Undersea Instrumentation for Photographic and Video Documentation

By JAMES F. SELVIDIO

Photoinstrumentation in undersea exploration is discussed with particular reference to the U.S. Navy's recent success with Project Sealab I. Photographic equipments used in the experiment are described and recommendations based on observations made during the experiment are outlined.

Man and his descendants, the inhabitants of Planet Earth, have quite thoroughly explored even the most remote parts of its land mass, covering approximately 30% of Earth's surface. Seventy per cent, covered by the water of the oceans, remains virtually unknown and unexplored. Understandably, man has turned his attention to the limitless space outside his immediate world and has made tremendous strides in developing knowledge of its vastness. It appears likely that it is only a matter of time before man will be able to travel to the moon and beyond. Even so, mankind is now forced by increasing population to pause and take a more serious look at his own back yard — the 70% of his world covered by water that we call the *inner* space of Planet Earth.

Earth may be the only planet with so much water, but, for thousands of years, man's need for life-sustaining oxygen has barred him from exploring the depths of the seas. He has ventured over them to a great extent, but his adventures under the surface of the seas, due to lack of knowledge, have been restricted to time-limited and dangerous dives which have carried him just a few feet below the surface and have left most of the remaining depths a mystery.

At the U.S. Navy Underwater Sound Laboratory, one of our main interests is, and has been for the past 25 years, this realm beneath the surface of the sea. In our daily work we consider this area our "hydrospace" challenge.

Our interest arises from a demand for knowledge of this area in which we must work in the research and development of underwater acoustical equipment and systems. Soon after any object goes very far below the surface, man becomes relatively blind to its further subsurface penetration. To overcome this condition, he has used cameras and video systems, separately or in combination. This "marriage" of camera and video has provided him with eyes to see at practically any depth where sufficient illumination is available or can be provided. He is then able to retain the desired images at will by supplementary photographic means.

Man's exploration of the vast ocean depths presents one of the most exciting areas of applied research. It offers considerable promise for results, which will be applicable, not only to the U.S. Navy, to strengthen its operational capability for the future, but to the world and to mankind's continuing existence. The question then is: to what extent can man himself adapt to an oceanic environment?

Underwater swimmer-divers represent an important capability for performing specialized tasks which can be accomplished most quickly and economically by man himself. However, depth and duration limitations, manifested primarily by the requirements for extended periods of decompression after only brief working periods at relatively shallow depths, have led to a radically different concept. Studies by Capt. George Bond, USN, (Principal Investigator on the Sealab) at the Naval Medical Research Laboratory, New London, Conn., have demonstrated that man can live in an artificial helium-oxygen atmosphere at a depth of 200 ft for prolonged periods and apparently not be subject to harmful after-effects.

The Sealab I Experiment

Project Sealab I (Fig. 1) was the first exploratory attempt to apply in practice the results of the exhaustive laboratory studies of Project Genesis. These studies involved placing men in an underwater environment for extended periods, where they lived at ambient pressures equal to a depth of 200 ft beneath the ocean surface and made excursions at will into the water to accomplish scientific tasks. It is believed that man can accomplish useful work at 1000-ft depths, or perhaps

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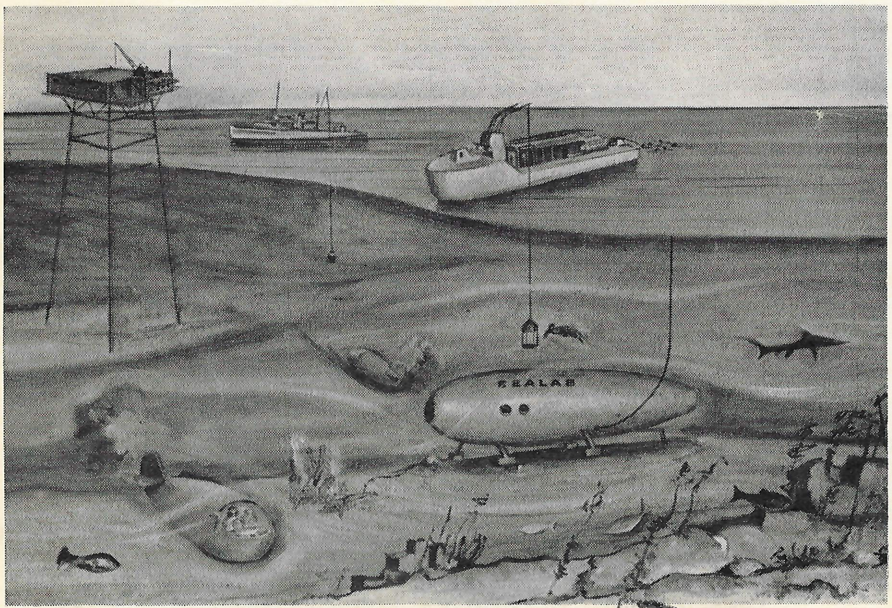

