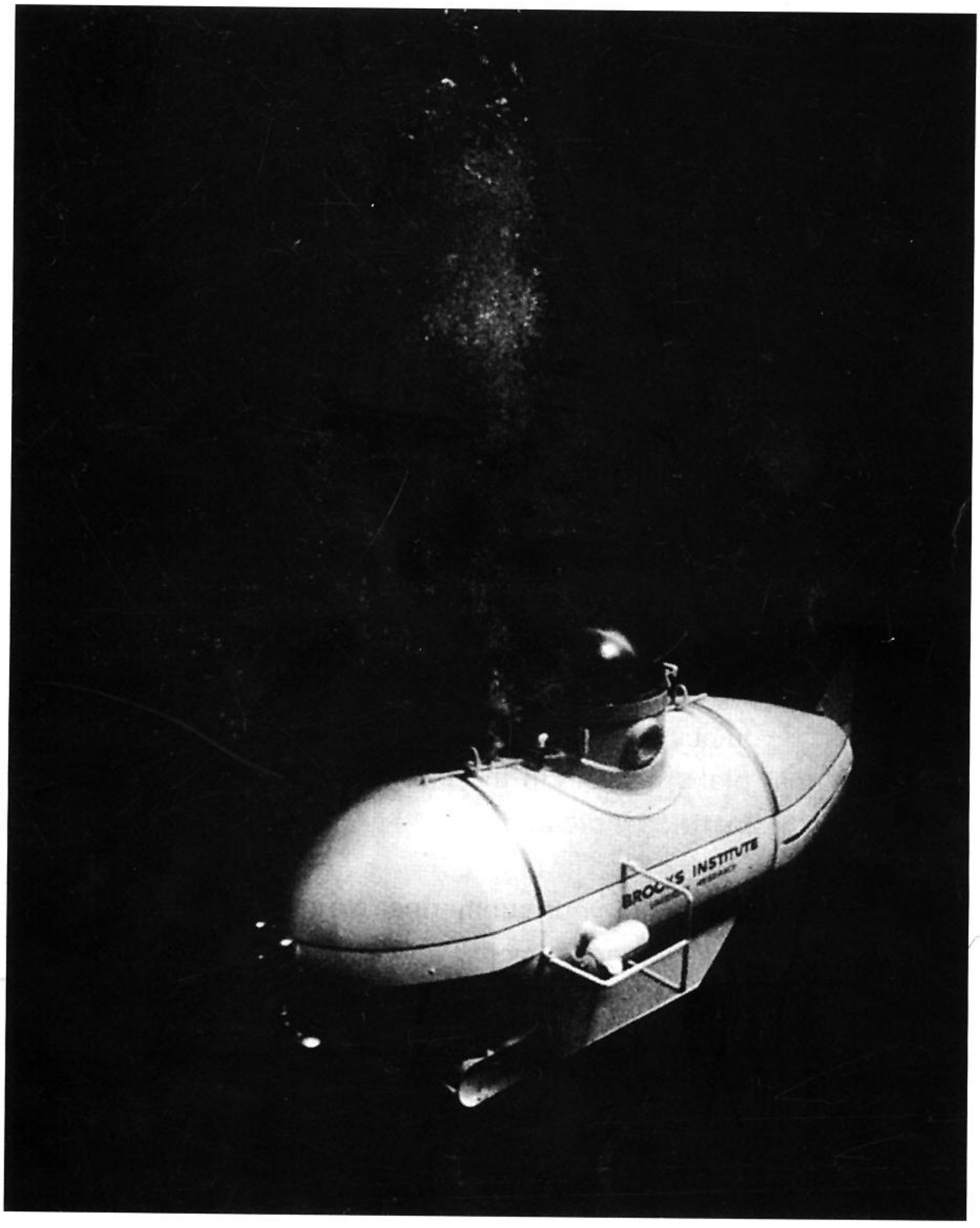
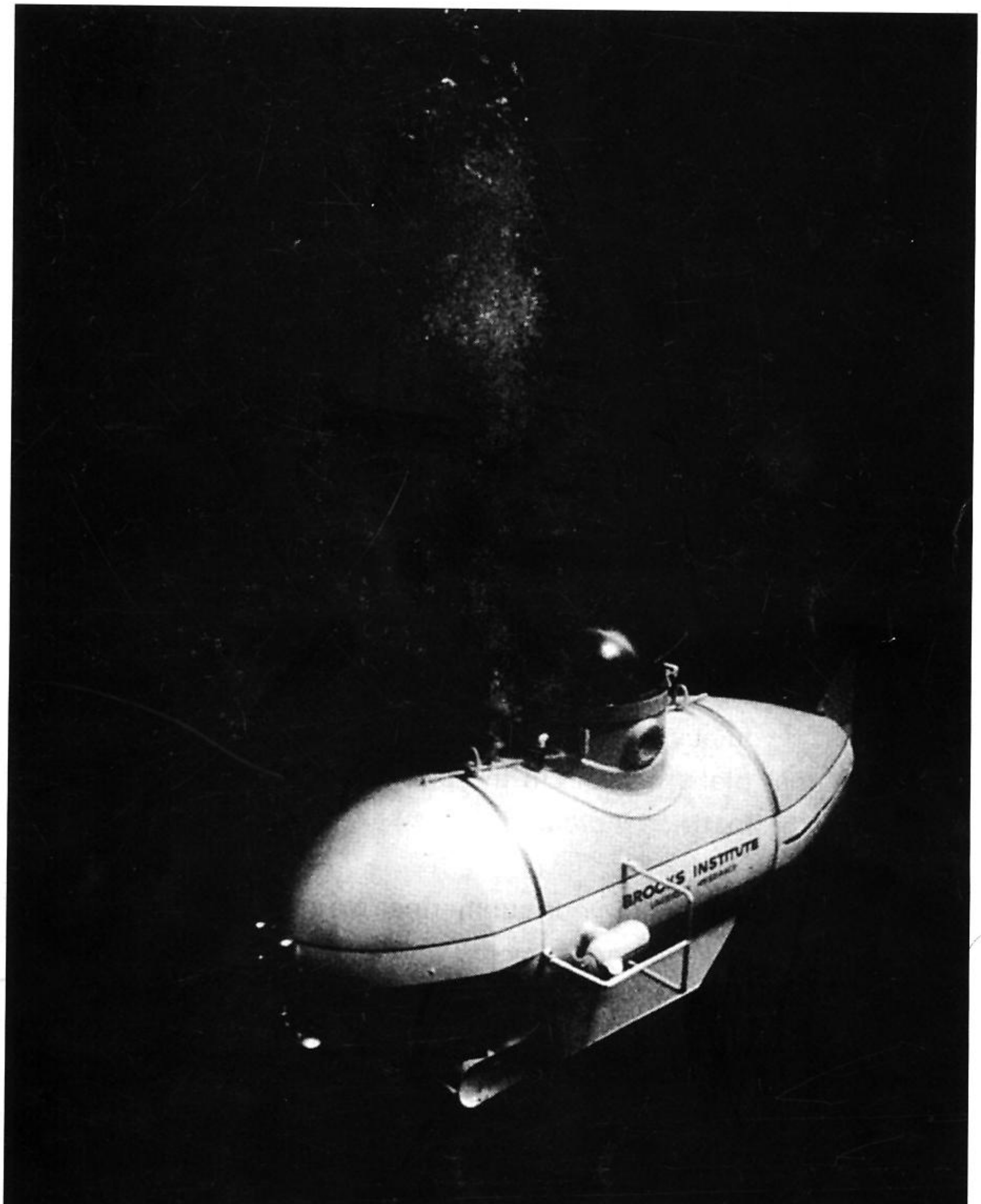
SUBMARINES



Kittredge Industries, Inc.

SUBMARINES



Kittredge Industries, Inc.

