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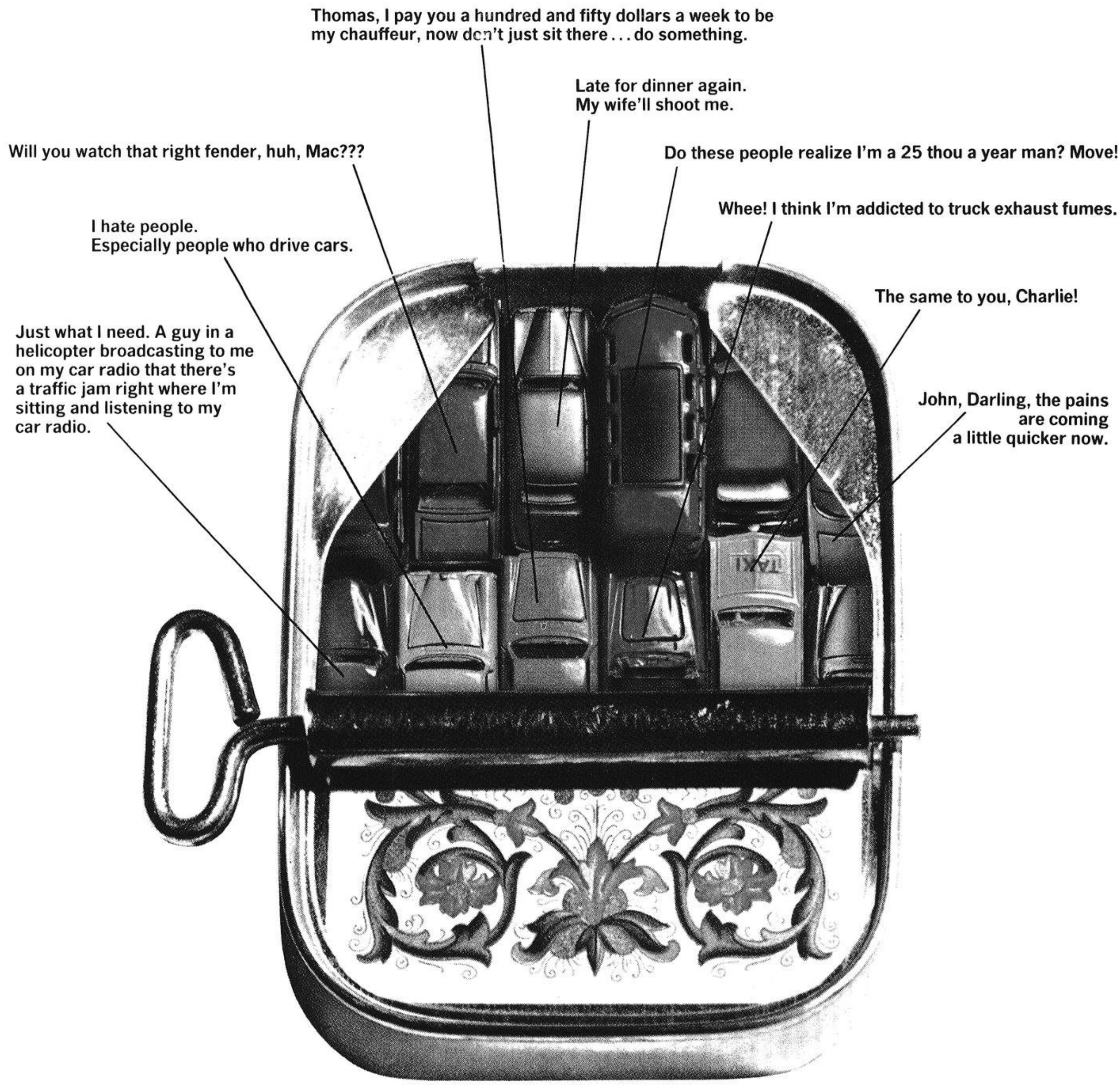

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EDITORIAL

Here's To St. Patty's Day...

About fifty years ago, St. Pat's was a day the lawyers dreaded! Not only were they unable to grow longer beards, or chug more green beer than the engineers, they couldn't win the queen contest, or the float competition, or the rotten egg throw, or even play better practical jokes. (Remember the day that they chained the law building doors shut and only the engineers knew where the lead link was?) It's sad that the lawyers haven't got the spunk to try any more, because it's always been such fun beating them.

St. Pat's this year is going to be really good! All the committees are in full swing, planning (and plotting?) for the beard contest, buttons, a great dance band (reported to be Robin and the Three Hoods), and all the green beer your heart desires.

By the way, even last year the lawyers were trounced, I hear. Seems some enterprising young souls covered their Gargoyle (that last relic of that old relic—the old law building) with plaster of paris and green paint. Poor lawyers — they were so busy chipping it off they had no energy left to retaliate.

This year, for any new lawyers who want an in on the action, the engineers are offering a challenge — prove that you can get the best of us this year (net efforts, now 'til St. Pat's day). We'd like to see some proof of your existence, if only for old times' sake.

Oh, and by the way, in case you didn't know — ST. PAT WAS AN ENGINEER! Lawyers are only long-winded.

The Engineers

LETTERS

→ FEEDBACK ←

To encourage discussion of the problems of the College of Engineering and general student hang-ups, THE WISCONSIN ENGINEER will publish letters which we feel are of interest to you, the reader. If something about school or THE WISCONSIN ENGINEER bothers you, just leave a note (or a bomb) in our mail box in the M.E. lobby. We will do our best to make you be heard.

I must take a negative attitude to your editorial in the November 1967 Engineer. It is very true that the engineer accepts the responsibility to serve mankind in his work. Perhaps there are those who feel that the manufacture of weapons systems negates this obligation in that it assists in destroying our civilization. It would be logical to assume that anyone who participates in this scheme is to blame for its results. I cannot agree with this idea. History will show that the development of the rocket as we know it occurred because of World War II. Scientists worked to develop the ultimate weapon. In doing so, the rocket system was given a tremendous boost. It is true that the first aim of the scientists was to render harm, but without this boost, I suspect our rocket and space technology would be greatly retarded.

The age of Atomic Energy was spawned because of a weapon — The Atomic Bomb. Now, atomic energy is used for such beneficial purposes as cure of cancer, power to light the home, food preservation, etc.

In short, my point is that war is bad. It does destroy people, places, and things. However, it is a commonly held idea that nothing good can come from war. Certainly, this is not true. Scientific work is given a tremendous uplift in the time of national emergency. Weapons of war can be used for peaceful purposes to the benefit of humanity.

As to the engineer, when is he working to produce a war machine? Is the engineer working for Dow in their pharmacy division contributing to the service of humanity? How about the engineer working for a power company who supplies the napalm plant with power. Is he serving humanity? In summary, our economy has become so complex that practically everyone will have something to do with a process concerned with war. However, one must also realize that in his work, he can also do much good for society.

By the time this is printed, and I hope it is, I will have departed this university for industry. I cannot leave without expressing my views on this subject because indifference is in effect agreeing, and I most certainly do not agree with your stand.

Respectfully,
Thomas M. Kulas
EE Class Jan. 1968

FEEDBACK

I was very pleased to see your editorial in the November 1967 issue of THE WISCONSIN ENGINEER in which you cited the functions and responsibilities of an engineer in terms of a quotation from "Faith of an Engineer."

I have found that such a basic idea is best identified in terms of the performance of specific engineers. One such engineer who just died about a week ago was John L. Savage, a Wisconsin graduate. I am enclosing some newspaper clippings regarding Mr. Savage and I presume Dean Wendt's office had considerably more reference material which might serve as a basis for an article describing his notable career.

With best wishes, I am,

Sincerely yours,
Adolph J. Ackerman
Consulting Engineer
Madison, Wis.

Dam builder John Lucian Savage, who died in Denver last week at the age of 88, was praised in 1948 by a national magazine which said: "more people are indebted to him, and will be for generations, than to any other engineer."

Such praise was applicable then and it has been bulwarked since by Savage's career which continued long after his retirement from the U.S. Bureau of Reclamation in 1945.

For 40 years after joining the reclamation agency at a salary of $60 a month in 1903 Savage designed many domestic dams, including such famous ones as Hoover and Grand Coulee Dams. He earned his share of brass plaques.

But Savage went far beyond the limits of the United States. He designed dams in China (on the main channel of the Yangtze), in India (the great Bhakra Dam) and projects in Manchuria, Mexico, Afghanistan, Australia and Ceylon (and the list is by no means complete).

Savage made far better salary as a consultant than he ever did with the bureau. He retired from a job which paid less than $10,000 a year; he often earned $100 a day plus expenses as a consultant. He could have had more than that but he kept down his fees, in relation to what other engineers charged, because he believed in helping underdeveloped nations.

Many millions of people throughout the world have light, power and irrigation water today because of John Savage's efforts. This Denverite was the sort of American whose name and reputation may well outlive the brass plaques bearing his name in many parts of the world. — *Denver Post,* Dec. 31, 1967

COVER STORY

OCEAN ENGINEERING:

by A. W. Bedford, Jr.

General Electric Corporation

THE WORLD'S FIRST UNDERSEA RESEARCHER:

Alexander the Great used a glass barrel for an undersea investigation in the fourth century, B.C. The following account is taken from the 13th century manuscript in a Brussels Library:

"He looked to the bottom of the sea to show him the wonders there. He called for glassmakers and ordered that they make a glass barrel that would permit him to see clearly all things at great depths. Then Alexander (the Great) ordered that the barrel be held by good iron chains. For darkness (he ordered) glowing lamps — then entering, had the door well closed on the barrel. When he had disappeared from view into the sea, he saw little and great whales and many other fish that had the form of beasts that live on land and walk on legs and that lived among the trees which nourished them. The whales came to him and then drew back. He also saw many wonders that were unbelievable for man to see and that were unknown to all. He saw fish that resembled men and women and that walked on the bottom of the sea, devouring other fish as men do in this world. When Alexander had seen enough of these wonders of the sea he made signs for those above to draw him up."

THE NEW FRONTIER

● Most of us are aware of a few basic facts about the world's oceans: that they are divided into several main bodies, that they represent 71 percent of the world's surface; that parts of them are very deep; and that they are a food source for many of the world's inhabitants.

Usually, also, we are more dimly aware of other facts, such as drilling for offshore oil and reclaiming magnesium from seawater and accounts of undersea mountains and volcanoes. Thereupon our knowledge usually fails completely. No aspect of our natural environment is less understood after thousands of years exposure to it than are the world's oceans and the land beneath them.

Our lack of knowledge of the oceans and the underseas configurations is understandable. For centuries man's basic physical limitations in such an environment kept him from going down deep enough, staying long enough, covering a large enough area, and making enough significant observations to develop a body of knowledge that was equivalent to his increasing understanding of other phases of his environment. Furthermore, there was no great need to give impetus to developing a science or technology for overcoming these basic limitations, as long as the earth provided the food and minerals for man's survival. It is only within the past half century that a true interest has developed at all, and only since World War II that a real, and increasing need for knowledge of oceans and the lands beneath them, has been recognized.

That interest has been emphasized by mankind's needs. Although 29% of the world's area is dry land, only 41% of that amount supports habitation. Thus our current world population of about 3,000,000,000 people, with its constantly increasing demands for foods and resources, lives on only 12% of the world's surface. The oceans may well be the largest untapped source for supplementing the world's food and mineral supply.

We have already begun to draw upon the ocean's food and mineral resources.

For example, in addition to the familiar forms of fish food, a good, vitamin-rich flour has been developed from fish types thought to have no commercial value; kelp farming is already a profitable investment off the California coast. Iron ore is being reclaimed from the sands of Tokyo Bay and there is enough aluminum and copper in reachable ocean beds to last the world a million years at the present rate of consumption.

Such advances are indicative of the ocean's potential. The problem, indeed, is in making that potential more readily attainable.

The extent of this potential is very large. The oceans vary in depth up to about 36,000 feet. About 8 percent of the total area the oceans occupy, however, is represented by continental shelves where the depth is about 600 feet or less. These continental shelves are submerged land masses protruding from continents for distances up to several hundred miles. Most of the useful undersea food and mineral sources exist in these regions — and the area that these shelves alone can open to us for utilization is about 11,500,000 square miles, roughly the size of the African continent!

The potential and the rewards are here, in the depths. So is the problem of working in a hostile environment. The sea, a mystery as old as the stars, has become the new engineering frontier.

Mr. Bedford is manager of G. E. Knolls Atomic Power Laboratory NR-1 project—the group developing the power plant for the first atomic-powered research lab.

