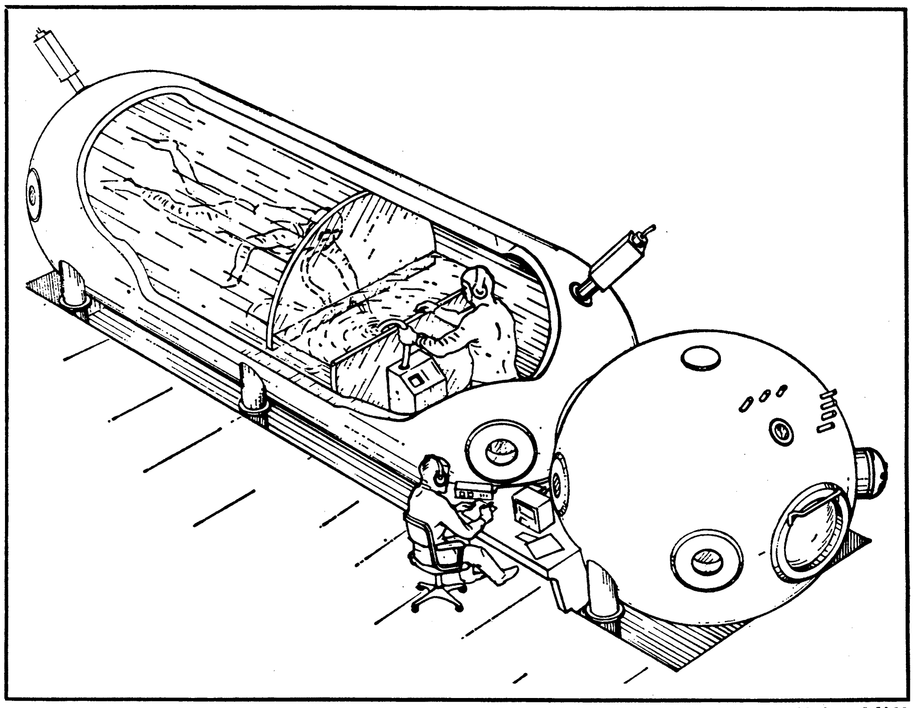
OCEANOGRAPHY

Aping the ocean's deeps

A chamber able to simulate mile-deep pressures will aid man's downward quest

by Jonathan Eberhart



State Univ. of N.Y.

Mercury barometer principle keeps truck-sized chamber wet and dry.

While projects such as Tektite and Sealab are still taking the first halting steps at helping man to live and work beneath the sea, researchers are already looking ahead at human performance under extreme pressure, far greater than that encountered in present undersea habitats.

Simulated and actual dives have been made to depths of more than 1,000 feet, where the water pushes in with 30 times the pressure of the atmosphere at sea level.

This month, the State University of New York at Buffalo took a step which could push the quest even farther down, with the possibility of ultimately testing man at pressures found more than a mile below the ocean waves.

The university is having built, for delivery next summer, a huge steel tank that its designers believe will be the highest-pressure hyperbaric chamber ever made for use by man. Equipped with double steel walls and windows up to half a foot thick, the tank will be capable of subjecting its occupants to 170 atmospheres of pressure, equivalent to an ocean depth of 5,600 feet. Such pressure will subject every square inch of a subject's body to a force of some two and a quarter tons.

The chamber certainly has the greatest depth capability of any in the United States big enough for manned use, and probably of any in the world, says Richard A. Morin, one of its four designers. The only facility known to come close is that of Prof. Jacques Chouteau in Marseilles, France, which can produce 150 atmospheres of pressure.

The primary use of the new chamber will be not merely to observe the general effects of increasing pressure, but to see if there are physiological barriers that show no traces at lesser depths.

"Many familiar physiological problems require further investigation at higher pressures," says Dr. Edward H. Lanphier, associate professor of physiology and director of the new facility. "But the most crucial need is for a bold effort to determine what problems will set new limits to man's penetration of the sea."

There have already been indications in deep simulated dives at Duke University that the descent is more than a simple, unchanging process. For example, helium, presently used instead of nitrogen below about 100 feet because of nitrogen's toxicity at increased pressures, may itself turn out to become less suitable at depths below 1,000 feet.

There is considerable evidence, says Dr. Lanphier, that pressure itself is harmful to living human tissues at pressures over 100 atmospheres, regardless of the breathing mixture; animals seem to show undesirable effects at lesser pressures, such as 50 atmospheres for squirrel monkeys.