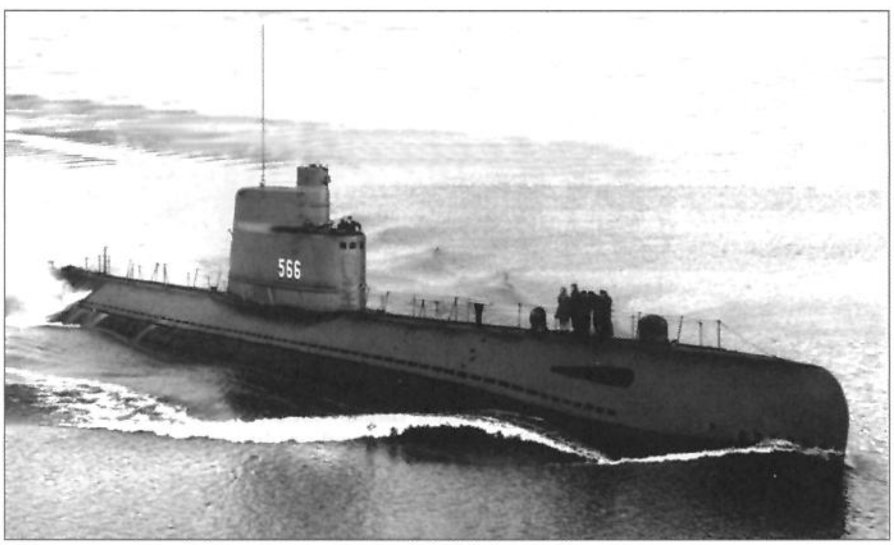
Background

One of the most daring and successful naval operations of all time was the attack on Alexandria harbor in the early part of World War II. Lieutenant de la Penne and five men, using three midget submarines penetrated Alexandria harbor defenses and sank two British battleships, HMS Queen Elizabeth and HMS Valiant, and a 16,000 ton tanker. At the time, they were the only battleships the Royal Navy had in the Mediterranean. Fortunately, the Italian High Command did not follow up the attack. If they had, the British could well have lost North Africa and the entire course of World War II might have been different.

The midget submarines which Lieutenant de la Penne and his men used, were of the "wet" type. They had a trim system. They were powered by electric motors and batteries and had diving controls. Two men "rode" each submarine. The three midget submarines were carried in containers by a mother submarine, the Scire, which released them about a mile and half to the seaward of Ras el Tin lighthouse at Alexandria harbor entrance.

As a result of this attack, the British began the development of very small submarines. First, they came up with the "Chariot" which was an English version of the Italian midget submarine. But after North Africa was secured, naval operations shifted to northern waters and the cold reduced severely the efficiency of "Chariot" operators. So emphasis was shifted to other types of small submarines. The one-man Wellman submarines and the four-man "X" craft came into being. The "X" craft were very successful, immobilizing the German battleship Tirpitz in Trondhiem Fjord in Norway and sinking the Japanese heavy cruiser "Takao" in Singapore harbor. The Wellman one-man submarines were not successful operationally, largely because they used a system of magnets for attaching a timed explosive charge to an enemy's hull. Still, the Wellmans were intriguing little submarines and they performed quite well as training boats.

Many years after World War II, I had the opportunity to try out a Wellman one-man submarine. It happened when I was commanding



The fast attack submarine "Trout" was one of three submarines which Captain Kittredge commanded during his naval career.

officer of the fast attack submarine Trout (SS-566). We were based in Saint Thomas for the winter. Also based in Saint Thomas was an Underwater Demolition Team and they had a Wellman. It didn't take but one dive in the Wellman in the clear waters of the Virgin Islands to convince me that the first thing I was going to do when I got out of the Navy was build a one-man submarine.

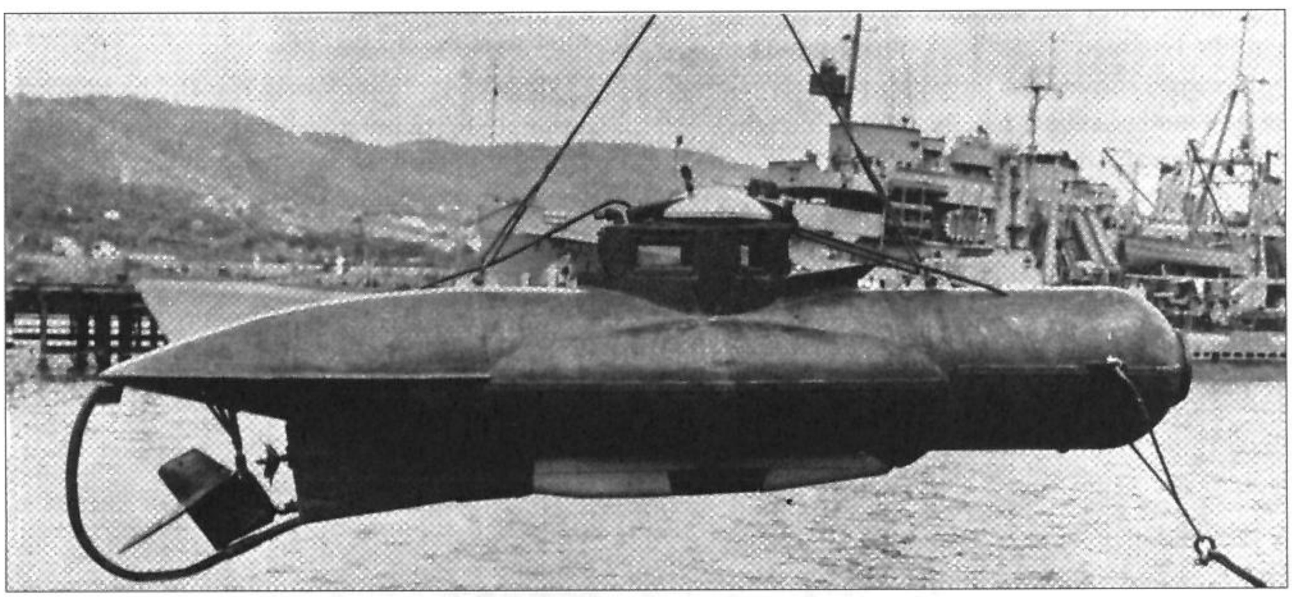
But the Wellman submarine had certain drawbacks.

First, it had main ballast tanks but no variable ballast tank system. The main ballast tanks were fine for surfacing but without a variable ballast system the Wellman could not achieve neutral buoyancy. A variable ballast system is absolutely essential to any submarine. Unless you have some way of making the submarine weigh exactly the same as the water it displaces, you are not going to maintain depth control. If you are too heavy you are going to sink and if you are too light, you are going to come to the surface. With the Wellman, you tried to achieve neutral buoyancy by placing lead weights in a tray outside the conning tower, a most unsatisfactory arrangement.

Secondly, the Wellman was too big, over 16 feet long, and weighed too much, several tons.

And finally, the diving controls were inadequate. A combination diving plane and rudder was mounted in the wash directly aft of the propeller and was virtually useless at slow speeds or when the boat was badly out of trim. Still, the Wellman worked. It was a lot of fun. But more important, it told me both what I wanted and what I didn't want in a small submarine.

On the way back from St. Thomas, an event occurred which reinforced my desire to build a midget submarine. The Trout (SS-566) was



British one-man Wellman submarine about to be lowered into the water. The rudder was made integral with the diving planes and the Main Ballast Tanks were two "blister tanks" on either side of the pressure hull. Light part of keel is a movable weight to obtain fore and aft trim and could be dropped in an emergency.

participating in a naval training exercise en route to New London, Connecticut. We had a day between phases of the exercise in which we had nothing to do. As we lay to, a school of Mako sharks appeared and began to circle the ship. The machinist mates made a large hook, attached it to a chain for a leader and baited the hook. The other end of the chain was bent to a manila line and taken around the forward capstan. As soon as the baited hook was thrown in the water, one of the Makos took it.

Now I wasn't about to bring a big, live Mako shark on board so when the crew heaved in on the capstan, I put two clips from a 45 caliber automatic into that Mako shark's head and body but he was still thrashing about when we got him on deck.

The bridge on the Trout (SS-566) was 22 feet above the deck. We hoisted the Mako up alongside the forward part of the conning tower for photographs. With his tail even with the bridge, his head was still on deck and that shark was not the biggest shark in the school by any means. As soon as the photographs were taken, we threw the Mako back in the ocean. The other sharks turned on him and tore him to pieces. The water was churned to a bloody froth. Nothing could have lived in the midst of that school of Mako sharks. More than ever I was determined to build a one-man submarine and put some steel between me and a possible shark attack.