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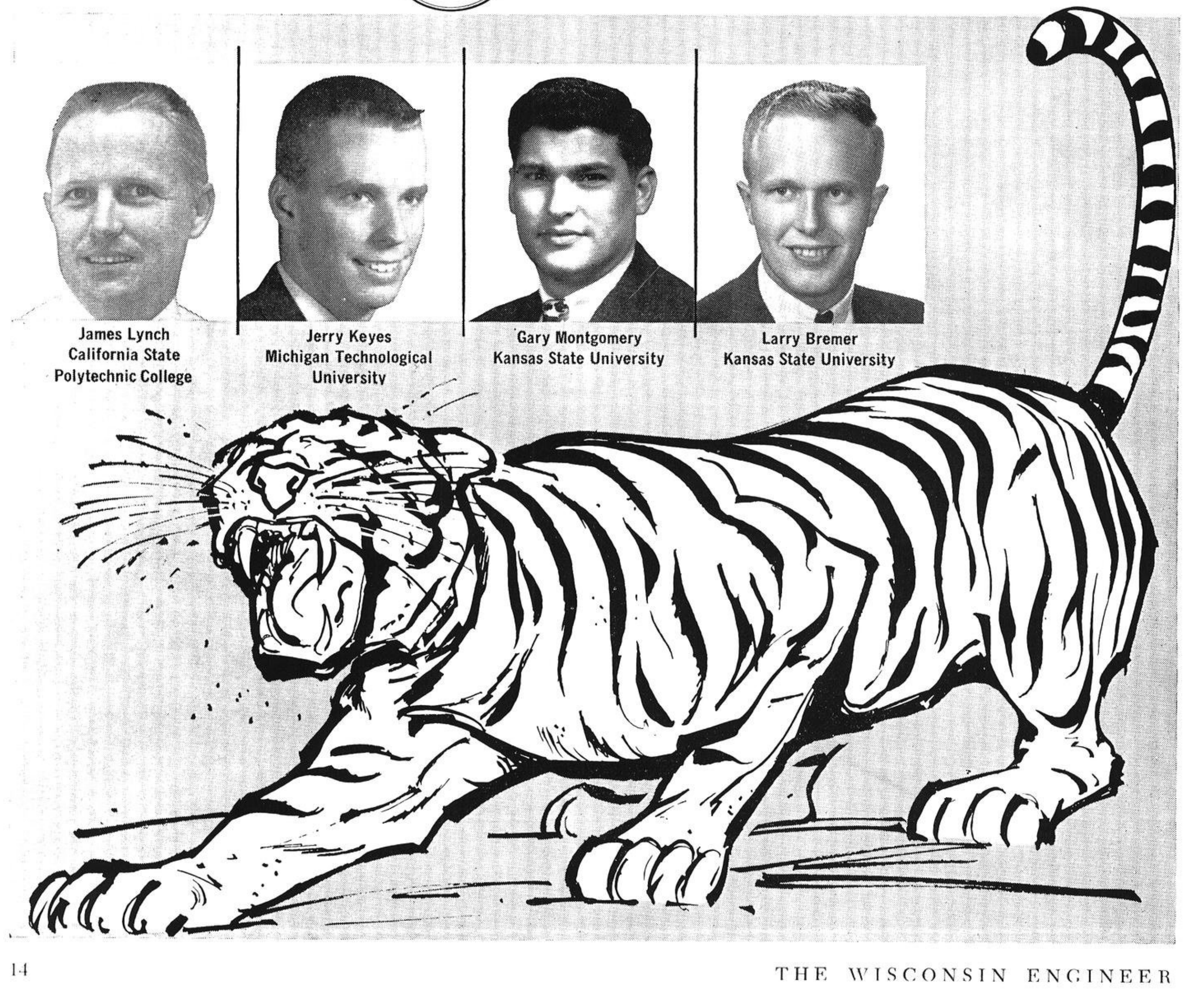

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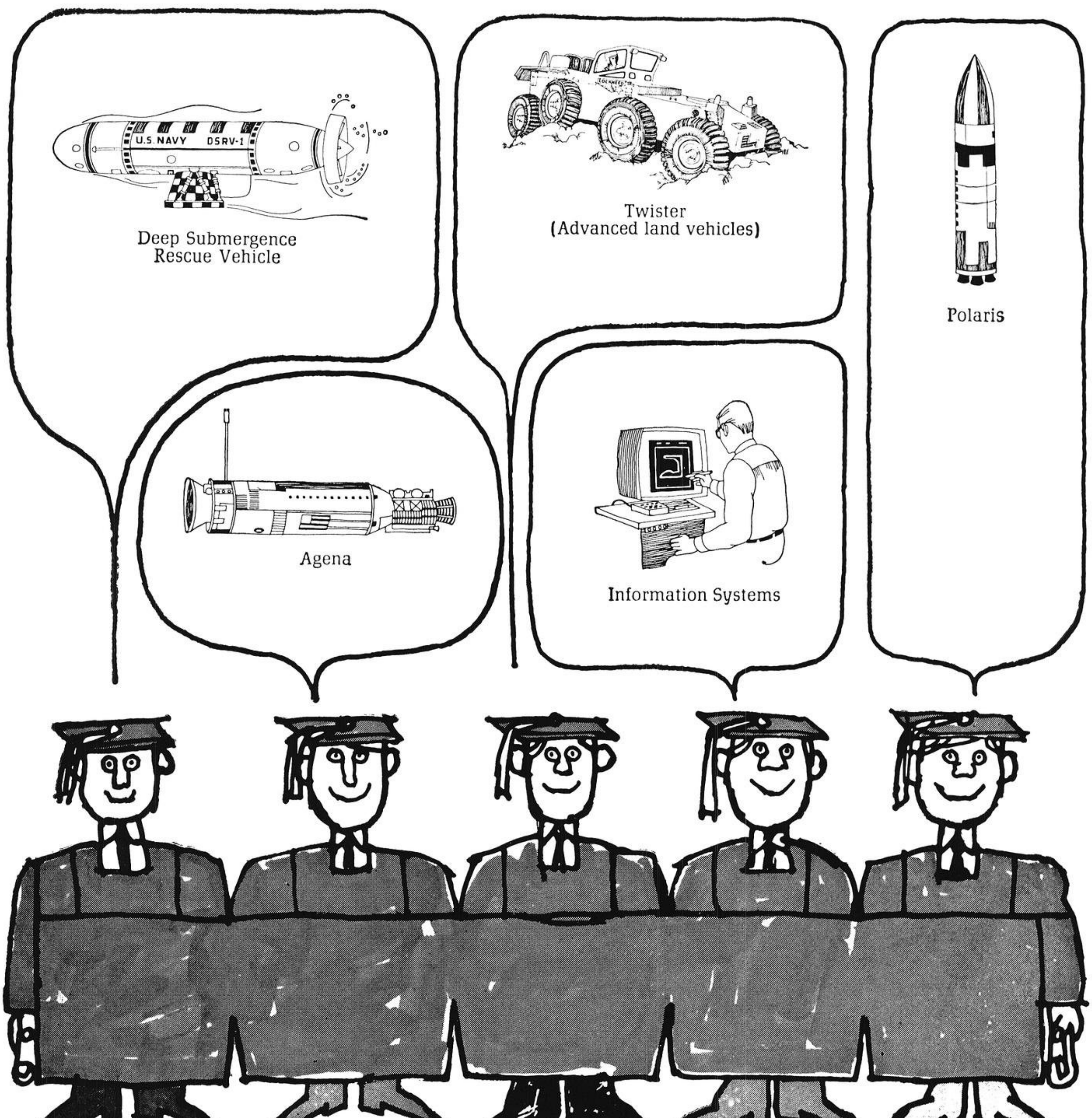


RESEARCH SUBMARINES

or

rubba-dub dub, two men in a sub

by Bruce Pease
ME 68

One dreams of flying after having seen the birds winging gracefully through the air. It is only natural, then, that having observed fish swimming effortlessly through the water, man would also want to venture beneath the surface of the water. Supposedly, there are early accounts of men attempting to build submersibles capable of moving underwater for extended periods of time. Little did they realize the importance the oceans would have today. Their crude underwater boats have been refined and turned into valuable instruments for reaping the treasures of the sea. The following discussion is meant to briefly inform the reader of the development of underwater research vehicles as we know them today.

HISTORY OF THE SUBMARINE

Early Attempts

Man's first journey into the sea was recorded by Aristotle in the Fourth century B.C. when Alexander the Great was lowered underwater in a barrel equipped with portholes. During the Renaissance, Leonardo da Vinci supposedly designed a submersible. However, the thought of what evil men might do with his machine, made him destroy the plans.

King James I rode what might have been the first submersible down the Thames River. The device, built by Cornelius van Drebble, consisted of a wooden framework over which greased leather was sewn, with oars protruding from the sides for propulsion.

In 1653, a Frenchman named de Son, built a submersible incorporating an odd paddle wheel for propulsion. The inventor claimed his vessel could "undertake in one day to destroy a hondred ships, can goe from Rotterdam to London and back againe in one day, and in six weekes to goe to the East Indiens, and to run as swift as a bird can flye, no fire, no storme, no bullets, can hinder her unless it please God." However, the craft's odd propulsion system failed to move it.

Submarine innovations continued at a slow pace and a large screw turned by hand eventually replaced exterior oars as a means of propulsion. In 1747 a submersible was developed which ascended and descended using a leather bottle water ballasting system. John Day, a ship's carpenter, used rocks to make his submarine sink to 30 feet at which point the rocks were released and the craft ascended. In 1773, Day again tried his submarine, but this time in 130 feet of water. Unfortunately his primitive hull design and materials failed under the high pressures.

The Submarine As A Weapon

The inevitable came, and man began to use the submarine as a weapon. During the American Revolutionary War, David Bushnell, an American, perfected an underwater time bomb and wished to attach them to British ships anchored in New York harbor. For this purpose, Bushnell built the first submarine meant for warfare. The "Turtle" was a one-man submersible, built of wood and leather, propelled by a hand-cranked screw at speeds up to two mph. He employed several simple devices. One was a snorkel with a waterproof valve. Another was a simple depth gauge. The depth limit of the sub was 18 feet. At this depth, however, there was very little light, so fox-glow was employed for light.

Sergeant Ezra Lee piloted the "Turtle" on its first mission, September 16, 1776, against the British ship "Eagle." The mission failed when he was unable to auger through the copper sheathing on the bottom of the "Eagle" to secure the time bomb. Lee later released the time bomb as he was being pursued by a British whaleboat. The bomb exploded harmlessly and the "Turtle" escaped.

Robert Fulton, inventor of the steamboat, built several subs entitled "Nautilus." He used iron frames with copper coverings, a diving plane to maintain certain depths, and water-filled ballast tanks to control buoyancy. Fulton traveled from country to country trying to sell his submarines, but received little encouragement from various governments. Later he received funds from the United States and built a sub propelled by steam engines and capable of carrying 100 men. However, Fulton died just before its trial, and the craft was left to rot at its mooring.

One of the most successful submarine men of that period was the Bavarian, Wilhelm Bauer. He and a crew of two made perhaps the first submarine escape. Their submersible was stranded on the mud 50 feet down. By flooding the interior they were able to open the hatch and make a free ascent to the surface where they arrived safely except for a slight case of the bends. His second submersible was more successful and made 134 dives before being lost.

During the Civil War, Confederate generals were willing to try most anything to break the Union blockade of Southern ports. A number of submarines were built, among which was the "H. L. Hunley." It was a hard luck vessel from the beginning. It carried a crew of eight husky men to crank the screw propeller. Over a period of time, five different crews died in the "Hunley" by asphyxiation or drowning. The sub's true worth, however, was to be demonstrated before its final trip to the bottom. On February 17, 1864, the submersible set out from hiding to attack the USS Housatomic, anchored near Charleston harbor. The "Hunley" succeeded in sticking an explosive spar into the ship by ramming it. The 90 pounds of gunpowder exploded prematurely and both the ship and sub went to the bottom. This was the first successful submarine attack in combat, and from then on, sea warfare took on a new look.

Silent Service

John P. Holland, "Father of the American Submarine," came to the United States in 1872. Although a teacher by trade, he spent much of his time thinking of submarines. After 30 years of designing and building submarines, he constructed his ninth submarine, the "Holland," which was launched May 17, 1897. The "Holland" was an advanced design and boasted a torpedo tube, three torpedoes, and two dynamite guns. The "Holland" was bought by the United States Navy for $150,000 and commissioned October 12, 1900.

Thus began the United States Submarine Service. Soon to follow were submarine fleets of other countries. The advent of the diesel engine in the 1890's quickly replaced the gasoline engine in the submarines because of its operating efficiency, simplicity, and cheapness of operation. From the early 1900's to present, submarines have been used primarily as a military tool. During this time, the submarine has progressed from a clumsy contraption to a highly sophisticated machine. The hulls today are stronger and safer, being made of high quality steels. Nuclear energy has taken the place of hand cranking for the propulsion of the subs. And modern vessels utilize precise communications and navigational systems.

Ocean's Importance Grows

The importance of the oceans increases more each year. There are tremendous stocks of valuable minerals, metals, oil, and food to be found in the seas. Fortunately most of these raw materials are to be found within the limits of the continental shelves, which extend to several hundred feet out into the ocean off a land mass. The depths of the shelves are seldom greater than 1,000 feet. It is here that man must direct the majority of his efforts.

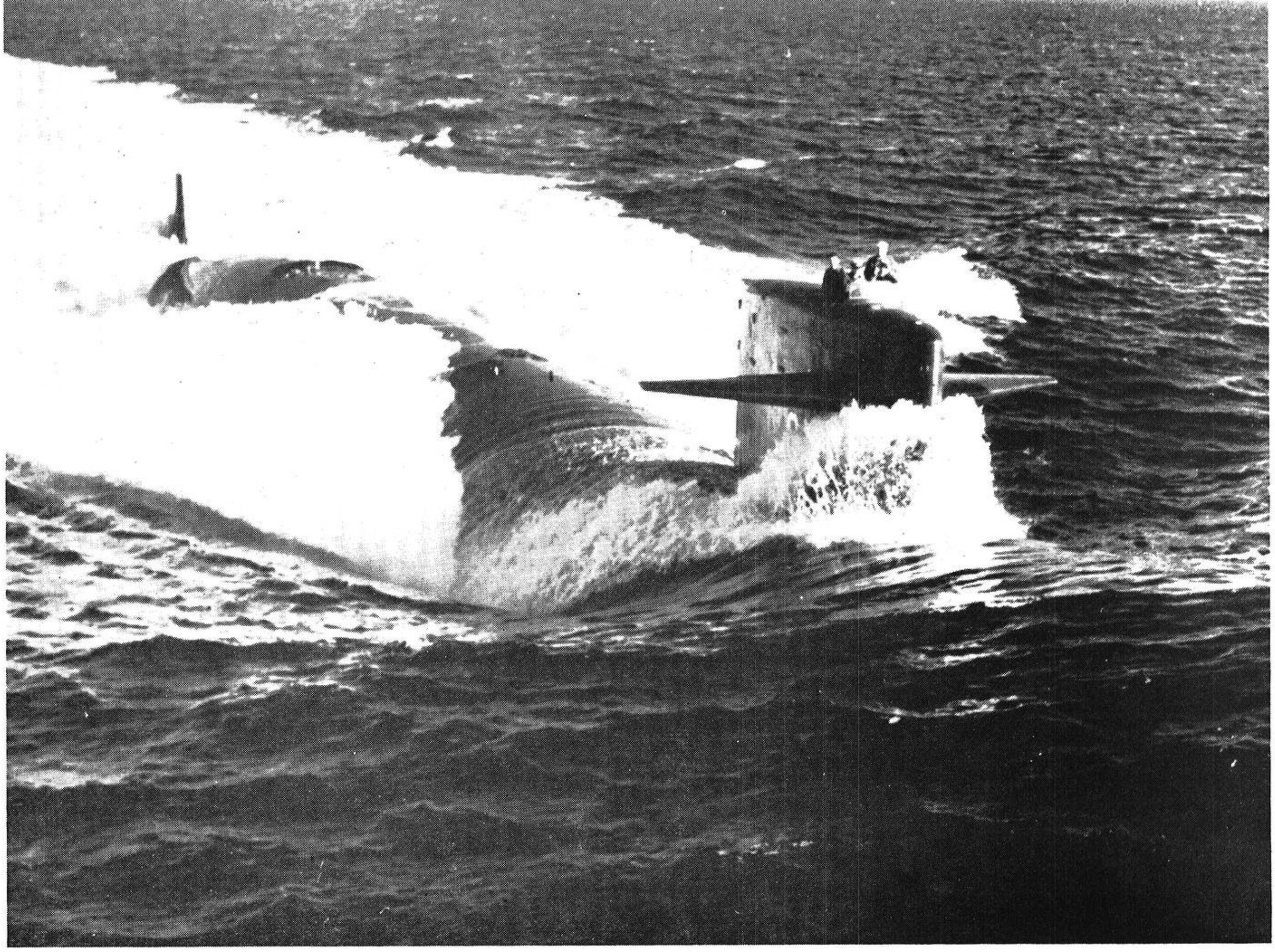
THE MODERN SUBMERSIBLE

The Modern Submersible

It would seem logical that man will descend in some type of submersible vehicle capable of going to great depths, and once there perform a work function. Military submarines today operate at depths greater than 1,000 feet, and are capable of moving at greater speed under the surface than above water. As work and research vessels they are quite inadequate. Accordingly, the past several years have seen a new revolutionary type of submarine in the making. This "new breed" is often referred to as deep research vehicles-DR/V.

