glowing iron. Instantly the miraculous happened. The flame, which had been at most a few inches long before, suddenly lengthened out to more than a yard, and there, streaming through the dark water like the trail of a rocket, was a dazzling array of white hot sparks, a torrent of burning metal more brilliant in its unearthly radiance in the dim ocean depths than any possible fireworks display!

Beneath the torch tip, framed by the whiteness of igniting iron, a black cut about an eighth of an inch wide appeared in the stud and, as I slowly drew the torch across, lengthened out till, perhaps a minute later when nearing the other edge of the stud, the cut was complete and the two severed halves of that heavy iron bar fell from the link with a metallic clatter to the pontoon beneath.

Deliriously intoxicated by the sight, I stared at the gap in that chain link where the stud had been. I had cut through a two-inch bar of iron on the bottom of the sea; I had cut it on my first attempt; I had cut it starting in a semi-stupor! No doubt about it now—that torch was a success. I never doubted again from that moment that we would lift that submarine!

WE DID, too, and in that achievement the underwater torch bore an important part, mainly in providing us with an easy method of securing the pontoons to the lifting chains.

Since then, that torch has served on many jobs far removed from submarines and from salvage, and even from the sea. It has served to cut up and remove twisted steel bridges swept away by floods. On one bridge foundation job after another, it has changed the technique of construction.

Since the success of the torch, there have been many other improvements in underwater work. I believe that work by our Navy has opened a new chapter in deep sea diving. It should be possible now for trained divers with competent supervisors and properly designed equipment actually to *work* at depths down to 400 feet and even perhaps as far down as 1,000 feet should there be real occasion. There is not at the present time any wreck at such a depth worth bothering with, but should the time come when such wrecks exist, better methods for working than have existed in the past will be available, and we may look for men under the sea to work there more effectively than ever before. ***