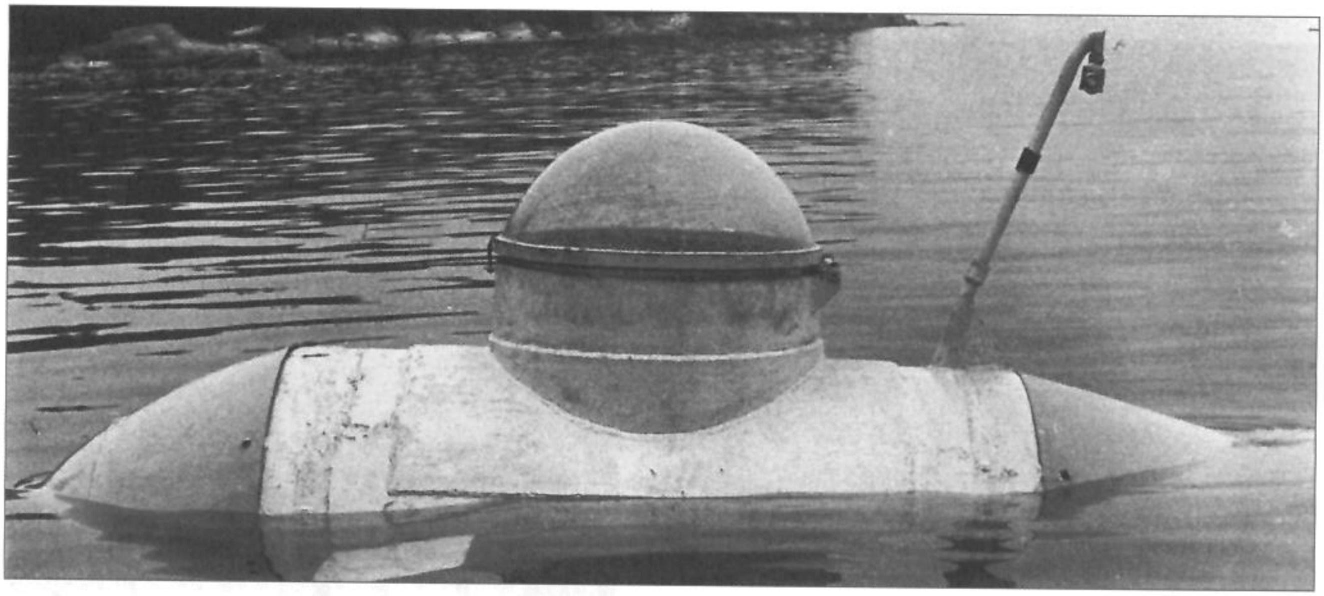
And I did. As soon as I was separated from the Navy, I started work on my Mark I submarine. I had already made most of the computations. Some of the best "heavy structure" men in the world had checked my design. Both for reasons of cost and because I wanted to make sure how the boat was put together, I took a course in welding and decided to do all my own work. The Mk I, when it was finished, was neither a success nor a failure. The day it was launched, it almost didn't dive.

I started building the Mk I in my garage. It isn't often that someone builds a one-man submarine in a small town in Maine; so almost every day, as the word got around, a visitor or two would drop by. Many of these men were lobstermen. Almost invariably as they turned to leave, they would say, "Do you think it will float?" At first I would shrug off the remark with a joke. But soon I got to thinking. These men are practical men. They have gone to sea all their lives. They may not know anything about integral calculus but they have a good eye for small craft. I think I'll check my figures again and I began to cut down on the fixed ballast just to have a safety factor in case I had made a mistake in my displacement calculations. Above all, I didn't want my first submarine to be too heavy.

Finally, the Mk I was finished and the great day for the launching arrived. Several hundred people lined the bank. Every kid in town was there. I rolled the trailer into the water and the submarine floated clear. I rowed out to it, got in and rigged the boat for dive. Then I vented the main ballast tanks. The Mk I settled a bit in the water. So far so good. I began to flood the variable ballast tanks. Soon the variable ballast tanks were filled and still the submarine stayed on the surface. All systems worked but it didn't want to dive. I quickly blew all tanks, opened the hatch, and yelled to the kids to bring all the rocks they could find. Finally, with the bilges filled with rocks and a small boy standing forward of the conning tower and another small boy standing aft, I got the Mk I under.

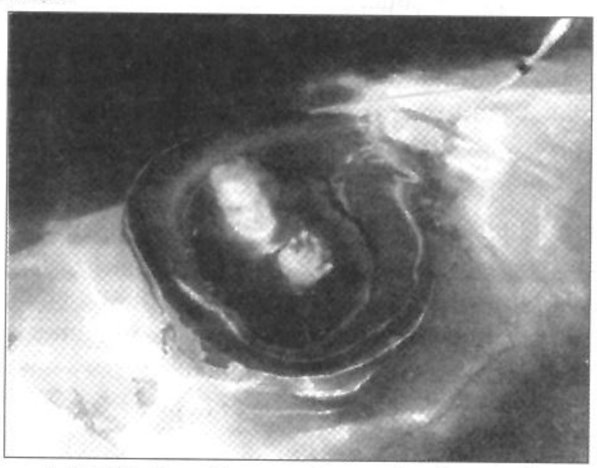
The original Mk I submarine which was scrapped after twenty-seven dives. Note the propulsion motor case in gimbals. Failure of hydraulic cylinders to adequately position line of thrust led to design change.

It didn't take long to increase the amount of fixed ballast for the Mk I. In fact, if I had trusted my computations, I would have had no trouble at all. But the Mk I had another defect. I was still under the influence of the design of the Wellman when I built the Mk I. I thought the diving controls of the Wellman could be corrected by changing the combination of the rudder/diving plane to an active rudder principle so I mounted the Mk I's propulsion motor in a water-tight case set in gimbals. In that way, the line of thrust could be oriented in three dimensions and the submarine, theoretically, could have been directed up or down and right or left. Maybe it would have worked if I had had better hydraulic rams to position the propulsion motor but I used surplus hydraulic cylinders in a master slave combination. Invariably, one ram would end up pumping the other until it was jammed at the limit of throw. So I decided to scrap the Mk I and build the Mk II with different type of controls.



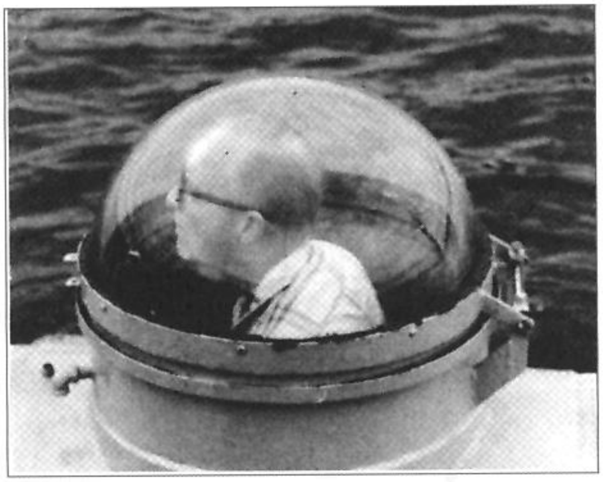
The first Mk II submarine moored off Owl's Head, Maine. Note the diving planes visible underwater, forward of the conning tower.

The Mk II was a highly successful one-man submarine. I had the main ballast tank system and variable ballast system of the Mk I but instead of the gimbaled propulsion motor, it had bow planes and a rudder. This combination worked fine. It made for a particularly rugged submarine, easy to maintain and simple to operate. As soon as neutral buoyancy had been achieved and the submarine submerged, the bow planes would permit you to plane to any depth. The Mk II was especially good in cold weather. Once I kept it in the water too long in the fall and it got iced in for the winter. It still worked the following spring but it had "grass" about six inches long all over the sides and bottom when I hauled it out.



A Mk II submarine passing under the tender.

The nearest thing I ever had to a casualty with the Mk II was when I had a local lobsterman tow me out for a night dive. I had rigged an underwater light on the submarine because I wanted to see what the bottom looked like at night along the Maine coast near Owls Head, just south of Rockland. The night was very dark and I was afraid that I might surface far enough away from the lobsterman's boat that he wouldn't see me so I attached a line about 500 feet long from the boat to the submarine and went ahead and made my dive. After I had spent about a half an hour checking the marine activity on the bottom, I turned off my underwater light to see if there were any luminous fish. Almost, immediately, I felt a mighty tug on the submarine and the Mk II took an up angle. On the surface, the lobsterman had been watching the loom of the light. When he saw the light go out, he thought something was wrong and started to haul up the submarine. Although nothing really happened I simply went ahead and surfaced, and I discontinued the use of the "umbilical cord" after that. There was always a chance the line would get fouled in the surface craft's propeller and bang up both boats.