The "Trieste," one of the first deep research vehicles and still the most dramatic is a bathyscaph. Designed and built in 1958 by famed underwater pioneer Auguste Piccard, the "Trieste" has descended 35,800 feet to the deepest point of the oceans.

The bathyscaph is, in effect, an underwater balloon. The gondola, a spherical pressure hull, is hung below a thin metal "gas." The "gas" is actually 32,000 gallons of light gasoline and is used to provide buoyancy much as helium does for a balloon in the atmosphere. There are also



The nuclear attack submarine Flasher, shown here, is a descendant of the "Turtle" used in the American Revolution.

photo courtesy of General Dynamics

two silos filled with 16 tons of metal shot ballast, held by electromagnets. To begin descent, a passageway for the two-man crew is flooded. The balloon skin is thin because there is no pressure difference across it and seawater has free flow into and out of the balloon through the holes in the bottom. As the vehicle goes deeper, the gas compresses slightly and seawater flows into the void. This in turn makes the balloon denser, less buoyant, and it may be necessary to drop some of the ballast shot to prevent the rate of descent from going above three feet per second. Should the bathyscaph encounter colder, denser water, some gas may be valved off to decrease buoyancy so that the balloon will penetrate the colder region.

The conquering of the ocean's greatest depth was a feat achieved by Jacques Piccard, son of designer Auguste Piccard, and Lieutenant Don Walsh, USN. Remarkably, they observed a shrimp and a fish at this great depth where the sphere felt a total force of 200,000 tons due to the ocean's pressure of 16,000 psi.

Although the "Trieste" had great depth capabilities, there is need for more maneuverable vessels. This fact was conclusively demonstrated by the searches for the USS Thresher and the lost H-bomb off the coast of Spain. The oceans are waiting to be picked of their treasures; it only remains for man to come and take them. Before Thresher, there were perhaps a couple of companies seriously considering the development of the submersible for research and commercial interests. Today, there are almost a dozen firms involved with submersibles for some reason.

A "New Breed"

A whole array of "midget submarines" or DR/V's now exist and many more advanced models are on the drawing boards. The first deep research vehicle stressing maneuverability and lateral range was developed by Captain Jacques Yves Costeau in 1960, with the French Office of Undersea Research. A diving "saucer," its water jets propelled it to depths of 1,000 feet.

In 1962, John Perry's "cubmarine" became the first American-built deep research vehicle. It could only dive to 150 feet, but with a porthole-studded conning tower it had an excellent 360° field of vision.

Westinghouse is developing a series of submersibles known as "Deep Star." Deep Star 4,000 was the first and DS 2,000 and DS 20,000 will soon follow. DS 4,000 has an 18-foot tear-shaped fairing, covering a spherical pressure hull, 1.2 inches thick, of HY 80 steel. It can dive to 4,000 feet and has many capabilities in photography, salvage and environmental studies of the ocean.

General Dynamics' first research submarine was "Star I," which was also the first sub to have its motors run off a fuel cell. Its capabilities are limited to a one-man crew, one knot underwater speed, and a depth of 200 feet. However, Star II and Star III can go to 1,200 feet and 2,000 feet, respectively, at speeds up to five knots. Both have sophisticated electronic equipment and bow manipulators.

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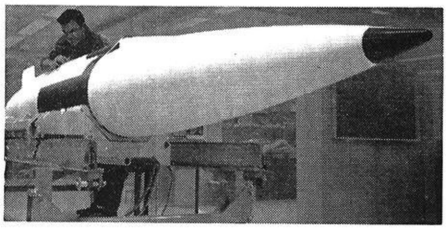
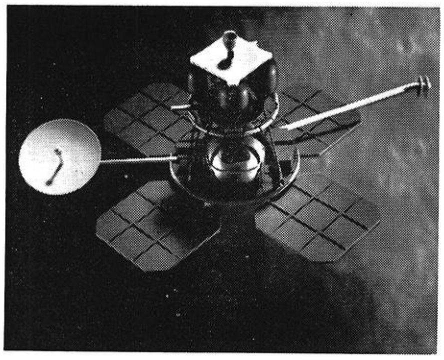
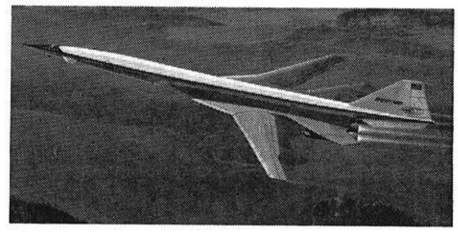
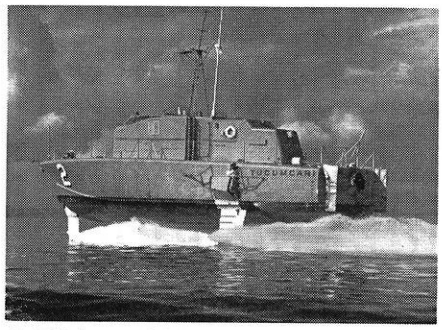







BOEING 737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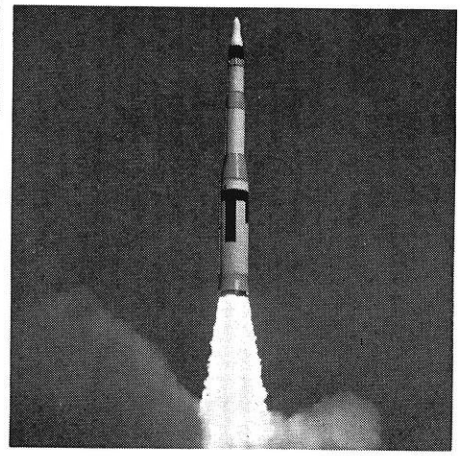

General Dynamics also built the "Aluminaut" for Reynolds International, Inc., in order to show the usefulness of aluminum as a hull material. The 51-foot craft could carry a crew of three to depths of up to 15,000 for 30.5 hours, or up to 12 passengers for less time.

"Submaray" is a small two-man boat with a 15-mile range, and can dive to 600 feet. "Pisces," built by three deep sea divers of International Hydrodynamics Co. Ltd. is capable of 5,000 feet, with a collapse depth of 12,000 feet. Weighing 13,000 pounds, it is propelled by two six hp motors at speeds up to six knots. "Deep Diver," built by Perry Submarine Builders, has two pressure spheres which can carry four men. One sphere has diver lock-out capability down to 1,250 feet. In addition, the lock-out sphere can be kept pressurized, so the submarine may return to the surface or travel to a different job site, while the divers decompress slowly.

An early deep research vehicle, "Alvin," helped find the lost H-bomb and can dive to 6,000 feet. It is owned by the U.S. Navy, and operated by Woods Hole Oceanographic Institution.

A real work boat about to come on the scene is "Deep Quest" by Lockheed. This submersible can go to 8,000 feet and lift 7,000 pounds. PX 15 is an interesting sub designed by Dr. Jacques Piccard and being built by Grumman Aircraft and Engineering Corp. in Switzerland. Its first job will be to drift 1,500 miles with the Gulf Stream at depths of 400 to 1,000 feet over a period of three to four weeks.

TYPICAL FEATURES OF A DEEP SUBMERSIBLE

All deep research vehicles as submarines are basically similar. Approximately 25 of these subs now exist. What then are the major considerations in construction?

Pressure Hull

Man's body cannot withstand the high pressures encountered at great depths. Therefore it is necessary that he be covered by a pressure-proof hull. The strongest and most common configuration used is the sphere ranging from five to seven feet in diameter. Other designs include ellipsoids, cylinders with hemispherical ends, and two or three spheres connected by cylindrical passageways. The hull is formed by forging, explosive forming, or hot spinning of the parts which are then welded together. The surface is finished by contour machining and possibly lapping to reduce stress concentration. After major heating operations the hull is annealed to remove internal stresses. High quality and high strength steels are used. Some of these are HY 100, HY 80 1045, ASTM A225 B and A 212B. Considerations in selecting a steel are its workabilities, weldability, strength, toughness, and resistance to stress considerations.

Pressure hull thicknesses range from ½ inch to two inches and more, depending on materials used and service specifications. Wood, glass, and glass-impregnated resins may be used in the near future. The hull will have several discontinuities where view ports, hatches, and control linkages are to be found. These areas are strengthened by adding more materials. All welds are inspected by dye penetrant and X-ray procedures. The hull undergoes strain gauge and sonic testing. All parts involved with the water-tight integrity of the hull are completely tested under rigorous conditions.

Visibility

View ports are made of plexiglass or cast acrylic blocks. They are shaped like truncated cones with the narrow end put towards the hull. With a little waterproof silicon grease and water pressure they are held tightly into their casings. Visibility is not good in many subs as view ports afford only limited fields of vision.

Fairing

All submersibles are fitted with a fairing sheet of glass-reinforced plastic or light metal. It is the fairing which covers the pressure hull and external apparatus to give the submarine its streamlined appearance. The fairing reduces the vehicle's drag and gives some protection in collisions with underwater obstacles. Collisions are not uncommon due to poor visibility.

Between the fairing and the pressure hull lies all equipment which is unaffected by pressure. The batteries and main ballast tank are to be

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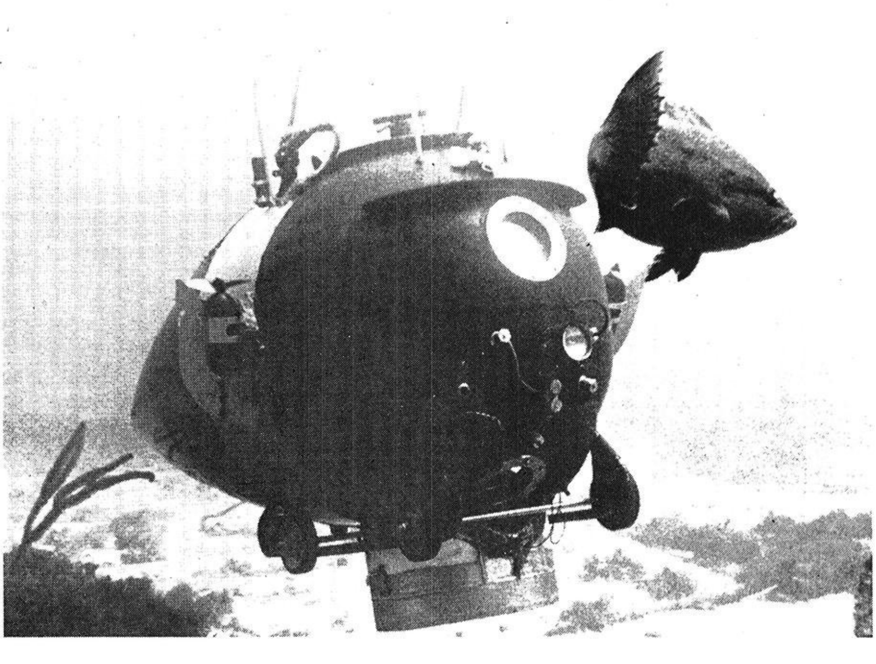

General Dynamics' first research submarine, Star I, has operated with a fuel cell as its only source of power.

PROLONGED SUBMERGENCE

by Mike Paulson
Wisconsin Engineer
Staff

● Man's contacts with the riches of the sea are surface ships, which cannot tap those materials lying more than a few feet below the surface. Submarines can travel well underwater but are of little value in extracting materials from the sea. Man's most direct contact with the sea is in diving, but divers cannot do extensive underwater work because of the problems caused by pressure of the depths, the cold, poor lighting, certain friendly fishes, and other natural hazards of this hostile environment. This article will point out the most important problems and describe one of the most recent developments in the conquering of these difficulties — prolonged submergence.

DANGERS IN DIVING

Many problems can be encountered in diving, making it one of the most dangerous occupations. One factor that is often thought of as a problem, the extreme pressures, is in fact not a problem at all. Pressure does not have a crushing effect on divers at currently reached depths because the diver's body is largely water and thus cannot be compressed. The only part of the body subject to significant collapse due to pressure is the respiratory system. This area is protected by the breathing apparatus, which is so designed that the breathing mixture is subject to water pressure and therefore keeps the respiratory system at the same pressure as the water. The problems involved in diving are therefore not directly caused by the crushing force of pressure but by the physiological effects of depth.

One danger is too much nitrogen in the body, called nitrogen narcosis or rapture of the deep. Absorbed nitrogen in the body has an intoxicating effect, so similar to that of alcohol that divers have a rule called Martini's law: every 30 feet of depth is equivalent to one martini. Divers have been known to succumb to rapture of the deep and swim happily away, never to be seen again. This problem is overcome by removing most or all of the nitrogen in the gas mixture. Compressed air, 80% nitrogen, is used in shallow depths, up to 150 feet. At greater depths, helium usually replaces the nitrogen. The nitrogen narcosis problem is thus eliminated, but care must be taken in the ratio of oxygen to helium, for oxygen under pressure is dangerous because it becomes toxic when the amount absorbed by the body is significantly more than that absorbed at normal atmospheric pressure.