Fig. 1. Artist's conception of the Sealab and support facilities.

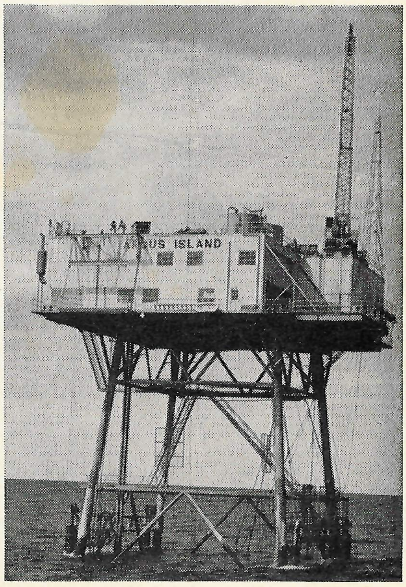

Fig. 2. Navy Research Tower "Argus Island."

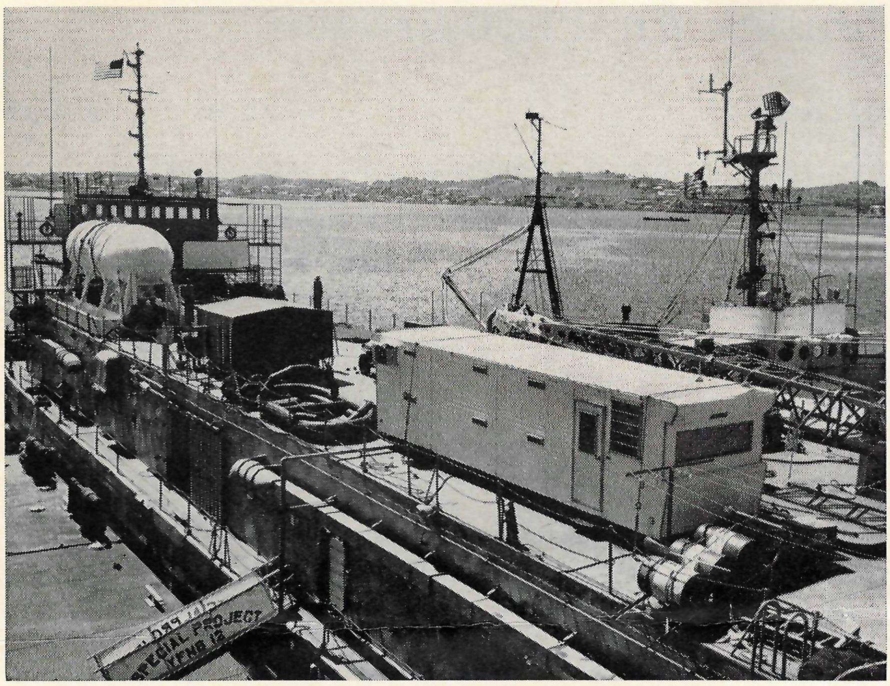

Fig. 3. Sealab I (cylindrical object at upper left of photograph), auxiliary power plant (center) and communications trailer.