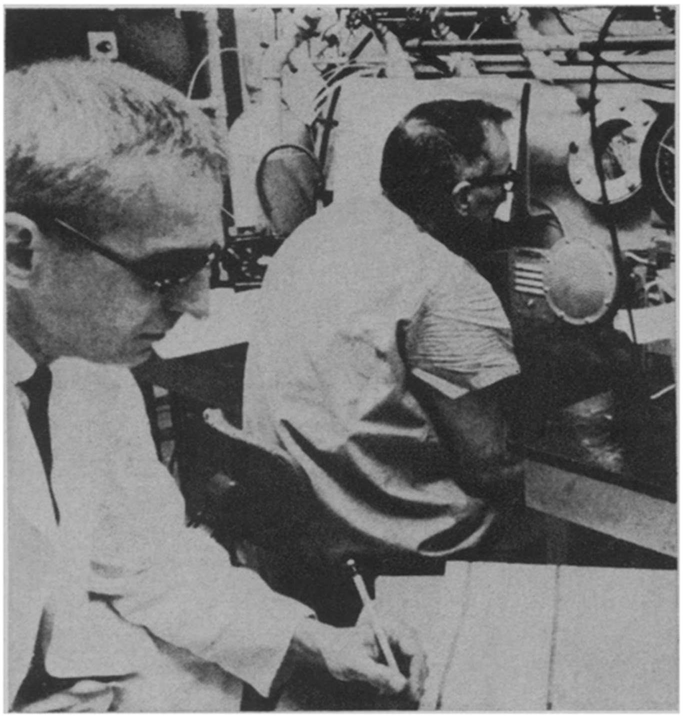
Prof. Chouteau found, in studies with goats in the chamber at Marseilles, that if oxygen in the breathing mixture was reduced to avoid oxygen's own toxic effects at depth, the goats developed symptoms of lack of oxygen. Earlier, Dr. Lanphier had reasoned that this might occur because of the oxygen's difficulty in diffusing through the blood vessels of the lungs as the density of the gases increased. He predicted that beyond about 50 atmospheres the oxygen percentage might have to be cautiously increased; when Prof. Chouteau independently did just that, the goats reached 100 atmospheres with little trouble.

"Perhaps," Dr. Lanphier says, "when a man is working in high-pressure submergence, he will need an increased percentage of oxygen in his breathing mixture—a percentage that would be toxic when he is at rest. This could present serious problems, and we intend to investigate this area thoroughly."

The chamber in which such studies will be made is as big as a truck. It comprises two pressure vessels, a 7-foot-diameter sphere welded to a 7-foot-high, 14-foot-long cylinder. The 60-ton facility has been on the drawing boards for two and a half years, construction is expected to take from 9 to 12 months, and even the checkout process, to make sure it is safe for man, could take another year, Morin says.

The cylindrical chamber is divided into wet and dry compartments, but not by any solid wall. Instead, water is kept in one half of the cylinder by a pair of semicircular clear plastic barriers, placed so that a diver can climb over one and duck under the other to enter the water compartment; the air pressure keeps the water in place. The principle, the same as that of a mercury barometer, dates from the 17th century, although the U.S. Navy, whose Office of Naval Research is paying for the facility, has applied for a patent on the new application. The barriers can also be completely removed to leave the chamber dry throughout.

The chamber will be equipped with a variety of remotely controlled observa-



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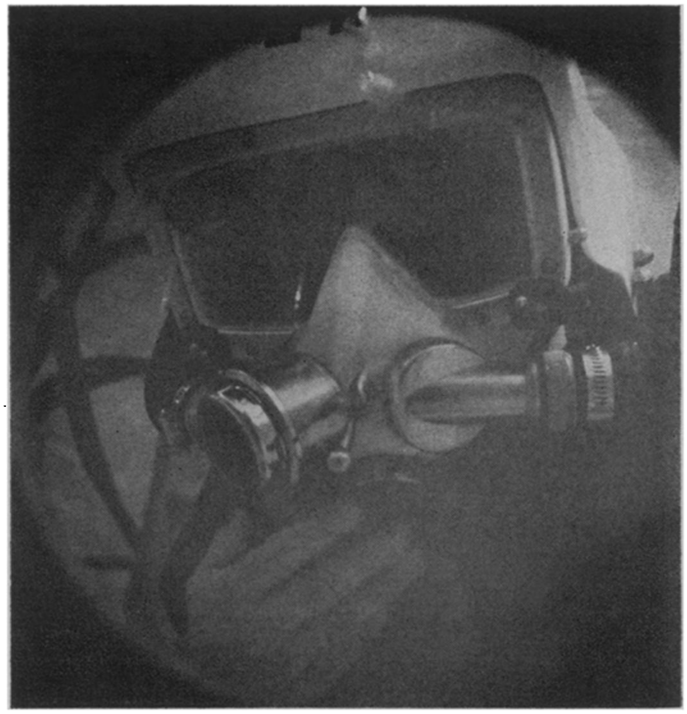
Designers Lanphier and Morin at small chamber controls.