Oxygen toxicity is explained by the compressibility of gases, Boyle's law, which states that the volume of a gas decreases in proportion to the pressure if the temperature remains constant. This means that as a diver goes deeper, his breathing mixture becomes more dense. For instance, if a diver is at a depth of 200 feet, he will breathe the same mass of air as he would at the surface, but the density of this gas would be seven times as great (the pressure at 200 feet is equal to seven atmospheres), meaning that he would be breathing seven times as much oxygen as at the surface, an amount that can be toxic. To eliminate this problem, the proportion of the breathing mixture that is oxygen is varied with the depth.

Another major problem that divers encounter is cold stress. The hands and feet are the first areas that are subjected to the effects of cold, with a resulting loss of finger dexterity, sense of touch, and muscle strength that greatly reduces the safety of the diver. As continued cooling occurs, mental agility is impaired, along with memory and the ability to express oneself. With normal wet suit protection, a diver would be unable to stay active underwater for more than an hour with the water temperature at 32°F. or much more than four hours with the water at 50°F. This severely limits the working time of a diver, and a method had to be found to extend working time to a practical length without endangering the diver with extended contact with the cold. The answer is the diurene wet suit (picture #1) which circulates heated water over the diver's body by means of tubes within the wet suit. With this suit, divers can be kept warm enough to work for indefinite lengths of time without any appreciable loss of physical or mental ability.

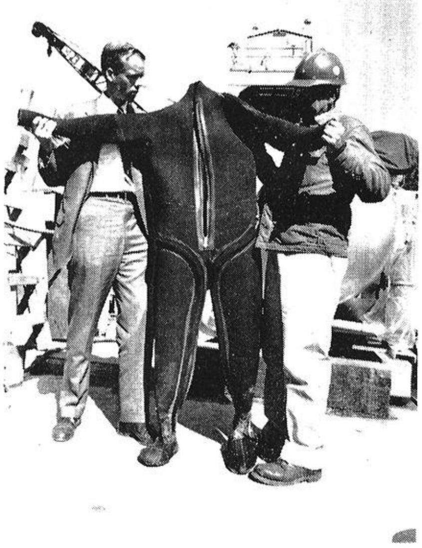

Fig. 1. This special "wet" suit circulates warm water over the diver's body to keep him warm in the cold depths.

photo courtesy of Westinghouse

DECOMPRESSION DILEMMA

One of the most respected dangers of diving is the bends, also known as decompression sickness or caisson disease. This occurs when gases form bubbles in the body. As a diver goes to greater depths, his body absorbs gases. As the diver returns to the surface and the pressure on his body decreases too rapidly, the gases come out of his body tissues and form bubbles. The gas rushes out of the body much as carbon dioxide fizzes from a carbonated beverage when the bottle is uncapped. The bubbles collect at turns or narrow points in blood vessels, such as joints, and restrict blood flow, causing severe pain, convulsions, injury to body tissues and sometimes death.

If the pressure is reduced slowly through decompression, the gas will come out of the body tissues slowly and be dissolved by the blood to be expelled by the lungs. Decompression can be accomplished by either ascending slowly in stages or in a decompression chamber. Experiments and experience have developed rates of decompression that allow decompression to occur safely. These rates, which are in the form of decompression tables, take into account depth, composition of the gas mixture, and time of dive. The longer a diver is submerged at a deeper depth, the longer the time he must spend in decompression. For example, the diver at 200 feet for 20 minutes on a mixture of oxygen and helium must take one hour to decompress.

Decompression poses a problem, however, because for a diver to accomplish significant results, he must remain at the working depth for more than a few minutes. But, because he must spend a great deal of time in decompression, his time on the bottom is severely limited. Prolonged submergence, or keeping divers under pressure extended periods of time, is the present solution to the decompression dilemma.

PROLONGED SUBMERGENCE SYSTEMS

The technique of prolonged submergence was proposed by U.S. Navy Captain George Bond, M.D., and used in the French Conshelf, and in the U.S. Navy Sealab experiments. In Conshelf III, famed underwater explorer Captain Jacques Yves Cousteau and a team of French oceanauts lived for 24 days at a depth of 330 feet. In one Sealab experiment, three teams of U.S. aquanauts, including Astronaut M. Scott Carpenter, spent 15 days each at a depth of 205 feet with two 19-minute dives to a depth of 300 feet. These two systems were bottom mounted, with the total time under pressure being spent in the water.

A more recent and advanced system is the Cachalot system developed by the Underseas Division of Westinghouse Electric Corporation. A closer look at the Cachalot system will reveal many of the techniques used in all systems of prolonged submergence.

CACHALOT CHAMBERS

Cachalot, the French name for the deep-diving sperm whale, consists of two chambers, the deck decompression chamber (DDC) and the submersible decompression chamber (SDC) (picture #2). The DDC has two connected main chambers, each ten feet long with a seven-foot internal diameter. On one end of one chamber is a mating flange for connection with a similar flange on the SDC. At the opposite end of the other chamber is a five foot by five foot, six-inch internal diameter entry lock which permits the entrance of technicians and medical personnel to the DDC while maintaining its pressure.

While they are not engaged in their underwater activities, the divers spend their time in the DDC. They eat, sleep, and carry on their non-diving duties under a pressure close to that which they will be subjected to while in the water. For example, in a recent dive when the SDC went to a depth of 600 feet, the pressure was kept at the equivalent of 350 feet in the DDC, with an air mixture of 3% oxygen and 97% helium. Because of the helium atmosphere, small changes in temperature would be uncomfortable, so the chambers are air conditioned. Food was prepared on the outside and passed in through a service pressure lock.

The SDC (picture #3) is a single chamber eight feet, nine inches high and five feet in internal diameter. Besides its side hatch for connection with the DDC, it has a bottom hatch 27 inches in diameter for entrance and exit underwater. When the SDC reaches its working depth, this hatch is opened, and since the pressure inside the SDC is at the same pressure as the water, water is kept out of the chamber just as it is kept out of an inverted glass placed in water.

THE DIVERS' EQUIPMENT

When divers leave the SDC, they are connected to it by an umbilical cord which supplies their breathing mixture, a communications line, an instrumentation line, and a hose for warm water to their special diving suit. The air mixture is stored in cylinders attached to the outside of the SDC. The breathing apparatus carried by the diver consists of a breathinging vest, two canisters of carbon dioxide absorbant, and a face mask. The breathing vest has two compartments, an inhalation bag and an exhalation bag, both worn on the diver's chest. The inlet of the inhalation bag is connected to a pressure regulator to keep the bag filled which is in turn connected to the manifold of the gas cylinders on the SDC by means of the umbilical. At its outlet, the inhalation bag is connected to the face mask. The exhalation bag is connected to the breathing mask at its inlet. At its outlet it is connected to the canisters of carbon dioxide absorbant on the diver's back. As the breathing mixture passes through the canisters, the carbon dioxide is removed. The mixture is then returned to the inhalation bag for reuse.

The flexible breathing vest is used to insure that the breathing mixture is at the same pressure that the diver's body is subjected to. This insures that there is no pressure difference and therefore no injury to the diver's respiratory system. As an additional safeguard, about ten percent of the breathing mixture is exhausted into the water on its way to the canisters. This insures that the pressure in the exhalation bag is also at a safe level. This type of system, where part of the mixture is exhausted, is called a semi-closed, or "hookah," breathing apparatus. This system is used for economic reasons because helium is very expensive. A closed system that releases no gas into the water has recently been developed.

Communications are somewhat difficult because of the helium atmosphere. Since the atmosphere is much less dense than air, the vocal cords produce a speech known as helium speech, which sounds like that of Donald Duck and is very rapid. Recently, a helium speech unscrambler was developed which makes communications much easier.

The instrumentation line is primarily to insure that the diver is receiving the proper air mixture. It is connected to a regulating device known as the Krasberg oxygen partial pressure control, an oxygen sensing and controlling device. If the diver was receiving the wrong amount of oxygen, the unit would signal the surface crew which would in turn signal the diver to return to the diving chamber. This unit also automatically controls the oxygen in the DDC by making corrections itself on the air mixture.

The hot water line is used to heat the special diurene wet suit. By means of tubes built into the suit, hot water is circulated over the diver's whole body. Without this source of heat, the diver's effective working time would be drastically reduced, as explained earlier.

CACHALOT ADVANTAGES

The greatest advantage of this Cachalot system is that it removes the necessity of repeated, time-consuming decompression. Because the divers remain under a pressure equivalent to that of the working depth, they must decompress only at the end of their working cycle of many six-hour shifts. The usual cycle lasts about two weeks, followed by a single decompression period; for example, a two-and-a-half-day period followed the 600-foot experimental dive in June, 1967. This greatly increases the effective working time of divers and shortens the time spent on one job. By a Westinghouse estimate, the Cachalot system is about 80% efficient in terms of utilizing a diver's working and decompression time. By this standard, at depths that the Caachalot system is used, conventional decompression diving is only about five per cent efficient.

In addition to solving this decompression dilemma, the Cachalot sys-
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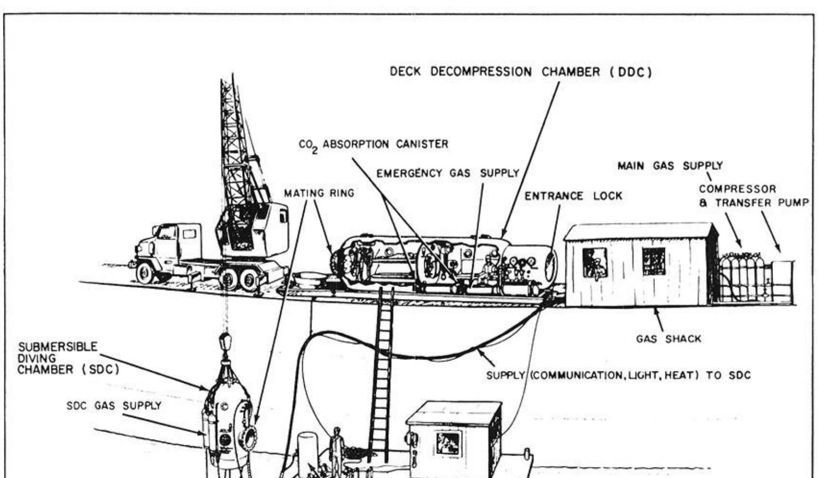
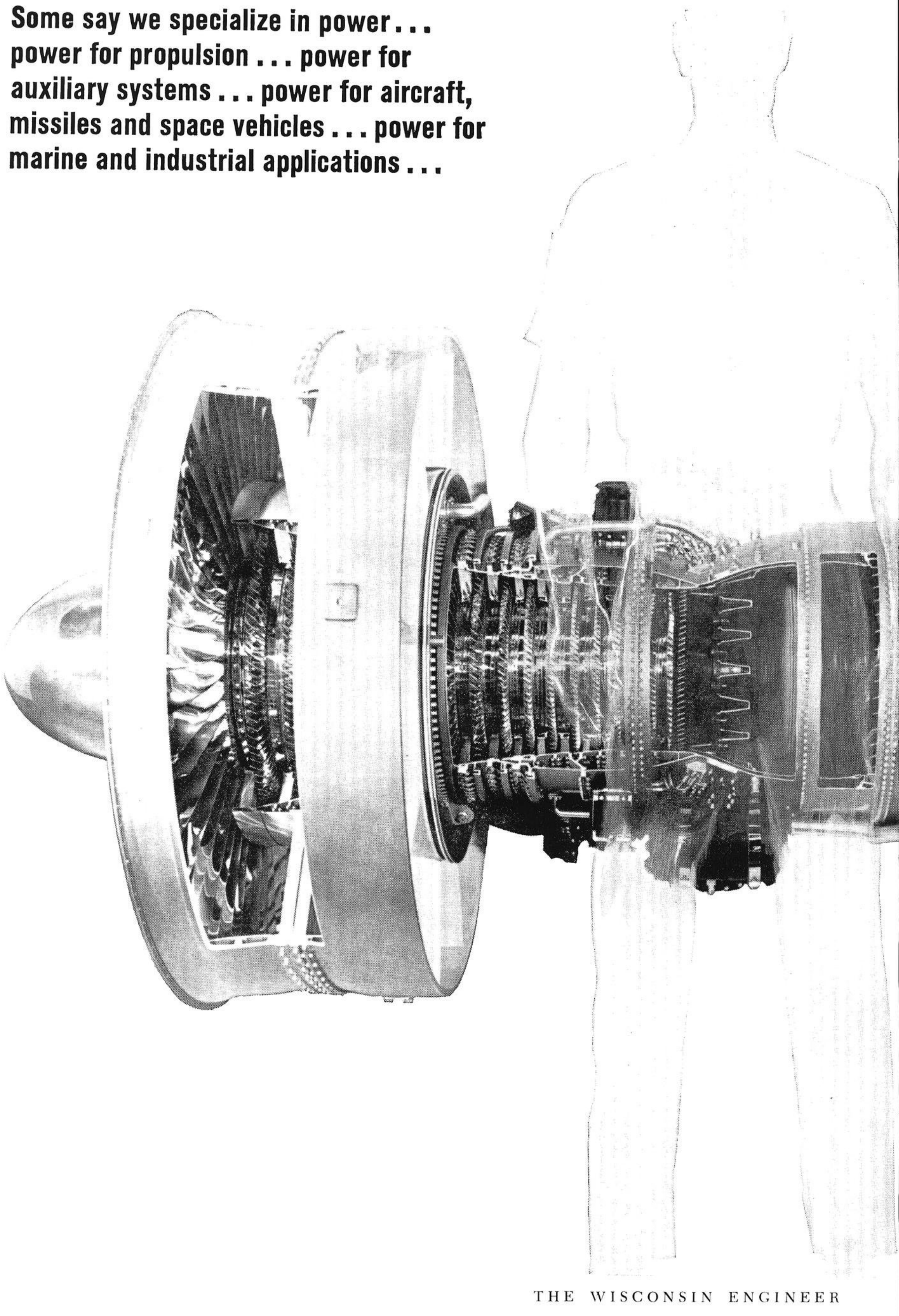
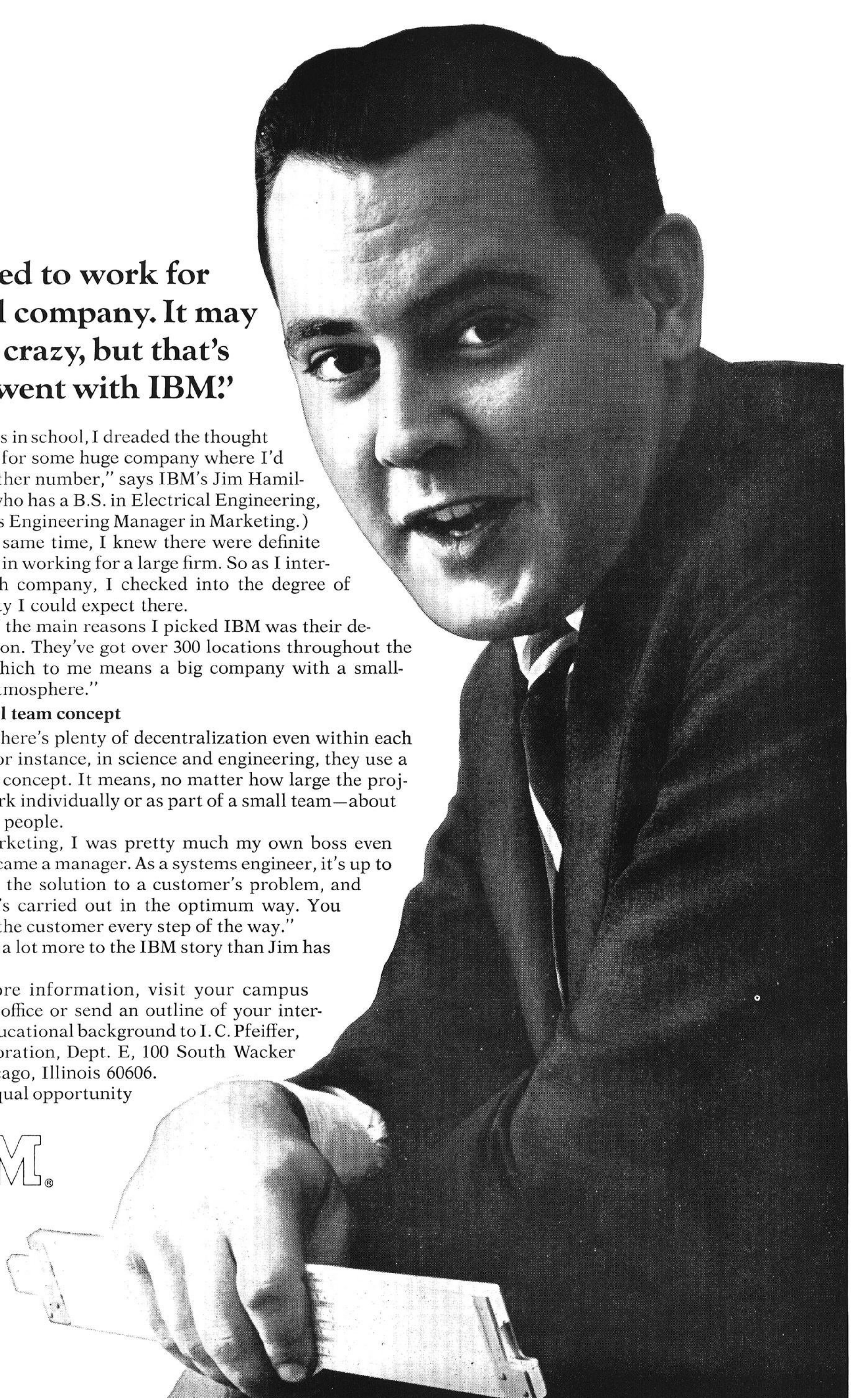