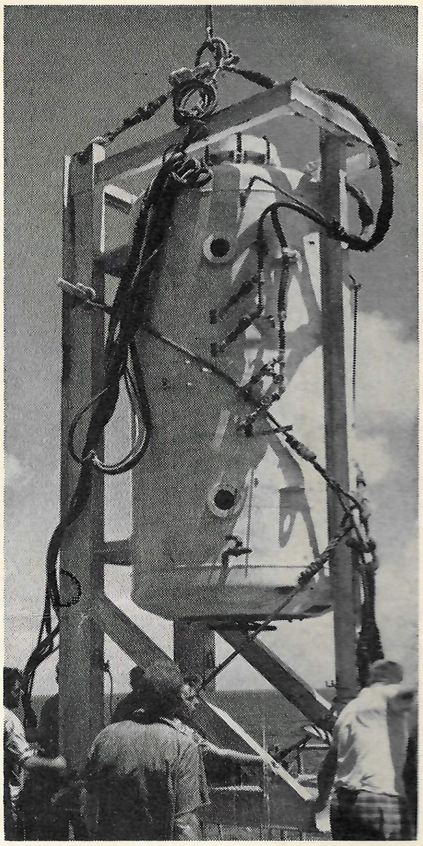

Fig. 4. Submersible decompression chamber.

greater, with this technique of integrating the swimmer-diver more fully with his undersea environment. Otherwise, the diver is limited to brief, expensive undersea forays.

In the Sealab experiment it was planned that Navy Scuba divers would live and work 192 ft under the surface, to test man's ability to work under high pressures for fairly long periods of time, the personnel to include one Navy doctor and three enlisted men.

During the time underwater, they would undergo numerous physical and physiological tests, to determine man's ability to work and live at these depths on a continuing basis.

Experiment Completed

Recently, Project Sealab I, sponsored by the Office of Naval Research in collaboration with the Bureau of Ships and the Medical Research Laboratory at New London, was carried to a successful conclusion in the vicinity of the Navy Research Tower on Argus Island, in the ocean, 26 miles southwest of Bermuda (Fig. 2). This site was chosen because the ocean bottom there is flat and affords excellent visibility. The time of year chosen was June and July, because the weather is at its best there during these months.

The Sealab Project facilities (Fig. 3) consisted of Sealab I, an auxiliary power plant, and a communications trailer; also a submersible decompression chamber (Fig. 4) and the surface support vessel YFNB-12, which provided necessary services.

The Sealab I capsule is a modification of a large cylindrical experimental minesweeping float, 9 ft in diameter and 40 ft long (Fig. 5). This capsule is divided into two sections, separated by a bulkhead.

Fig. 5. Sealab I capsule.

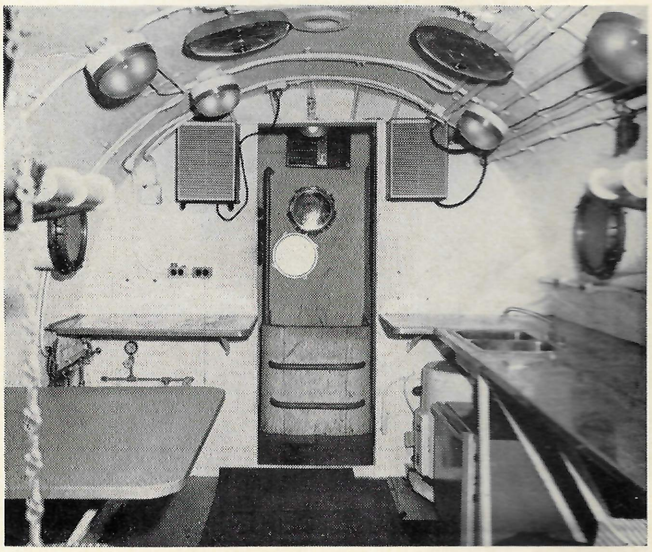

Fig. 6. Forward view of portion of laboratory and living space section.

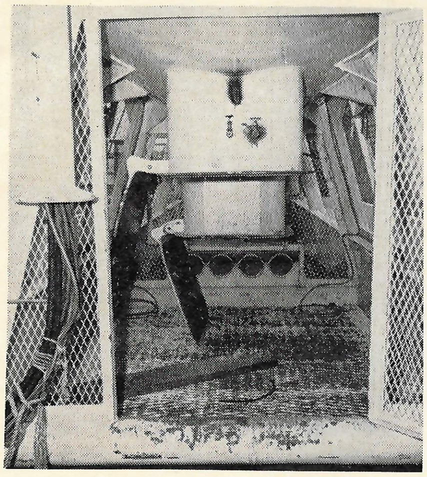

Fig. 7. Doorless hatch providing access to the water.