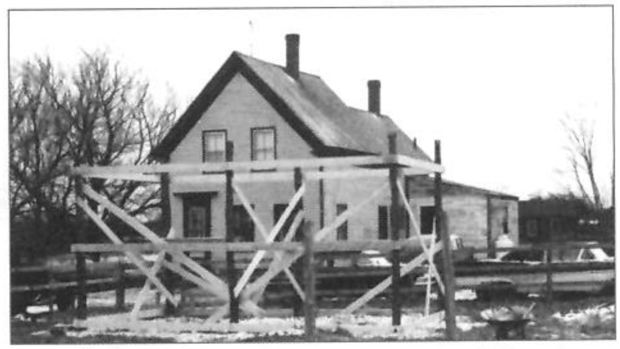
Dr. Trimble Johnson of Atlanta, Georgia operating a Mk II submarine.

The Mk II was so successful that people all over Canada and the United States began to drop in to see it. Many asked to buy plans. I now had to make a decision, either to keep it as a hobby or make it into a business. The number of inquiries left me little choice. I formed "Kittredge Sports Subs, Inc." and for two years advertised the plans in Skin Diver magazine. The response was gratifying. Many people bought plans for the Mk II. An eye surgeon in Atlanta, Georgia, Dr. Trimble Johnson, did a fine job in completing a submarine from the plans and so did a Marina operator in Massachusetts. All around the world people were writing to me for parts for the Mk II. I sent two complete conning towers to a gentleman in Hong Kong who stretched out the hull and made it into

The two-man submarine which Mr. Charles Yuen Yong Wong built in Hong Kong from plans and parts furnished by Kittredge Sport Subs, Inc.

a two-man submarine with the second man sitting in tandem. The day he dived his submarine, he did so before the cameras of a local Hong Kong TV station and sent me a telegram.

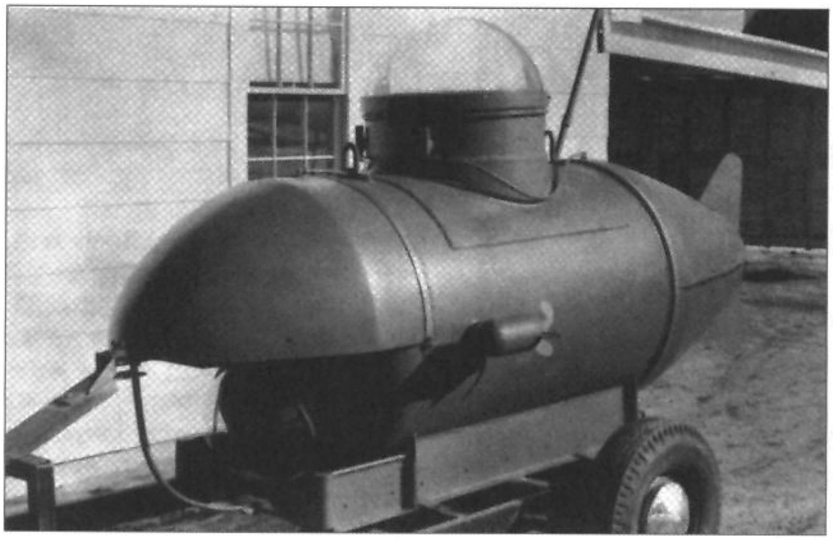
It soon got to the point where I needed a building but I didn't want to go into debt so I went out in the woods and cut nine tall, stout junipers and nailed together a 40' x 4O' pole type structure. No sooner had I completed it than my



The start of the framing of the original Kittredge Sport Subs, Inc. Lacking funds, Captain Kittredge went out in the woods and cut juniper trees to form the corner posts of the building.

first order for a submarine came in. A scientist in the Florida Keys needed a special one-man submarine for a scientific study. And so the Mk III submarine was born.

The principal improvement of the Mk III over the Mk II was its submerged maneuverability. Substituted for the bow planes were two electric motor driven propellers that could be rotated through 360^{o}. This meant that once neutral buoyancy had been obtained, the submarine had unlimited maneuverability submerged. With one motor in the ahead position and the other motor rotated 180^{o}, the Mk III would twist in place without advancing. With both motors rotated 180^{o}, the Mk III would back. Up, down, back, ahead or any variation, you have only to rotate the two motors of the Mk III accordingly. In addition, the two motors of the Mk III were pressurized to ambient sea pressure in much the same way that a scuba diver has ambient sea pressure in his lungs. Thus, regardless of depth, there was no differential pressure on the propeller shaft seal and the possibility of leakage was greatly



The first Mk III submarine built on order for Mr. Knauth of Daytona Beach Florida. Mr. Knauth used it for scientific studies in the Florida Keys.

reduced. By using this system of motor pressurization, we were able to use series wound dc motors thereby getting all the power we needed plus good speed control at greatly reduced cost.

Less than a year after Kittredge Sport Subs, Inc., began building Mk III submarines, a firm which had just gone public, made an offer to purchase the manufacturing rights to the Mk III. It was an offer that I was not in a position to refuse so, regretfully, I liquidated Kittredge Sport Subs, Inc., and began to build Mk III submarines for the new owners. And we made some improvements along the way.

We changed the underwater telephone unit from audio to a carrier frequency of 23 Khz. The motor pressurization system was improved and the conning tower and bottom viewing port reinforcements were beefed up. But the main emphasis was placed on quality control and testing.

It was decided to build the Mk III submarine in production runs of six. As soon as a hull was finished it was taken to Bath Industries (builders of destroyers for the U.S. Navy) where all welds were either x-rayed or magnafluxed. The first hull to be completed was sent to the General Dynamics pressure chamber at Groton, Connecticut, with orders to test it to destruction in order to prove the design. Although the Mk III was designed for a maximum operating depth of 250 feet, the hull successfully withstood pressure equivalent to 800 feet at which point the acrylic hemisphere which formed the conning tower hatch, failed. No other damage was done to the hull. The last of the first six production Mk IIIs received American Bureau of Shipping A-1 certification. I personally operated the submarine for the testing required to obtain this certification.

After we built twelve of the Mk III submarine hulls, I was ordered by the company which had the manufacturing rights to cease production. I believe the reason for this was due to an inability to obtain product liability insurance at reasonable rates. In fact, the only premium quote which they were able to obtain, cost more than the price ($14,750) which they were asking for the submarine. Certainly, the decision to cease production was not due to a lack of interest on the part of the public. Even without an advertising campaign, we had over two thousand inquiries and although, I was not in charge of sales, I personally sold two submarines, one to Master Divers, Inc., St. John, New Brunswick, Canada, and another to Brown and Root, Belle Chasse, in Louisiana.

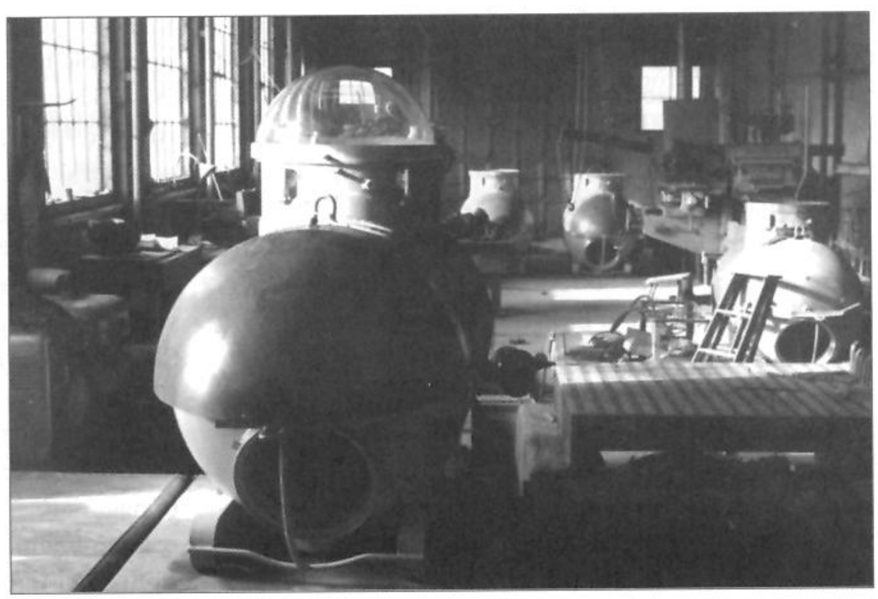
Following the decision to cease production of the Mk III, I spent the better part of a year trying to negotiate a dissolution of my contract with the company which had bought the manufacturing rights. During this time in collaboration with Al

The 40-ft. steel cabin cruiser "Aquatic" which was designed and built to carry a K-250 one-man submarine on a ramp on the stern. The center section of the transom lowers to form an extension of the ramp and the sub slides off the stern. Plans of the boat are available.