Fig. 2. The Cachalot prolonged submergence system.
courtesy Westinghouse Electric

Some say we specialize in power . . . power for propulsion . . . power for auxiliary systems . . . power for aircraft, missiles and space vehicles . . . power for marine and industrial applications . . .





CAMPUS

ST. PAT WAS AN ENGINEER!

ST. PAT'S DAY, 1925

● For the first time within the memory of most of the students now in the College, weather conditions for the annual St. Pat's Parade were perfect; Saturday, March 28, had in abundance all the qualities that long-haired, short-haired and entirely bald poets rave about. Welcoming the marked change from the rain, snow and sleet that greeted the last three parades, all true followers of old St. Pat pinned "a bit o' the green" to their flannel shirts and looked forward to a most enjoyable day.

Shortly after twelve o'clock, the parking areas behind the Engineering building, Science Hall and the Chemical Engineering building became scenes of great activity; a commotion reigned, in comparison with which the much advertised turmoil of Hollywood's motion-picture studios was as calm and peaceful as the reading room in a school for armless deaf-mutes. Floats began to take form; individuals and groups who were entering "stunts" assembled. For the small boys of Madison, who were out in force, it was a veritable circus day. The band arrived, thirty-five strong, with Steve Polaski, captain-elect of next season's football team, twirling a mean baton. Direct from a concert tour embracing New York, Boston, Philadelphia, Washington and Chicago, and acclaimed by John Phillip Sousa as "the best band I have ever heard," the musicians were at the peak of their powers. Many were attired in feminine apparel of a grotesque and bizarre nature, and large signs announced to an appreciative world: *All our men are women — not one a lady — and we blow about it too!*

Subpoenaed in a Dublin lawsuit, St. Pat was unable to appear in Madison in person this year, but a never-failing consideration for "His B'ys" prompted him to notify the parade committee well in advance of the date set, so that other arrangements could be made. In a radiogram to the chairman of the parade committee, St. Pat, in commenting upon the unfortunate circumstance that detained him in Dublin, said:

"The lawyers have utterly ruined Ireland. One time 'a little bit of Heaven,' it is now, by due process of law, rapidly going to the Devil. Now, when I call a man a scurvy rogue he sues me for libel instead of selecting his stoutest shillalah and coming over for a sociable evening."

A St. Pat Parade without St. Pat would be a more pitiful anomaly than ham without eggs (more of eggs, anon) or liver without the bacon. A contest promoted by the parade committee solved the problem. The student branches of the national engineering societies each selected a candidate to compete in a general election wherein votes were sold at the rate of ten for one cent. The funds raised in this manner went toward defraying the expenses of the parade.

Determined that their candidate should win, the civils hocked their winter overcoats and stuffed the ballot-box with money enough to bury every lawyer in Christendom. When the balloting was finished, Robert Morris, c '26, had piled up 130,000 votes, an overwhelming majority. He led Bruce Reinhart, m 25, by nearly 70,000 votes. Daniel Kelly, third in the race, polled 25,000 votes. The generously proportioned figure of the victorious civil was well adapted to the role of St. Pat. Clad in green and fine linen and armed with a shillalah that once reposed beside the harp in Tara's halls, Morris made an imposing figure. His carriage, in grace of line and luxury of its appointments, rivaled the coaches of the nobles of old France.

Shortly after two o'clock, the parade started down State Street to the stirring strains of the band. Near the middle of the column, a ten-piece orchestra played popular music for the crowds that lined the street. A replica of the famous Toonerville Trolley, entered by Triangle, attracted great attention; it was awarded first place among the fraternity floats. Second prize went to the Signal Club, Pi Tau Pi Sigma, for its unique float suggesting the recent aviation bombing tests that aroused so much controversy between the Navy and the Air Service. "Gold-diggers: 1849 and 1925," a float entered by the miners, took first place in the engineering society group. A.S.M.E. placed second with its float contrasting the Air Service with the Law School — "Hot Air, No Service." Among the unclassified floats, "Blockheads," the Wisconsin Engineer's take-off on the Student Senate placed first. "Richard's Inferno," entered by the A.I.Ch.E, depicted graphically the inevitable tortures of the law students.

V. W. Palen and D. E. Gotham put eccentric wheels on a flivver, mounted a barrel over the rear end, placed a saddle on the barrel and entered the contraption as the "Black - and - Blue - Hawk Riding Academy."

"St. Pat's Descendant" in a baby carriage fitted with all modern improvements, including pressure and temperature control on the milk supply, got many a laugh.

"The Lawyer's Handicap," a giant whisky flask, was another outstanding float.

About halfway down State Street the foul (the word is used advisedly) machinations of the "shysters" were disclosed. Smarting from the ridicule heaped upon them in past parades, a desperate though abortive attempt was made to break up the procession. Eggs, some 4,000 of them, that had been tried in the incubator and found wanting, were purchased by the ambulance-chasers and secretly conveyed to the roofs of several buildings on State Street. At the strategic moment, eggs rained upon the unsuspecting plumbers.

Taken by surprise, the engineers nevertheless handled the situation well. The parade was stopped while the roofs were cleared of the enemy's artillery. Although the clothing of the paraders within range of the flying henfruit was liberally spattered with eggs of most potent aroma, no serious damage was done to the floats. The lawyers made a desperate attempt to hurl all their ammunition before being chased by the engineer police, who were thirsting for gore; eggs were tossed from the roofs by the hundred to prevent their capture. Nevertheless, large stores of the ellipsoids came into the possession of the sons of St. Pat.

As a practical joke, it went considerably beyond the pale, for the clothing of participants and bystanders was all but ruined. The situation was aggravated by the fact that most of the eggs contained dead chicks. Many co-eds in new spring attire were struck by the missiles, for the aim of the shysters was no better than their judgment.

Two law students were captured and dragged through the mess on the street. That it was a mess is best indicated by the fact that it was found necessary to have the fire department flush the street. Even after this was done, that section of State Street had a most unsavory atmosphere for hours.

After the melee, the parade moved on again, around the square and back to the university by way of Langdon Street. The P.A.D. house, home of one of the law fraternities, is on Langdon Street, and the engineers had reason to believe that the P.A.D.'s were the ring-leaders in the afternoon's battle. Their mood for vengeance, as ripe as the lawyers' eggs, St. Pat's brigade tarried awhile before the P.A.D. house, to the great concern of its inhabitants, whose guilty consciences and fear of the results of their folly moved them to seek protection of the police.

Who was the first to use the lawyers' own weapon against them, we do not know, but the spatter of that first thrown egg on the more or less imposing facade of the P.A.D. house was the signal for a barrage of garbage that made the previous skirmish a tame and colorless affair. With the supply of refuse exhausted, the air cleared (though the aroma lingered) and the target stood out as the most artistic job of exterior decorating seen in Madison for years. A sally from the lawyers' castle was a failure; several P.A.D. paddles were taken from their owners and now hang in engineers' rooms as trophies of the battle.

Justice done, vengeance accomplished, the parade completed its course and disbanded.

An eventful day — eggs-actly so!

A HISTORY LESSON

Recent surveys have shown the existence of a deplorable state of affairs wherein many yearlings do not even know who Saint Pat was. (One even suggested that it was a brand of face powder.) In correction let us state, once and for all, that Saint Patrick was an Engineer. He was; he was; HE WAS. Patron Saint of engineers from Vancouver to Calcutta, he returns each year, like Santa Claus (remember?) to reward all virtuous Plumbers and, incidentally, to bat the ears off the few rash shysters who dare crawl out from behind the woodwork on that glorious day.

He was a great pioneer in his chosen field. His feat of driving the snakes out of Ireland was a fine bit of sanitary engineering. As a surveyor he had no peer. He did all the transit work on the road to Hell and was the first man to sight the Pearly Gates through a Dumpy level. He was so fast on the slide rule that his slider had to have a built-in water jacket and cooling system. For some years he had his shillelaghs custom built by Paul Bunyan. Perhaps the only blot on his record was his invention of calculus, but let's not talk about that. At last writing he was installing a burglar alarm on St. Peter's Golden Gates (somebody let a couple of lawyers into Heaven by mistake) and after his Madison visit will be off to Purgatory where he has contracted to teach a gang of ex-shysters how to make out steam engine indicator cards.

found here. The main ballast tank is flooded or blown by compressed air to make the sub sink or float. There are fore and aft trim tanks possibly using mercury for ballast. Most submersibles have a certain amount of syntactic foam so they are at all times slightly buoyant and will surface slowly if propulsion does not keep them down.

Propulsion

Once beneath the surface, the submersible requires a means of propulsion to travel. Except for the Navy's research submarine, NR-1, which will use nuclear power, the electric motor provides propulsion. The motors may be AC or DC and operated on voltages from 24V to 120V, with powers ranging from ½ hp to six hp. One or two motors are mounted on the back or sides and by rotating the mounts and varying the speeds, the submersible is maneuvered. Submersibles' speeds range from one knot to six knots underwater. The electric motors get their energy from storage batteries, normally lead acid type. A fuel cell has been used successfully on "Star I" to supply electric power. The motors and batteries are "pressure-proofed" by filling their casings with low viscosity oil or enclosing them in glass or reinforced plastic cases.

Electronic Equipment

Communications and navigation are becoming more important as the uses of the submersibles expand. Among the equipment normally carried is the sonic underwater telephone with a range of several miles. Fathometers pointed toward the surface and bottom give the relative position of the submarine in depth. External mechanical and electronic pressure sensitive depth indicators back up the fathometer as life and death may hang on accurate knowledge of the depth. Recently, a high resolution, side-looking sonar has been developed. It has proven itself invaluable in locating objects and preventing collisions.

Life Support

The most vital function aboard a submersible is that of life support. The basic procedure is supplying the crew with sufficient oxygen and absorbing the excess toxic carbon dioxide. Even back in the 1600's Van Drebbel is reported to have used compressed oxygen to rejuvenate the atmosphere aboard his boats. For a long time the accepted method was releasing oxygen from supply tanks manually or by automatic metering which reacted to the partial pressure of the oxygen in the submarine's atmosphere. The oxygen content was kept at about 21 per cent and carbon dioxide at about 1.5 per cent by absorbing it in lithium hydroxide. Recently, a different method of life support has been gaining in popularity, that is the use of superoxides such as KO_2. The KO_2 reacts with moisture in the air, releasing O_2 and KOH. The KOH in turn combines with CO_2 forming K_2CO_3 and $KHCO_3$. Thus carbon dioxide is removed from the air and oxygen put in.

Safety Features

The fact that neither a life nor a submersible of this variety has yet been lost is a tribute to the designers and operators. However, a number of safety features are built in, such as a generous emergency supply of oxygen, hull safety factors, positively buoyant submersible, and releasable marker buoys for submarines somehow trapped below. If the boat should fail to rise after blowing ballast, then a couple more thousand pounds may be dropped in the form of batteries and main ballast weight. Should the manipulator or propeller become entangled, they may also be released. There may be a chance the submersible still will not rise if the pressure hull is partially flooded. In this case, the pilot's only choice is to completely flood the pressure hull, enabling him to open the hatch and attempt a free ascent.