Duke Univ.

Studies at Duke have hinted at unexpected phenomena.

tion and data-gathering devices, to be used during exploratory animal studies at great pressures. One will handle the remote sampling of blood via catheters coming from an animal's body and connected to a selector valve which cues the appropriate sample to be passed out of the chamber. The same device can be used to administer drugs and intravenous fluids to the test animals during the experiments.

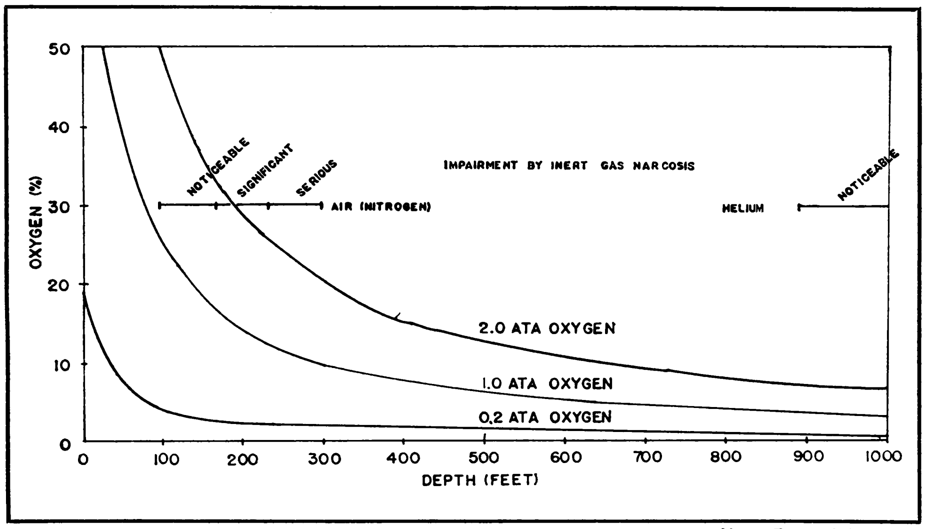
Regardless of the type of dive being simulated, human subjects usually will work at simulated undersea or diving tasks, Dr. Lanphier says. Low temperatures, darkness, pressure and submergence can all be part of the simulation, he points out; only the psychological experience of actually being in the ocean will be lacking.

Dr. Lanphier and his colleagues, however, are looking forward to the time when their researches will bear fruit, as men work and live in the depths of the ocean.

"The ocean bottom is more likely to have valuable resources than the moon," he says, "yet, ironically, we haven't yet placed a man on the bottom of the ocean except in a steel sphere."

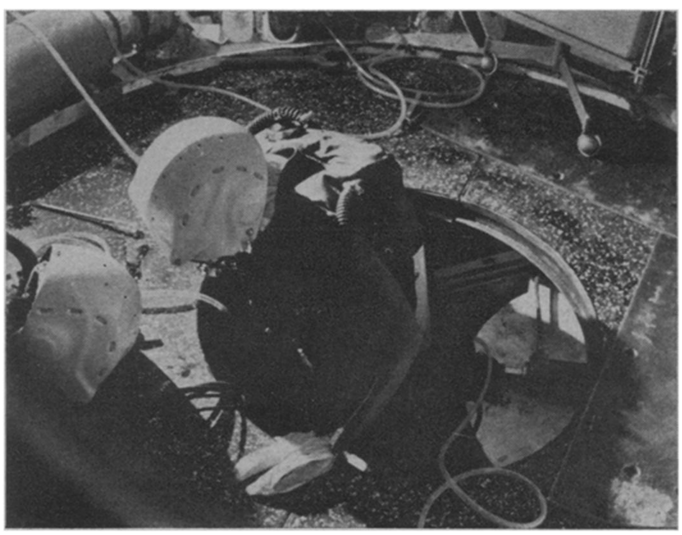
The pressure problem is considerably greater, of course—keeping tons of force per square inch out on the sea floor is more difficult than maintaining 3.5 pounds per square inch in a space suit on the moon—but the goal, in the long run, is just as important.

"If deep diving can be accomplished only in submarines," Dr. Lanphier says, "attempting to work at great depths will be like living on earth without getting out of your car." ◇



Navy Exp. Diving Unit

Even helium begins to show potentially dangerous effects below about 900 feet.



Duke Univ.

A Navy diver gets ready to take the plunge in Duke's so-called "wetpot."