Scaccia of Tenants Harbor, Maine, and Fred Bates of Damariscotta, Maine, I designed and built a 40 foot steel boat for transporting the submarine at sea. As you can see from the photograph of this boat, the transom lowers and the submarine is hauled up a ramp on the stern. Incidentally, this design makes an excellent dive boat inasmuch as a scuba diver can "beach himself" on the lowered ramp and does not have to climb a ladder. By having the ramp at the stern of the boat, a lee is formed which protects either the diver or submarine in bringing them a board.

Interestingly enough, the steel for this boat cost only $2,300; however, I don't want to mislead you. Although I sell plans for the hull of the boat, to finish it off as a cabin cruiser with a good diesel engine will cost you another $30,000. Diesel engines and electronic equipment are expensive.

I have also upgraded my shop facilities. We now have 4,000 sq. ft. of manufacturing space, a two ton overhead bridge crane, and the machine tools to do the job. We cut our own gasket grooves in the submarine hatch seats. Our largest lathe will take a piece of metal 38" in diameter and 96" long.



The interior of the former manufacturing facilities of Kittredge Industries, Inc. The 120 ft. long building has a two ton overhead bridge crane and all the machine tools necessary to build sophisticated small research submarines.

Improvements

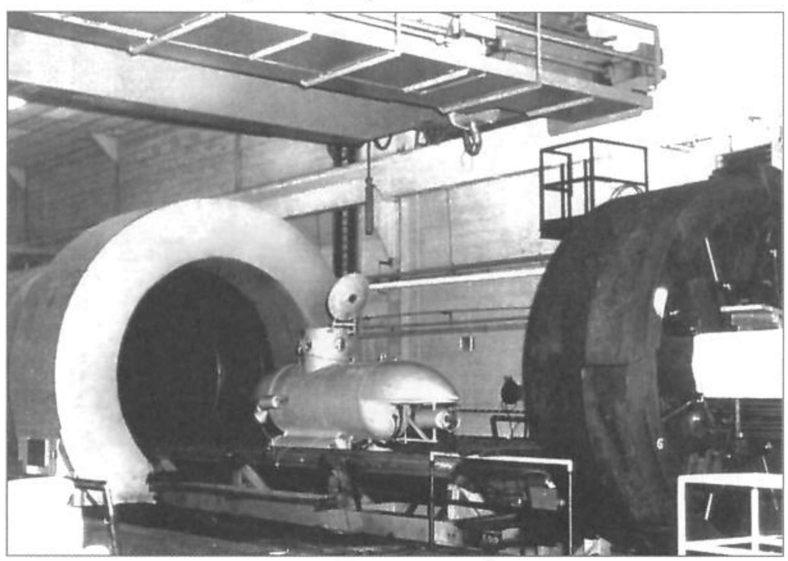
K-350 submarine. Note the sonar transducer on the raised fin.

In later designs of the K-250 we changed the Variable Ballast Tank. We found that by putting the VBT outside instead of inside, there was more room for the pilot without changing the overall weight of the submarine and by putting the VBT outside we could blow the tank with high pressure air and eliminate the trim pump. A plan of the revised K-250 submarine design is shown at the end of this booklet.

We had built over twenty-five K-250 submarines when Shell Motor Oil Company began showing a television ad describing what would happen when a car battery exploded. It set us to thinking. The batteries for the K-250 were inside the submarine. If whoever installed the batteries in the submarine connected them up wrong, there might be a bad casualty so we decided to design a new submarine with a greater operating depth and put the batteries in watertight, pressure proof pods on the outside of the submarine.

We had just started the design, when Joe Davies came over from England and met with us to see if we could design a submarine for his special needs. Joe owned a diving company called Diving Services Limited in Suffolk, England. He had been a commercial diver all his life and he had made a good living at it. One of his sons had been killed in a diving accident and he thought that a small submarine designed along the right lines would be safer for the search phase of diving. He also wanted a steel conning tower and more propulsion than the two side thrusters of the K-250 would give him. What we ended up designing was the one-man K-350. It had an added stern thruster of 3 hp which acted like an active rudder; eight batteries in two pods that formed twin keels, which were great for sitting the submarine on the deck of a ship; and a steel conning tower hatch which would take more abuse than the acrylic hemisphere of the K-250. The conning tower had four view ports in the tower and one view port in the steel hatch. Joe liked the submarine design so well that he had us build two of them.

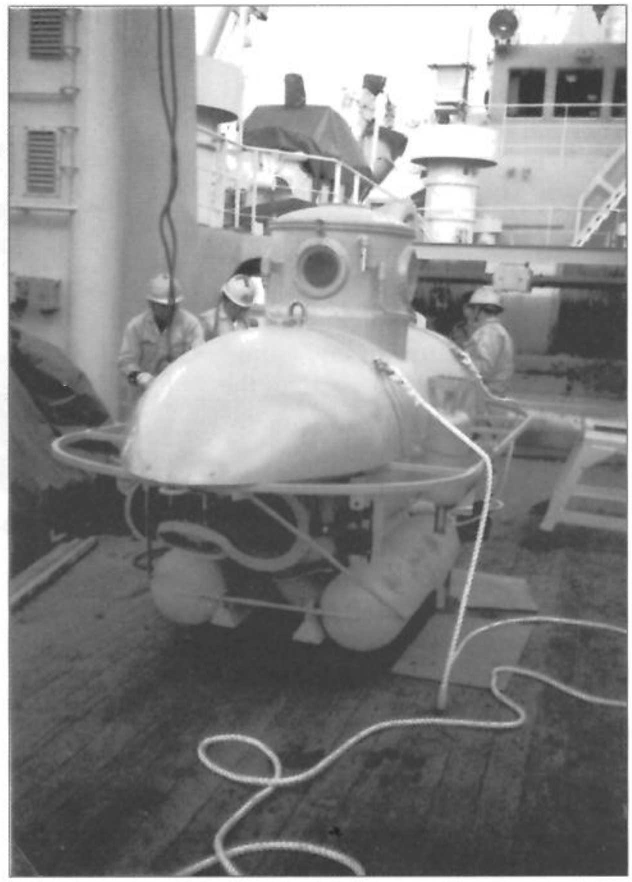
No sooner had we shipped the K-350 one-man submarines to England, than the inevitable happened. People started asking for a two man K-350 and we built the first one for a man named Rodney Cubbage who owned Konshelf Marine in Florida. We built this submarine under Lloyd's Rules and it was certified by Lloyd's of London. At about the same time, a Norwegian firm named Sub Services Ltd of Alesund, Norway wanted a submarine which they could use for pipe line inspections in an offshore oil field called Echofisk Alfa. The submarine was to be a one-man design and it was to have a maximum operating depth of 600 feet. It too was built under Lloyd's Rules and was tested in the U.S. Navy Pressure Chamber at Annapolis, Maryland. It was the fourth subma-



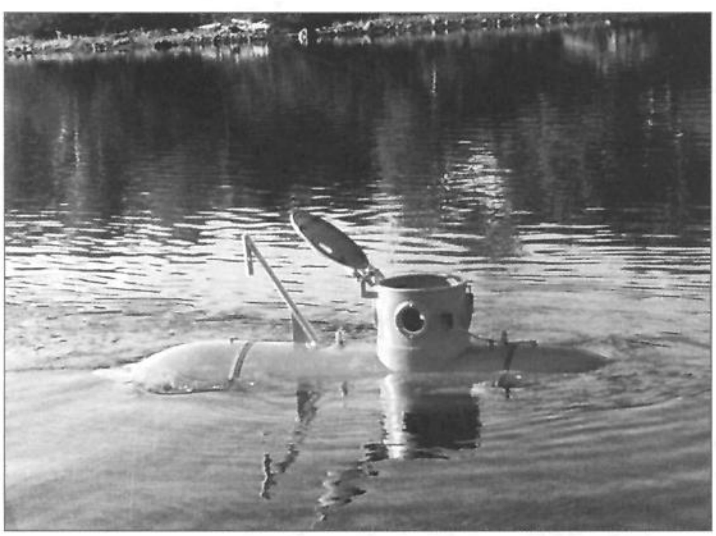
K- 600 in the U.S. Navy Pressure Chamber Annapolis, Maryland.

rine tested in the chamber, the first being Alvin, the second Lockheed's Deep Quest and the third a submarine that did not pass. Fortunately, the test of the K-600 passed with flying colors because I was the pilot for the test and if the submarine had failed I would not be writing this account.