External Apparatus

There are a number of devices placed outside the fairing. One thing may be a mechanical manipulator for grasping and lifting objects. An external television, with the capacity of electronic amplification, may be used to increase visibility. In addition one might find various measuring devices, color movie and still cameras, and thousand-watt lamps to light the black ocean.

A NEW INDUSTRY IS BORN

There is no doubt but that the field of undersea technology is rapidly expanding and advancing. George T. Scharffenberger, senior vice president of Litton Industries in California, says, "We are just opening the door. We're about where the space industry was ten years ago. My guess is that this new industry will

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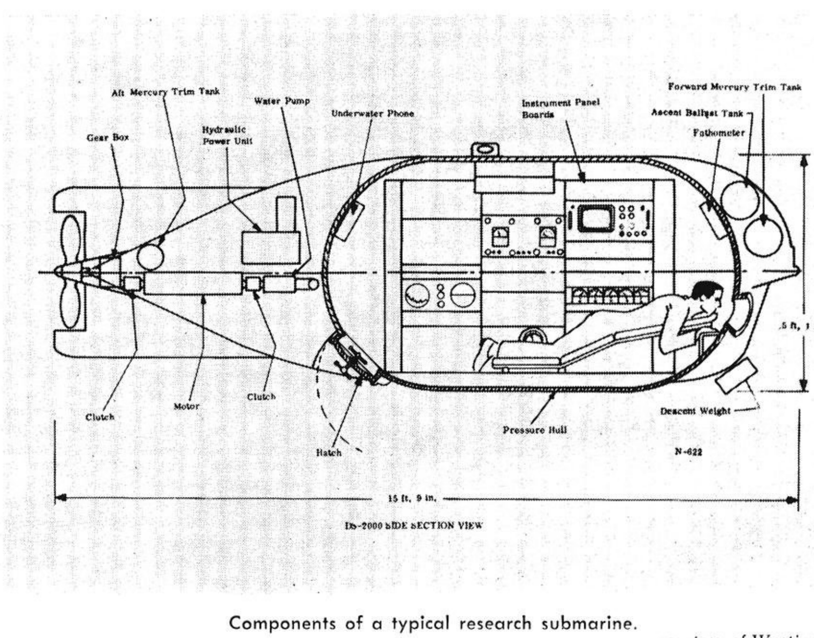
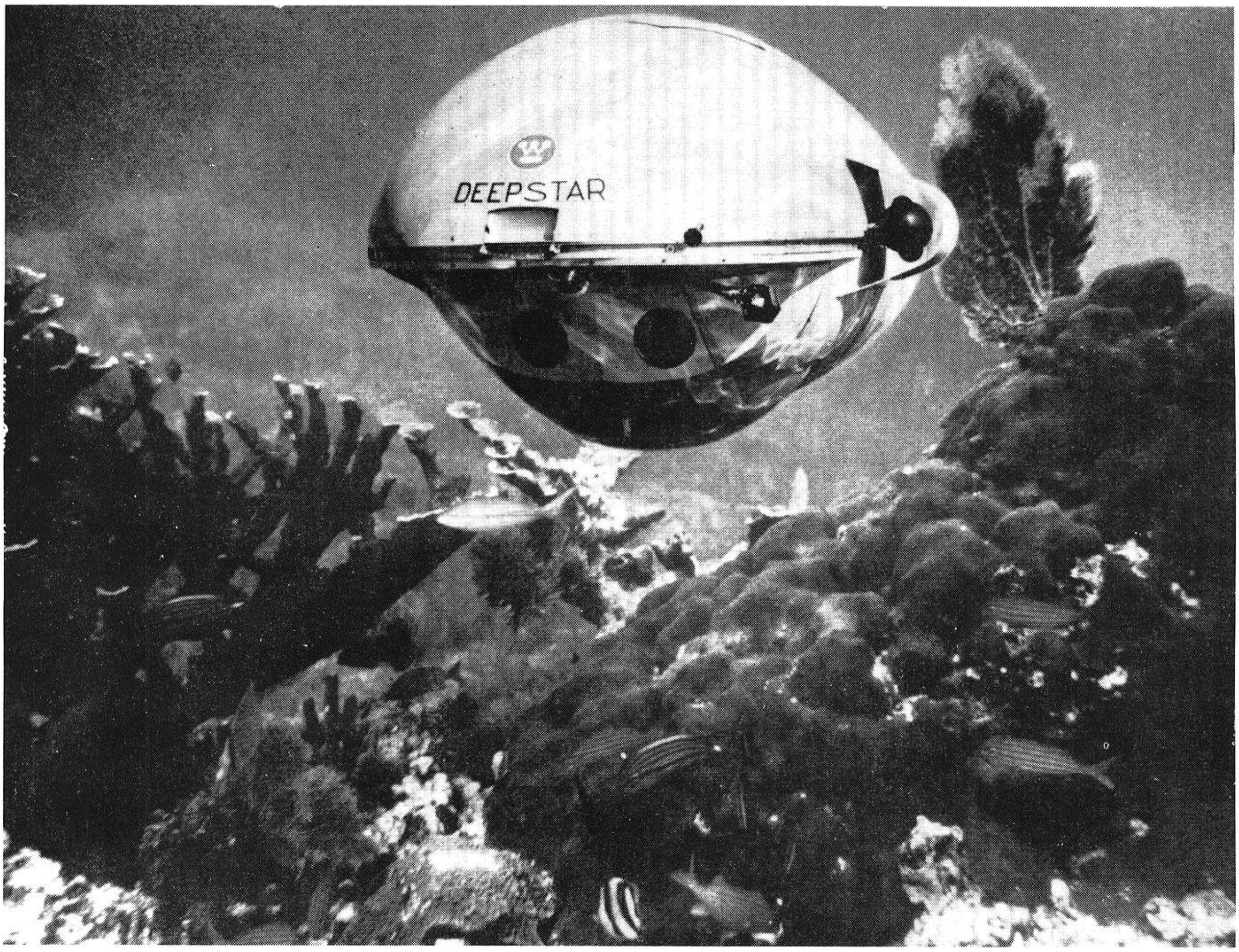


Components of a typical research submarine.

courtesy of Westinghouse



The Westinghouse Deep Star 4000 can be chartered for research projects or structure inspection.

Westinghouse photo

be larger than aerospace." What, then, awaits us in the oceans?

The Ocean's Treasures

There is possibly more oil underwater than on land. Even today, there are scores of oil wells in operation off the coasts of California and Texas. It is estimated that 490 billion pounds of fish could be harvested each year without upsetting the balance of nature. This is five times the world's present yearly catch. Huge supplies of edible seaweed are to be found in the sea. Some is already being harvested off the coast of Japan. Huge amounts of valuable manganese, iron, nickel, cobalt and copper nodules cover the sea bottom. Tin is being taken from the sea off Thailand, magnetite off Japan, and diamonds off Southwest Africa.

Man is already opening some of the doors. His progress with submersibles has grown fantastically over the past five years. It is estimated that by 1970 $5 billion will be pumped into economic activities involving the oceans; 70 per cent of this amount will be put up by private investors. Fortunately, a large fraction of the ocean's treasures lie on the continental shelf at depths to which most submersibles have easy access.

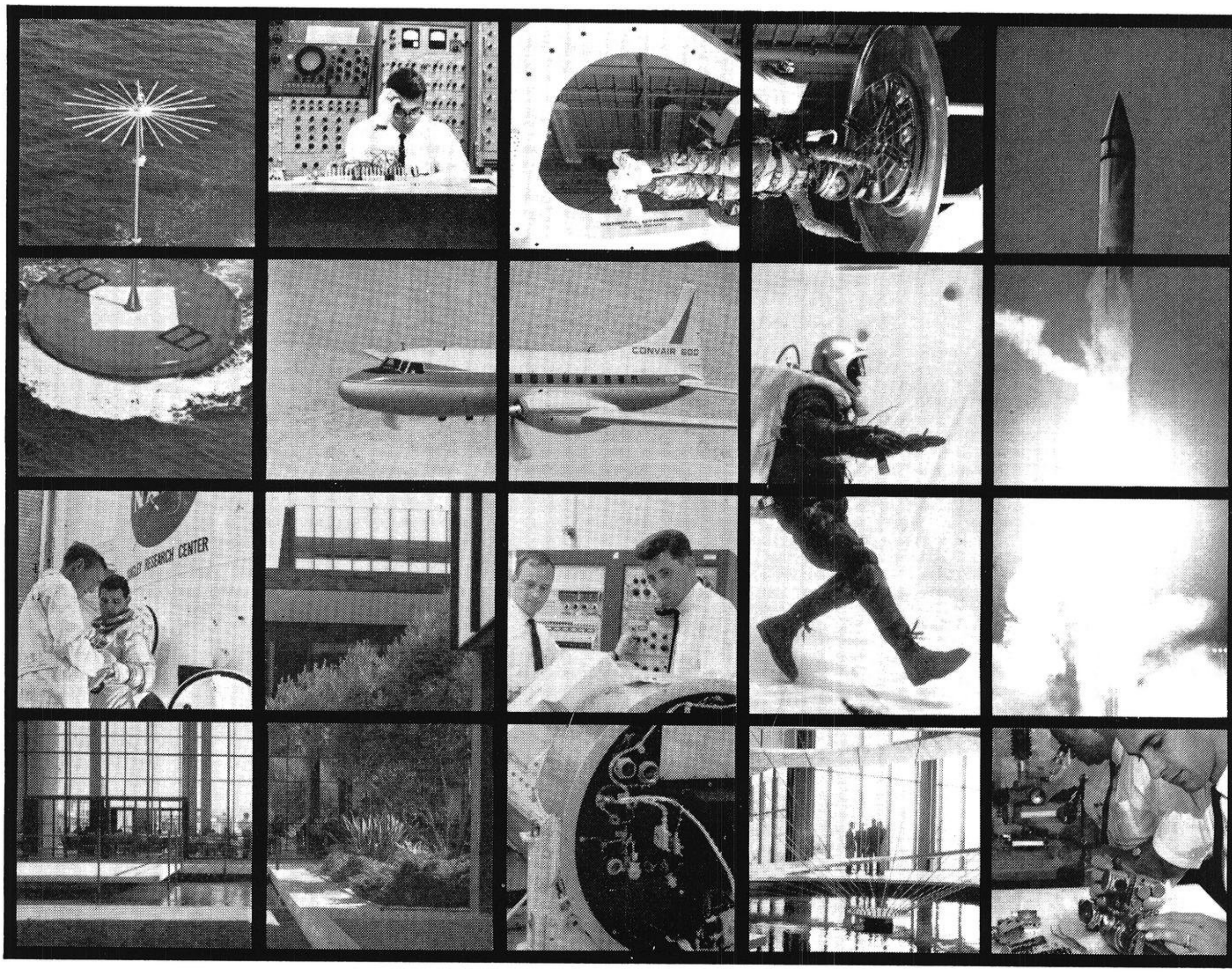
DR/V's Earn Their Keep

Although it is still early in the game, the deep research vehicles have shown themselves to be valuable instruments. The privately-financed boats cost from less than $25,000 for the two-man "Submaray" up to $5 to $10 million for boats such as "Deep Quest" and "Beaver." Small submarines such as "Cubmarine," "Submaray," and "Asherah" lease for $300 to $600 per day. Larger Larger craft, like "Aluminaut," "DS-4,000" and "Deep Quest," lease for $5,000 to $6,000 per day. All of these vessels' work schedules are booked solid.

The "Aluminaut" earned over $80,000 searching for the lost H-bomb off the coast of Spain. "Pisces" is recovering lost torpedoes for the U.S. Navy, which is willing to pay $2,500 for each practice torpedo found, as they originally cost $70,000 apiece. "Submaray" spent a day inspecting sewer pipe at 220 feet for a fee of $500, as compared to a diver doing the job at union scale cost of $3,000. "Star II" was working for an oil company in the waters off Texas, inspecting bases of offshore oil towers. In the future, these craft will be found more and more in the areas of mapping, salvage, farming, fishing, mining, oil and gas procurement, support of manned underwater stations, and pure research of the physical and biological ocean.

Conclusion

Thus, the deep submersible vehicle has been shown to be an effective tool that will eventually open the oceans for the good of all mankind. It is not a matter of time as far as the seas are concerned. They will always be there. But the opportunities do lie with the imaginative and courageous man, and it is he who will tap the ocean for some of her great treasures.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tem has a great many safety advantages. Because the diving chamber is nearby, the diver's safety is greatly enhanced and his peace of mind is increased immeasurably. Because the diver only has to swim to the chamber, he can escape dangers such as sharks easily and save himself in case of equipment malfunction. Without this chamber, as in conventional diving, the diver has no place to go but up, which is little help because it takes about three minutes to ascend 200 feet, and, even if a diver could last that long, he would have a case of the bends that would probably be fatal.

Another safety factor is the ability to continually and precisely control the gas mixture by means of the Krasberg unit. Another factor is the ability to provide quick medical aid to an injured diver because of the DDC. Outside technicians and medical men can easily enter the chamber or observe activities within the chambers. Other systems, such as the bottom mounted Conshelf, are isolated from medical aid.

One of the greatest advantages is the tremendous reduction in the number of times a diver must go through decompression and the precise control that can be maintained over the decompression cycle. Since none of the decompression cycle is spent in the water, the surface crew can efficiently monitor and control all stages of the cycle.

The safety advantages are illustrated by the statistic that in over 5,000 hours of working time there has been no disabling accident, a remarkable feat in one of the world's most dangerous occupations.

PRACTICAL USES OF CACHALOT

The Cachalot system is not just an experimental system developed to see how deep man can go. It has been successfully used on several commercial projects, with great savings in time and money. In 1965 the system was used to clean and repair trashracks on the face of Smith Mountain Dam near Roanoke, Virginia, at a depth of 200 feet. In 1966 the system was used in a salvage project in the Gulf of Mexico. Divers capped wells and cut apart two offshore oil platforms so they could be salvaged. The platforms had been destroyed by hurricane Betsy in September, 1965. After this job, the system was used to cut pilings to a uniform height for a bridge across Narragansett Bay between Jamestown and Newport, Rhode Island.

THE FUTURE

With this type of system, much deeper dives are possible than the currently reached depth of 600 feet achieved in June, 1967. Alan R. Krasberg, life support advisory engineer for Westinghouse Corporation, points out that "our 600-foot demonstration dive is one of a series of logical steps leading to prolonged submergence dives to one thousand feet by 1969, and eventually to 1,500 feet, possibly within the next five years. The technology is available now and we need only to refine our techniques and our equipment to go to greater depths."

With the capabilities to this depth, however, a vast new frontier of minerals, food, and other natural resources will be opened up, a frontier that could go far to eliminate man's worries about running out of supplies for the earth's ever-increasing population.

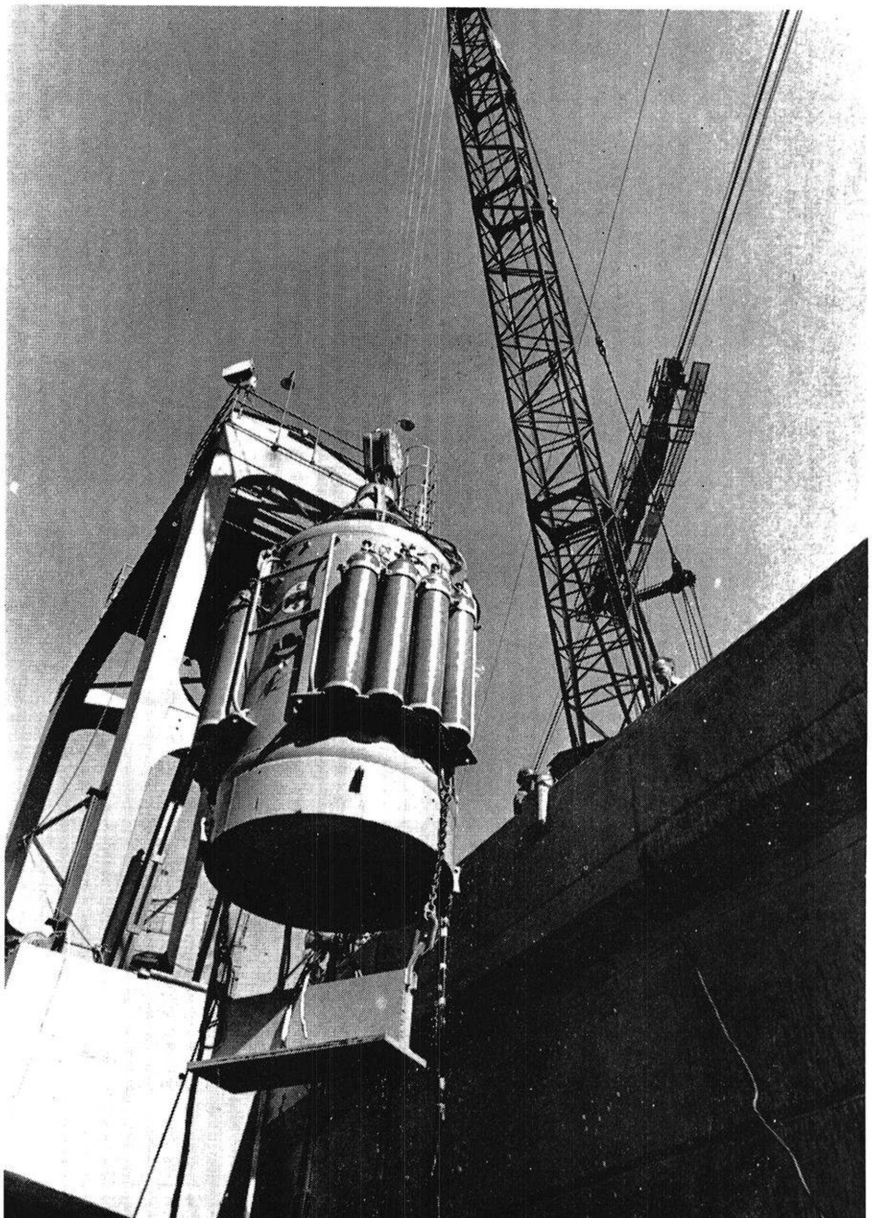


Fig. 3. The Submersible Decompression Chamber.

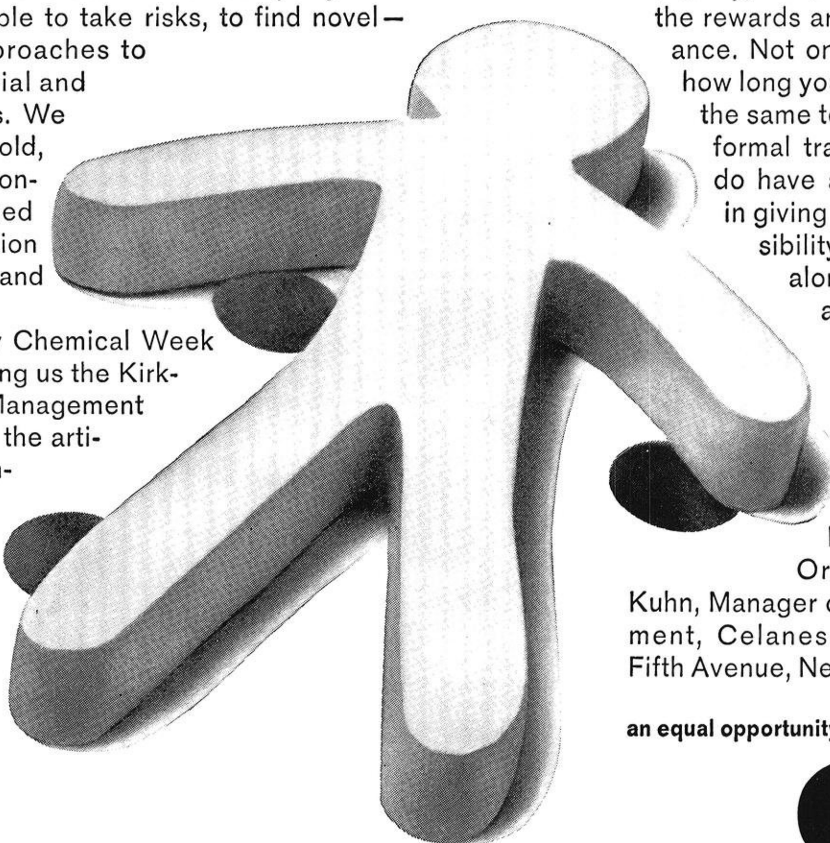
"It's possible that Celanese won't appeal to you."

"Unless You're Ambitious, Flexible, Creative, Imaginative, etc."

If you rebel at the idea of being dropped into a professional slot, you're our kind of person.

We need competent, imaginative, flexible individuals. Because we're that kind of company. We encourage our people to take risks, to find novel—even off-beat—approaches to technical, managerial and marketing problems. We believe that only a bold, creative staff can contribute to the continued growth of a corporation that is already bold and creative.

Maybe that's why Chemical Week magazine, in awarding us the Kirkpatrick Award for Management Achievement, titled the article "Portrait of a Winner." And wrote "Keys to Celanese Corporation's victory: an alert, aggressive management team, explicit planning and well-defined roles."



If you have a professional degree in chemistry, chemical, mechanical or industrial engineering, physics or marketing, Celanese has a lot to offer you.

Frankly, we also expect a lot. But the rewards are based on performance. Not on how old you are or how long you've been with us. By the same token, we do not have formal training programs. We do have a very deep interest in giving you as much responsibility, and in pushing you along just as fast and far as you can go.

If this sounds good to you, discuss us with your faculty and placement officer. And see our representative when he is on your campus.

Or write to: John B. Kuhn, Manager of University Recruitment, Celanese Corporation, 522 Fifth Avenue, New York, N.Y. 10036.

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CELANESE

We've got the little pond you're looking for...

If you are looking for the opportunity that can only be offered by a large corporation . . . one that will offer you an interesting position now and not three to five years from now . . . investigate what Automatic Electric has to offer!

Automatic Electric is the telephone company that stresses youth and the development of new ideas in electronic systems. Our project groups are small because we want to avoid that "little frog in a big pond" feeling.

We have positions for you in applied research, design, development and manufacturing, if you're a degree candidate in any of the following fields:

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Electrical Engineering
Industrial Engineering
Chemical Engineering
Physics
Mathematics
Computer Science

Find out how you can take a dip in one of our exciting little "ponds" . . . have a talk with the man from Automatic Electric. He'll also tell you about our educational program, with tuition paid when you attend graduate classes at one of the many colleges in our area. Or, you may enroll at one of the courses we hold on our own premises to earn credit toward an advanced degree.

See your placement director to arrange a personal interview, or write to James G. Cobban, Manager, Professional Employment, Automatic Electric Company, Northlake, Illinois 60164.

AUTOMATIC ELECTRIC
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Are you looking for something better from university life?

We are something better!

Recently, THE WISCONSIN ENGINEER was judged, by professional writers, editors and artists, as the "Third Best All-Around Magazine" in the fifty-five magazine membership of the Engineering College Magazines Associated (ECMA). For our special "Look at Engineering at Wisconsin, Past, Present and Future" issue last January, we were awarded honorable mention for "Best Single Issue". The striking deep pink cover of our May, 1967, issue was chosen as the "Best Cover for a Single Issue". We also captured the "Best Cover for all Issues" award.

Are you looking for something better?

We are something better. We could teach you about writing, layout, editing, photography and running a $16,000 a year business.

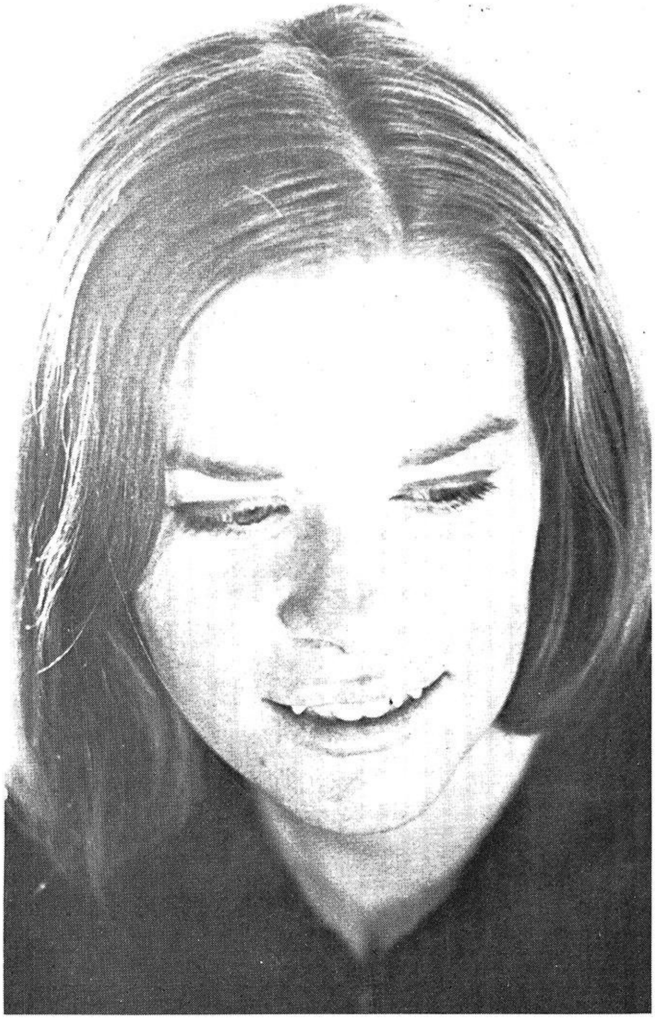
Then again, you might be able to teach us. We are looking for something better, too. Call me, Dick Shell at 233-1265.

PICTORIAL:

wisconsin's finest presents

Lyn Harris

Lyn, a home economics major, has a passion for living, for fun, and for freedom. She plays guitar and sings hundreds of folk songs. She loves to figure skate as much as she loves to dance.



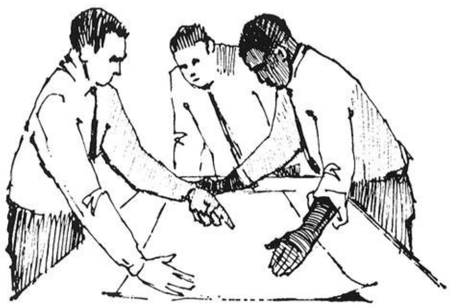
Lyn usually has a pet rabbit or a robin or a cat which she can't keep. Sometimes she takes long walks to seek out beautiful things in nature. We agree that Lyn is one of the beautiful things.

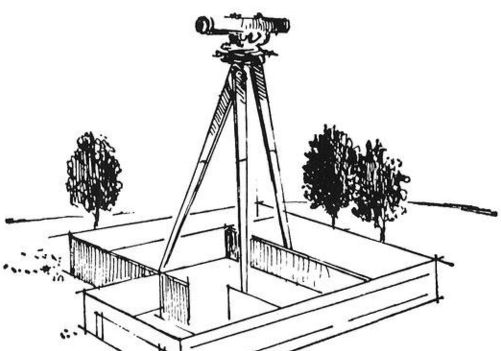
photos by Norm Frater

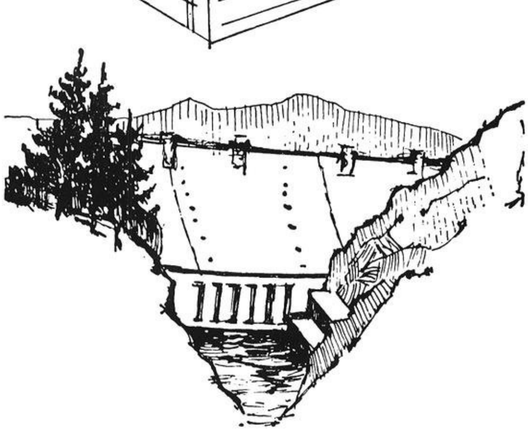
CONSTRUCTION

THE ARMY CORPS OF ENGINEERS

offers you a challenging civilian career with:







■ The world's foremost and largest engineering organization in the construction field, pioneering new and advanced engineering practices and concepts.

■ An organization whose work spans virtually the entire range of modern engineering, including comprehensive planning for development of water and related land resources of entire river basins; design and construction of multi-unit, multi-purpose, integrated systems that encompass navigation, flood control and major drainage, hydroelectric power generation, municipal and industrial water supply, irrigation, water quality control, beach erosion control and hurricane protection, water-oriented recreation, preservation and enhancement of fish, wildlife, and natural beauty values; and planning, design, and construction of complicated, advanced-concept military structures such as the Nike-X anti-missile system, launch facilities and bases for the intercontinental ballistic missiles, airfields, housing, schools, laboratories, and nuclear power facilities. In addition are the allied fields of cartography, geodesy, mathematics and engineer intelligence.