Somewhere along the way, we built a small diesel/electric submarine for a man named Norman Long in Anchorage, Alaska. It had a 5 hp Yanmar diesel in it for running on the surface and three electric motors for running submerged. Two of the motors were the standard side thrusters for maneuvering, but the third 3 hp electric motor was inside the hull and vee belted to a propeller shaft which extended through a seal in the aft head of the pressure hull and turned a 15 inch propeller. Just aft of the propeller was a balanced rudder. On the surface and getting ready to dive, the pilot would first shut down the diesel engine; then he would shut the quick closing valve to the snorkel and the quick closing exhaust valve in the bilges, as well as similar valves to the engine cooling raw water lines. The conning tower of this submarine was similar to that of the K-350 designs. Once the hatch was shut and the Main Ballast Tank vents opened, the pilot would put the diesel gear box in neutral and switch on the 3 hp electric motor.



The last K-350 which we built was a two man submarine for the University of Nagasaki in Japan It was built under Nippon Kaiji Kyokai Rules and certified by them. They use it on their training ship, the Nagasaki Maru shown above.



K-350 with diesel - electric modification.

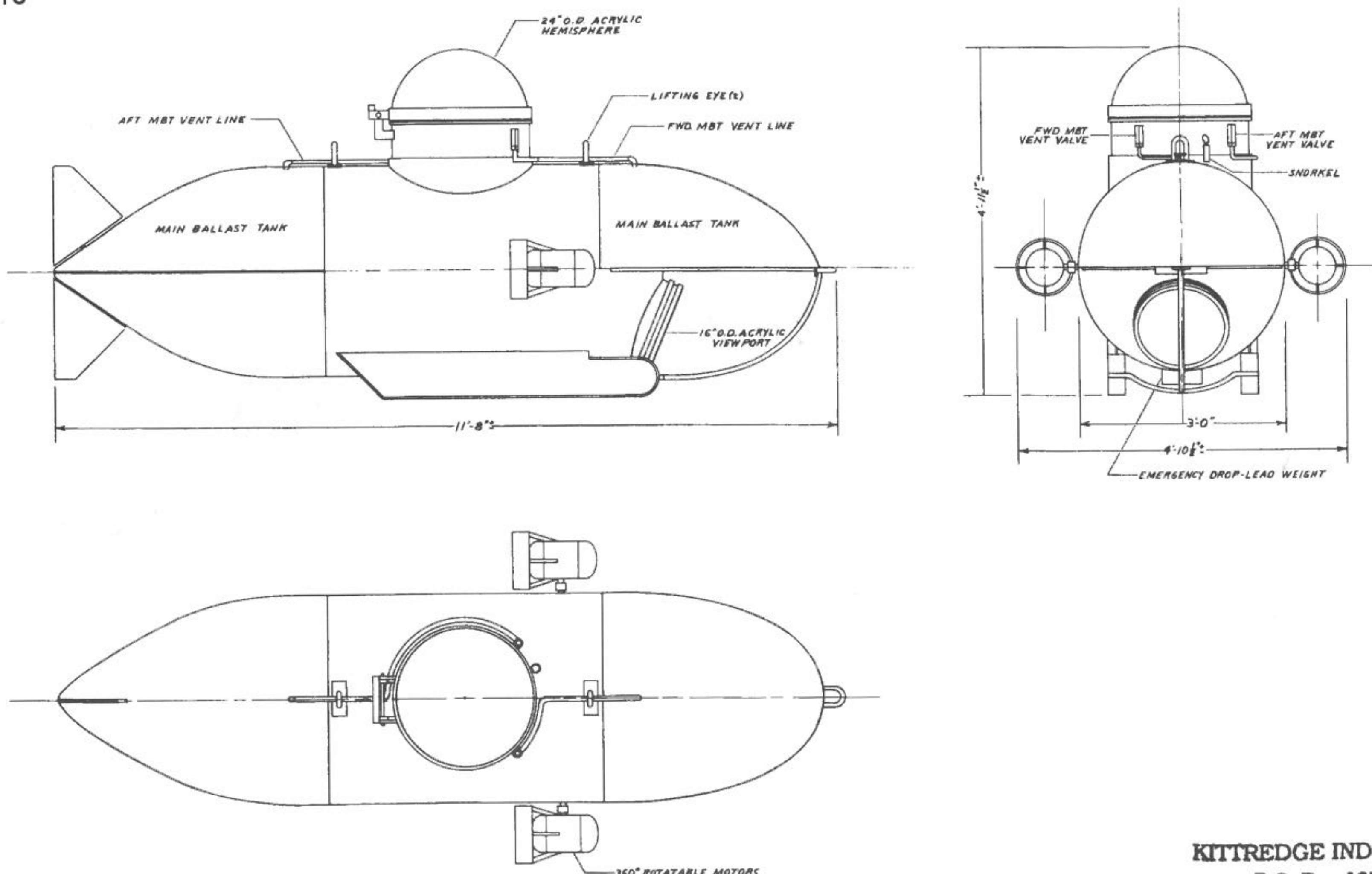
At this point, I decided it was time for me to relax a bit and enjoy some of the fruits of my labors. I sold my manufacturing plant and its surrounding 25 acres on Route 1 in Warren, Maine and went on a round the world trip. After that a safari in South Africa followed by winter in South America visiting every country but Uruguay and Paraguay. It was the good life but I missed the little submarines; so I built a small shop in my home Town of South Thomaston, complete with a marine railway and all the machine tools with which I could build a one-man K-350 submarine for myself.

After building and using it, I got tired of charging batteries and built a pedal power submarine which I call UEM, the ultimate exercise machine. It is based on a modified K-250 hull which has no electrical equipment on board. It is shown in these two photos.

Then, I got tired of pedaling and added a sail complete with telescoping mast that fits in removable brackets on the port side of the submarine. The boom for the sail fits in similar brackets on the starboard side. The submarine called UEM can go from sailing to diving in less than five minutes. I did not know what to call the sailing design. I thought of "SUEM" but it might give people ideas so I settled on UEM/S.

If any of the above submarines appeal to you, we can either build one for you or sell the construction plans to you so that you can build it yourself. All you have to do is write to us and tell us what you want.

Kittredge Industries, Inc.
P.O. Box 125
South Thomaston, Maine 04858



K - 250

KITTREDGE INDUSTRIES, Inc.
P.O. Box 125, Rte. 73
South Thomaston, Maine 04858

KITTREDGE INDUSTRIES, INC. WARREN, MAINE 04864		
TITLE K250 ONE MAN SUBMARINE		
SCALE 1"=1'-0"	DR. BY C. [illegible]	DRAWING NO K250-001
DATE 3/14/77	CH'D. BY	