■ An organization that recognizes each engineer as an individual, providing well-rounded career development programs with on-the-job training; courses at government expense in colleges, universities, and seminars as necessary to assure steady progression to top professional and managerial levels; encouragement and assistance in attaining professional registration and recognition; and an opportunity to win national and international awards.

■ An organization with offices and projects in nearly every one of the 50 States and in many foreign countries that encourages employees to further their development by accepting new and challenging assignments.

■ An organization which provides excellent rates of pay with liberal fringe benefits, including generous retirement annuity, complete health and life insurance coverage, paid vacation leave, military training leave with pay, generous sick leave; and special pay awards for outstanding performance and suggestions that improve operating efficiency.

If you're thinking this is all too good to be true, you're wrong! All of the above is available to you in a civilian engineer career with the U. S. Army Corps of Engineers. If you are interested, you can get further information from the Chief of Engineers, Department of the Army, Washington, D. C. 20315.

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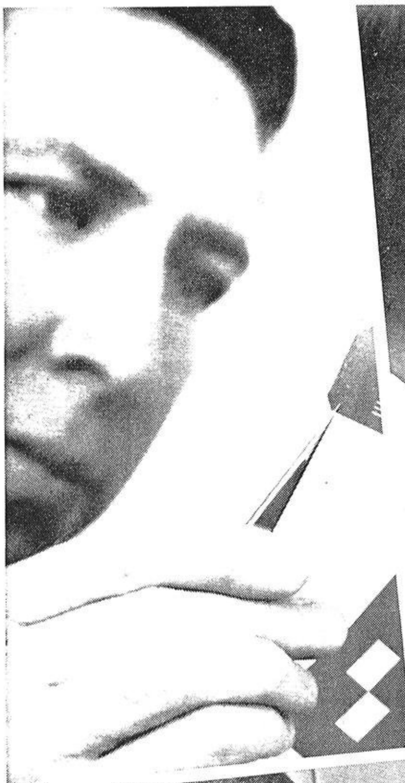
WRITE FOR AN ILLUSTRATED BROCHURE "YOUR CAREER"

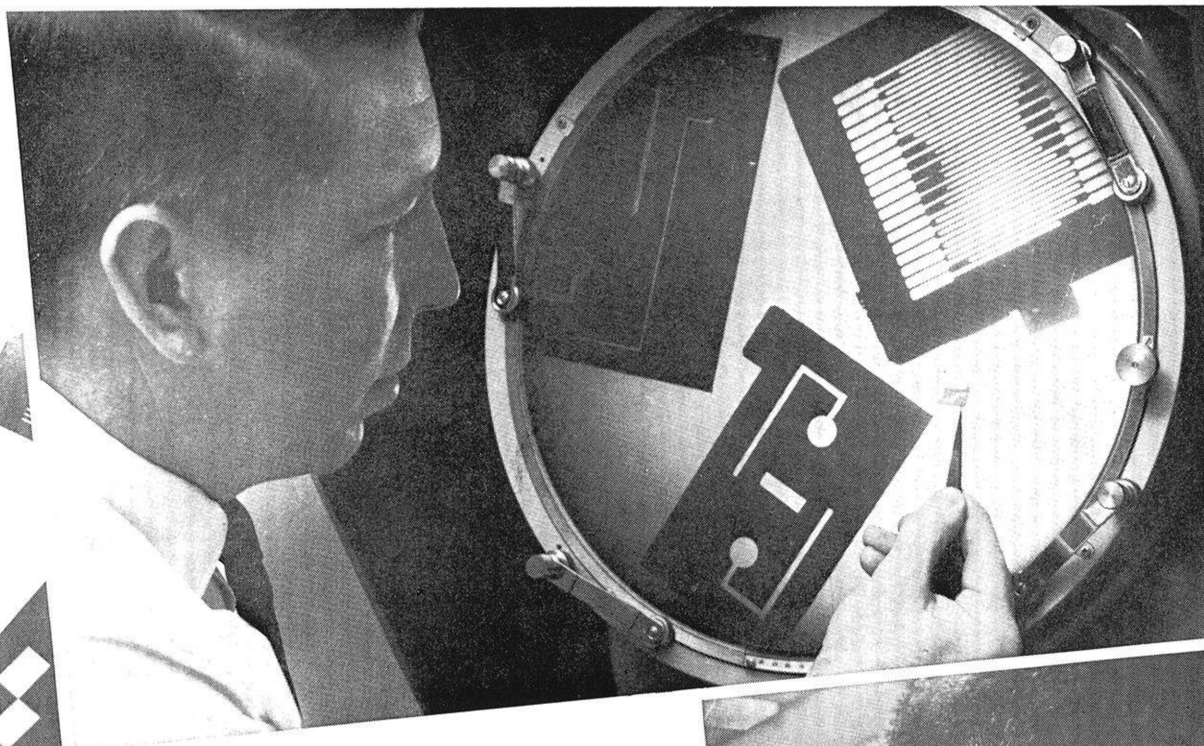
PICTORIAL

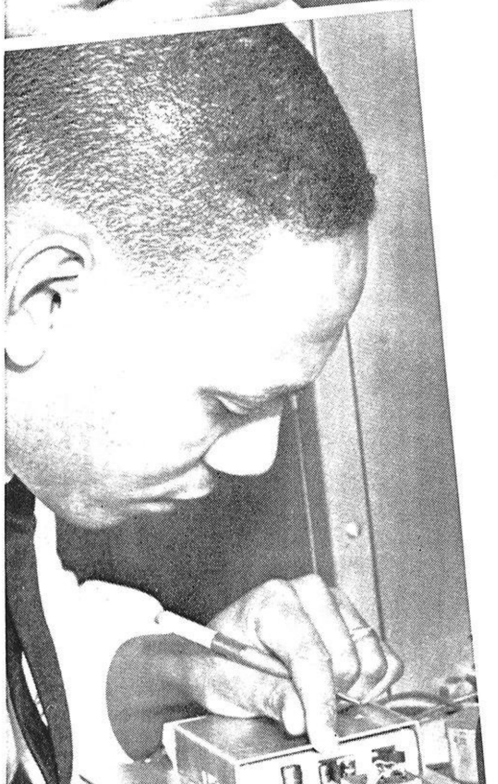
wisconsin's album

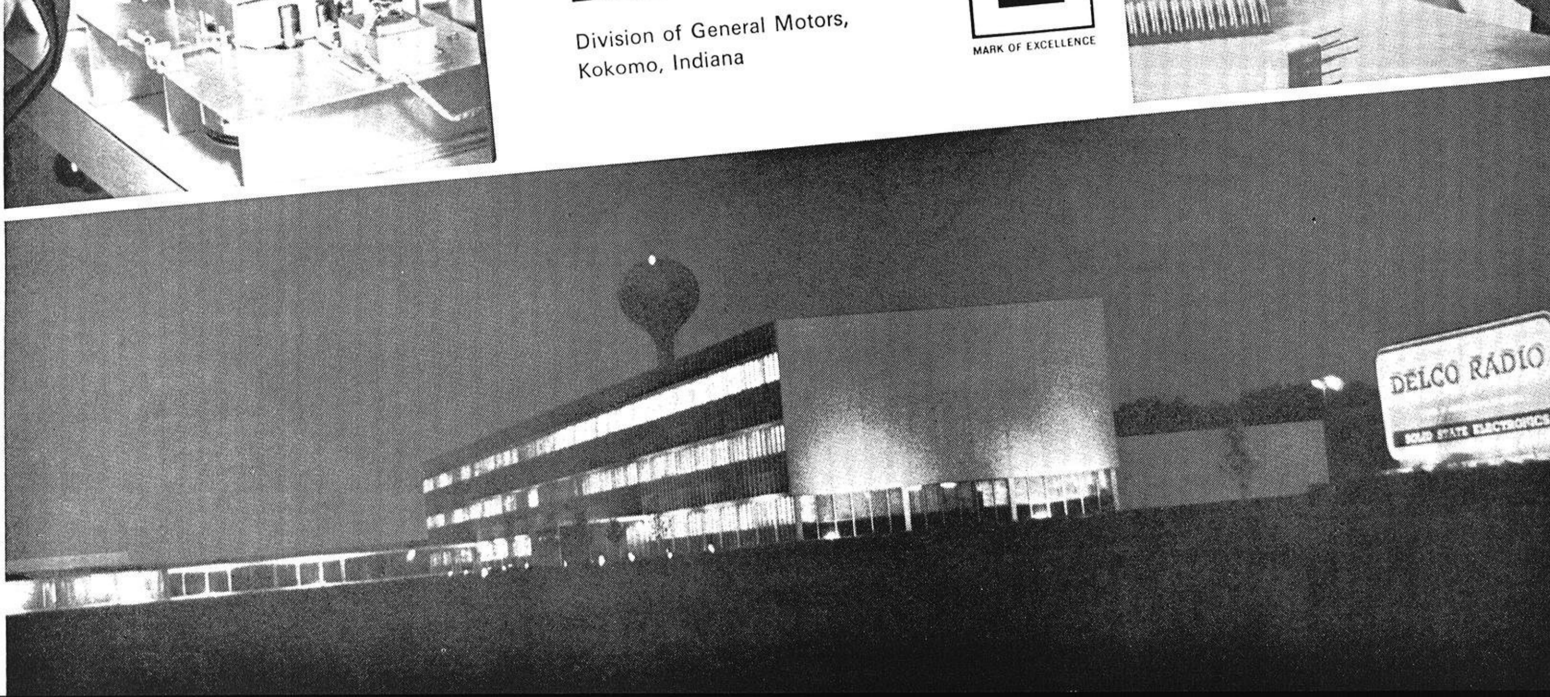
President Harrington's new office will overlook beautiful Lake Mendota.

courtesy State Historical Society of Wisconsin









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SOLID STATE ELECTRONICS

if not us... WHO if not now... WHEN?

* Speculation concerning the future is a luxury no one can afford. Therefore, it is fortunate that you have the opportunity of talking to many companies before you make a final decision.

All will offer good salaries, fringe benefits, training, personal growth opportunities and many other things.

At Whirlpool, we offer the same material things. So, what makes us different from all the rest?

Mainly, it's because ours is one of the few companies in which you have the opportunity to contribute to your own environment . . . and that includes everything from integrated appliance systems to food, water and waste management systems for NASA.

* You could say that Whirlpool is the "better living" oriented company . . . where young professionals like you are seen, heard and above all . . . listened to.

Since we *are* so very different, we ask you:

if not us .... WHO?
if not now . . . WHEN?

WE NEED YOU TO HELP US TAKE THE NEXT STEP.

Whirlpool *An equal opportunity employer*

HUMOR

FILEABLES

A Fairy Tale

Once upon a time a beautiful girl was walking through the woods when she came upon a poor little frog who spoke as follows:

"Lady, once upon a time I was a handsome prince, but a big black witch turned me into a frog."

"Oh, that's too bad," said the beautiful girl, "is there anything I can do to help you?"

"Yes indeed," replied the frog. "If you will take me home with you and put me on your pillow I will be saved."

So the beautiful girl took the poor little frog home with her, and the next morning when she awoke there beside her was a handsome prince. And, do you know, to this day her mother still doesn't believe this story.

* * *

M.E.: "Do you know who was the first engineer?"

E.E.: "No, who?"

M.E.: "Adam, he furnished spare parts for the first loud speaker."

* * *

Visiting a critically ill lawyer in the hospital, a friend found him propped up in bed, frantically leafing through a Bible.

"What are you doing?" the friend asked. Replied the lawyer, "Looking for loopholes!"

* * *

Engineers are continually surprised to find that girls with the most streamlined shapes offer the most resistance.

* * *

Lawyer: My ancestors came over in the Mayflower.

M.E.: It's lucky they did; the immigration laws are a little stricter now.

Looking coldly at the C.E. who had just given him a nickel for carrying his bag twelve blocks, the little boy said, "You know, mister, I know something about you."

"What?" asked the C.E.

"You're a bachelor."

"That's right. Do you know anything else about me?"

"So was your father."

* * *

The wife was always antagonized by her husband's going out at night. His departing words, which especially angered her, were always, "Good night, mother of three."

But one night, she could stand it no longer, and when he took his hat, started out the door, and called cheerily, "Good night, mother of three," she answered quite as cheerily, "Good night father of one."

Now he stays home.

* * *

An E.E. castaway on a desert island pulled ashore a girl clinging to a barrel.

"How long have you been here?" asked the girl.

"Thirteen years," replied the E.E.

"Then you're going to get something you haven't had for thirteen years," said the girl.

"You don't mean to tell me there's beer in that barrel."

* * *

Then there was the man who appeared in court to complain that he had awakened in the middle of the night to find his wife pouring gasoline over him.

"And what," the Judge asked, "did you think your wife was planning to do to you?"

"Well, your honor, I'm afraid she was planning to make a fuel of me."

A whale and a sardine frequented a certain bar together, once nightly for over three years. One night the sardine came in alone. Now, the bartender was an understanding man, so, after a respectable pause, he ventured to ask the fish, "Where's the whale," thinking, of course, that they were close friends after three years of drinking together. But, to his surprise, the sardine indignantly replied, "What am I, my blubber's kipper?"

* * *

A sweet young thing breezed into a florist shop, dashed up to an elderly chap puttering around a plant and inquired, "Have you any passion poppy?"

The old boy looked up in surprise. "Gol ding it!" he exclaimed. "You just wait until I get through prunin' this rose!"

* * *

Mrs. Catz would forage every day for food for her three kittens, Phht, Phht Phht, and Phht Phht Phht.

One day, the meal disagreed with her young, who soon became extremely ill. Ptomaine, no doubt, she thought as she called the doctor. Following his advice, she gave them each an aspirin and sent them off to bed. But, alas, poor Phht was too weak, and was overcome by the disease. Sadly she buried her youngest kitten. Distressed by the thought that her other offspring might die, and not feeling well herself, she called the doctor's office again. The secretary took the call, and said that the doctor was out for the day. Almost hysterical now, Mrs. Catz asked for his home phone. "It's a matter of life or death — you see, I already have one Phht in the grave."


CAREERS WITH
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