K-250 One-Man Submarine Specifications

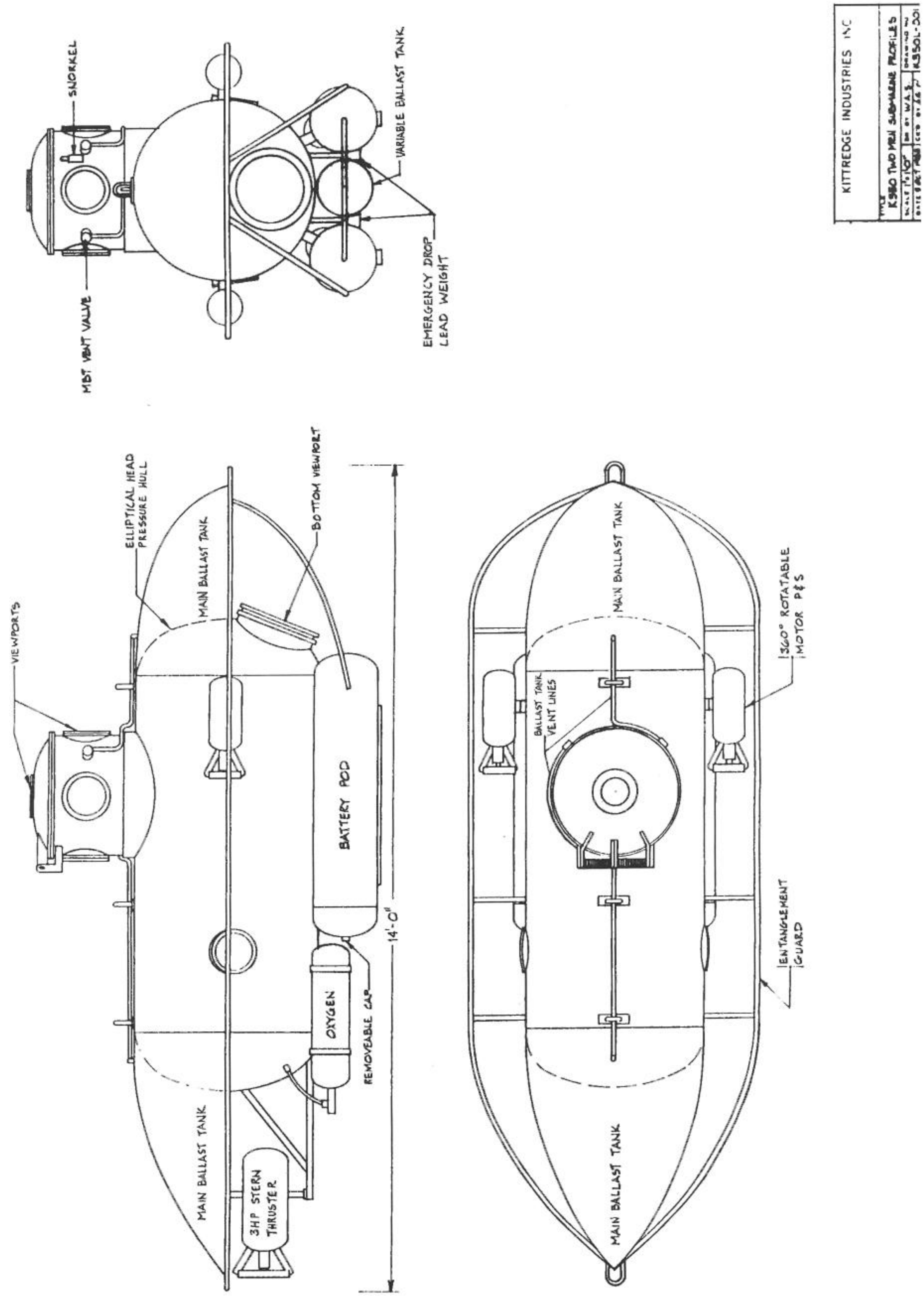
L.O.A.	11 feet, 8 inches
Diameter of Pressure Hull	3 feet I.D.
Material of Pressure Hull	¼" gauge ASTM 516 GR 70 PVQ steel shell with 1½" x 1½" x ¼ angle frames rolled on edge; doubler plates where necessary; all electrically welded.
Operating Depth	250 feet Maximum
Speed	2½ knots
Weight	Approximately 2,200 pounds (less operator)
Reserve Buoyancy	600 pounds
Propulsion endurance	1½hours for normal diving.
Propulsion through	Two side motors are external and capable of being rotated independently 360° thus providing maximum maneuverability.
Power Source	Three internal 12 volt 85 amp/hr marine batteries
Submerged Duration	Revitalize air every 1½ hours.
Main Ballast Tanks	Two external fiberglass, free flooding.
Variable Ballast Tank	Internal steel tank system, purged by air pressure.
High Pressure Air Supply	Two scuba tanks, 71.2 cu.ft. in each tank.
Conning Tower	Steel construction. Hatch is acrylic hemisphere blown from 1" thick material.
Bottom Viewing Port	16" O.D. 2" thick, acrylic lens.
Snorkel System	Consists of automatic, self closing outboard poppet valve and inboard quick closing ball valve. Permits unlimited surface operation without opening conning tower hatch.
Valves	Sea & stop valves are stainless steel Worcester ball valves; H.P. air valves are Whitey & Nupro check valves; MBT vents are Jamesbury ball valves.

Fiberglass Stern Fairings.
Twin Keels (Thus eliminating special cradle for handling)
One emergency drop-lead weights.
Internal Depth Gauge.
All sea valves double seal ball type.
Shafts stainless steel for rotating motors.

Optional Equipment

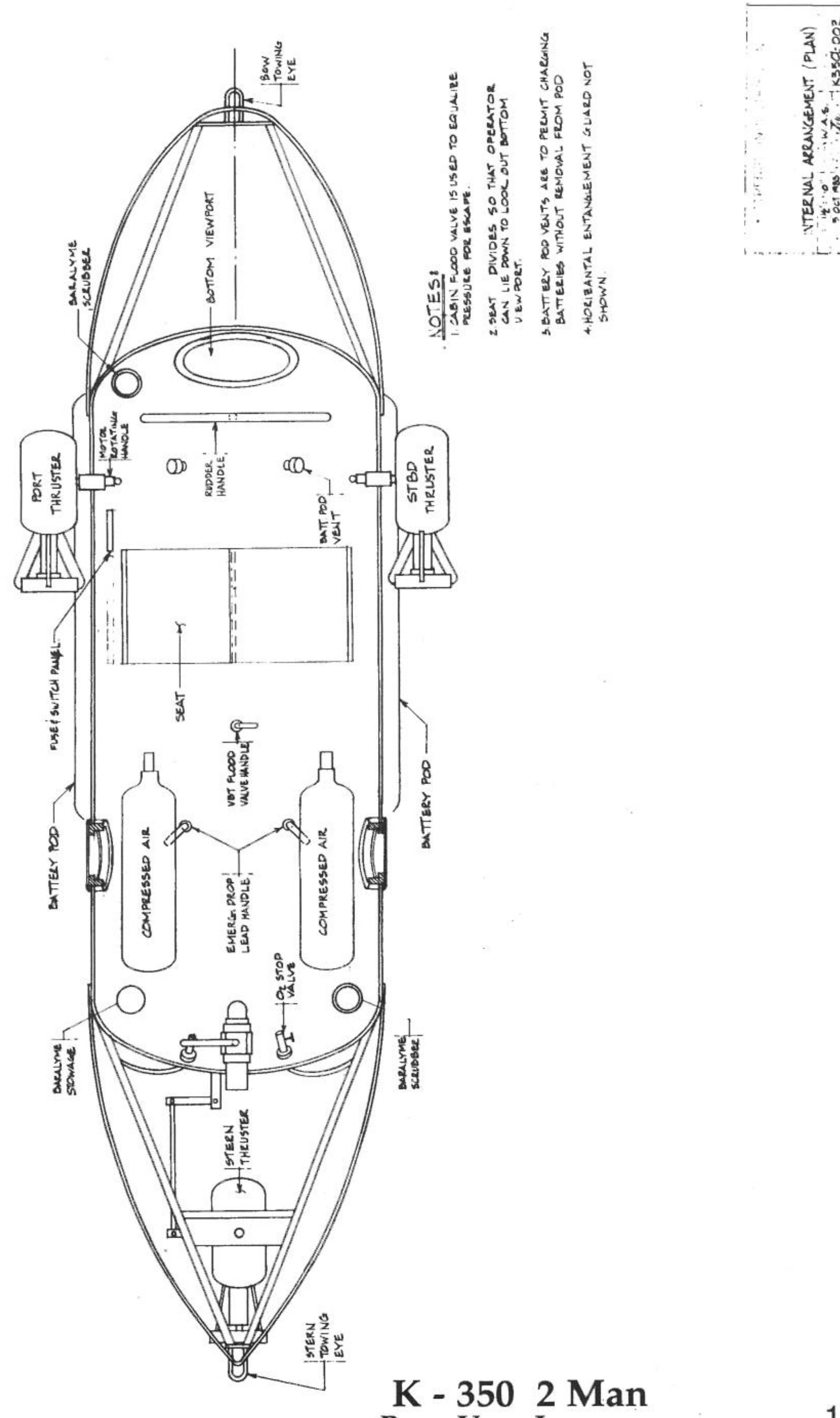
Two-way surface to submarine communication
Bottom floodlight
Tandem Axle trailer
Mechanical claw
Auxiliary external depth gauge

PLEASE NOTE: Kittredge Industries, Inc. reserves the right to change the design, components or specifications at any time.

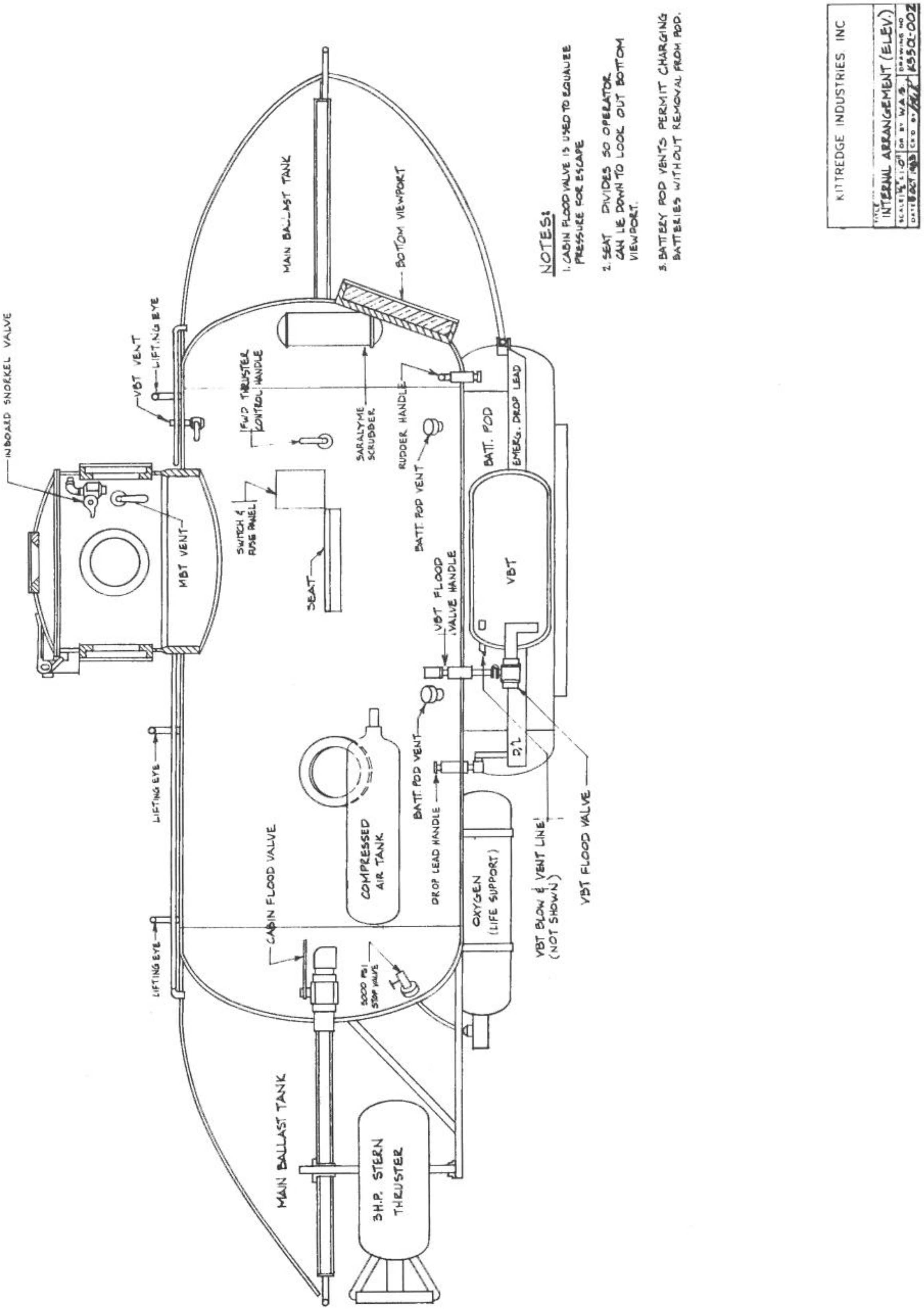


K - 350 2 Man

PROFILES



K - 350 2 Man
Plan View Internal



K - 350 2 Man

Elevation Internal

K-350 Two-Man Submarine Specifications

L.O.A.	14 feet
Diameter of Pressure Hull	3 feet I.D.
Material of Pressure Hull	¼" gauge ASTM 516 GR 70 PVQ steel shell with 1½" x 1½" x ¼" angle frames rolled on edge; doubler plates where necessary; all electrically welded.
Operating Depth	350 feet Maximum
Speed	6 knots
Weight	Approximately 3,500 pounds (less operator)
Reserve Buoyancy	600 pounds
Propulsion endurance	6 hours for normal diving.
Propulsion	Three motors. Two side motors are external and capable of being rotated independently through 360^{o} thus providing maximum maneuverability. Stern variable speed motor is also in external pod and acts as active rudder.
Power Source	Eight 12 volt 85 amp/hr marine batteries; located in two external pressure proof battery containers which serve as twin keels; thus eliminating cradle for handling.
Submerged Duration	1 hr.,12 min.without air revitalization equipment (see below).
Main Ballast Tanks	Two external fiberglass, free flooding.
Variable Ballast Tank	External steel tank system requires no electric pump; purged by air pressure.
High Pressure Air Supply	Two scuba tanks, 71.2 cu.ft. in each tank.
Conning Tower	Steel construction. Has five acrylic lens view ports – 4 in trunk 1 in steel hatch
Bottom Viewing Port	16" O.D. 2½" thick, acrylic lens.
Snorkel System	Consists of automatic, self closing outboard poppet valve and inboard quick closing ball valve. Permits unlimited surface operation without opening conning tower hatch.
Valves	Sea & stop valves are stainless steel Worcester ball valves; H.P. air valves are Whitey & Nupro check valves; MBT vents are stainless steel Lance ball type.

Fiberglass Stern Fairings
Internal Depth Gauge
Two emergency drop-lead weights

Optional Equipment

Two-way surface to submarine communication
Bottom floodlight
Tandem Axle trailer
Directional depth sounder and search sonar
Mechanical claw
Auxiliary external depth gauge

Air revitalization equipment(Scrubber). 8 hour duration with O_2 injection & CO_2 removal with 72 hr. emergency life support.

PLEASE NOTE: Kittredge Industries, Inc. reserves the right to change the design, components or specifications at any time.

K-600 One-Man Submarine Specifications

(There is a photograph of the K-600 on the cover of this manual.)

L.O.A.	14 feet
Diameter of Pressure Hull	3 feet I.D.
Material of Pressure Hull	3/8" gauge ASTM 516 GR 70 PVQ steel shell with 1½" x 1½" x 3/8" "T" bar frames; heavier plate inserts where necessary; all electrically welded.
Operating Depth	600 feet Maximum
Speed	5 knots
Weight	Approximately 4,500 pounds (less operator)
Reserve Buoyancy	600 pounds
Propulsion endurance	6 hours for normal diving.
Propulsion	Three motors. Two side motors are external and capable of being rotated independently through 360° thus providing exceptional maneuverability. Maximum thrust is obtained from an external 3 hp motor which serves as an active rudder.
Power Source	Eight 12 volt 85 amp/hr marine batteries; located in two external pressure proof battery containers which serve as twin keels; thus eliminating cradle for handling.
Submerged Duration	6 hours plus 80 hour life support system.
Main Ballast Tanks	Two external fiberglass, free flooding.
Variable Ballast Tank	External steel tank system requires no electric pump; purged by air pressure.
High Pressure Air Supply	Two scuba tanks, 71.2 cu.ft. in each tank.
Conning Tower	Steel construction. Five acrylic lens view ports, four in trunk, one in hatch.
Bottom Viewing Port	13" O.D. 2" thick, acrylic lens.
Snorkel System	Consists of automatic, self closing outboard poppet valve and inboard quick closing ball valve. Permits unlimited surface operation without opening conning tower hatch.
Valves	Sea & stop valves are stainless steel Worcester ball valves; H.P. air valves are Whitey & Nupro check valves; MBT vents are stainless steel Lance ball type.

Fiberglass Stern Fairings
Two internal Depth Gauges
Two emergency drop-lead weights
Three (3) external floodlights

Optional Equipment

Two-way surface to submarine communication on 22 Khz. Theoretical range 10 miles.
Air revitalization equipment(Scrubber). 8 hour duration with O_2 injection & CO_2 removal with 72 hr. emergency life support.

Search sonar
Tandem Axle four wheel trailer
Mechanical claw
Auxiliary external depth gauge

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