Sealab Facilities and Equipment

The laboratory and living space section (forward view) is shown in Fig. 6. It occupies 30 ft of the overall length and contains the synthetic atmosphere breathed by the "hydronauts." This atmosphere consists of approximately 4% oxygen; the remainder is mostly helium, with some nitrogen. The nitrogen was introduced to improve voice communication intelligibility from Sealab dwellers because the high helium content makes normal speech unintelligible. This mixture was maintained at the same pressure as the water outside. Thus, free access was provided between the chamber and the water via a separate doorless hatch for each area, descending, one behind the other, into the caged area from Sealab, (Fig. 7).

The other section, occupying 10 ft, was utilized as a communication/stowage area and contained compressed normal air, also equal to the outside pressure. This area housed the electrical power transformers, bulk supplies, Scuba equipment, and equipment for voice communications with the surface.

The Sealab is equipped with electric lights, bunks, lavatory facilities, work bench, heaters, dehumidifiers, emergency water tanks, fresh-water shower and cooking facilities, and several semi-closed underwater breathing systems and conventional Scuba apparatus used by the divers.

The Sealab I capsule was connected by an "umbilical" cord carrying power leads, communication circuits, fresh-water hose, and breathing gas hoses to the YFNB-12, moored overhead, which served as a surface tender.

A trailer was lashed to the top deck of the YFNB-12. This trailer was divided into three sections — an area for communication between topside control and Sealab (normally manned by Dr. Bond, Principal Investigator); living space for two; and laboratory space which housed medical research apparatus as well as video system monitors.

The physical condition of each man was continuously checked, and environmental conditions, such as breathing gas pressures, temperature and humidity, internal pressure, compressed air condition, water condensate measurements, and condition of electric circuits, were sampled and/or recorded.

A submersible decompression chamber was provided, and operated from Argus Island, to be used to evacuate the Sealab crew if the necessity should arise. It was also utilized as an underwater elevator in transporting support divers and material down to and up from Sealab.

Navy Underwater Sound Laboratory, because of its past experience and available subsurface instrumentation, was asked to participate with underwater vision and specialized photographic equipment. It was determined that in order to meet the requirements of the project, three video cameras would be used. Video camera No. 1 (a General Electric P9 with Zoomar 13 mm lens), installed inside Sealab, was placed in a fixed position to cover the laboratory work space and the entrance hatch to the Sealab work and living area (Fig. 8).

Video camera No. 2 (Norden Model 186-1000) a portable unit with electrical connections terminating in the compressed-air chamber, was placed in the open sea, outside, looking forward at Sealab, to permit topside personnel to view the exit or entrance excursions from Sealab and to provide a general view of the fish and any external activity (Fig. 9).

Video camera No. 3 (Oceangraphic Engineering Corp., Model 11A) a completely portable unit (Fig. 10), including its own Model 1A monitor and battery-operated power supply (Fig. 11), was used in various locations. It was completely independent of the others and was an invaluable aid in the survey of the bottom, and in the placement of the Sealab and its anchors, and many other functions where eyes below the surface were required.

In these respects, it is estimated that underwater video systems saved approximately 75% of bottom diving time. Bottom time for a surface diver is five minutes absolute for a no-decompression dive, and divers are severely limited as to the number of dives per day which they can make from the surface. Thus, the equipment added greatly to the overall success of the project.

One (Kintell) viewing monitor was installed in the trailer communications area for continual observation of key personnel during communications, at work, or relaxing.

One General Electric Model monitor for visual observations and two kinescope recording units were installed in the trailer laboratory area. The two units used were: (1) a USL-assembled unit utilizing an Arriflex camera and a Conrac CWA-10 monitor (Fig. 12), and a Vare Industries kinescope recording unit (Fig. 13). These units were able to record both inside and outside action

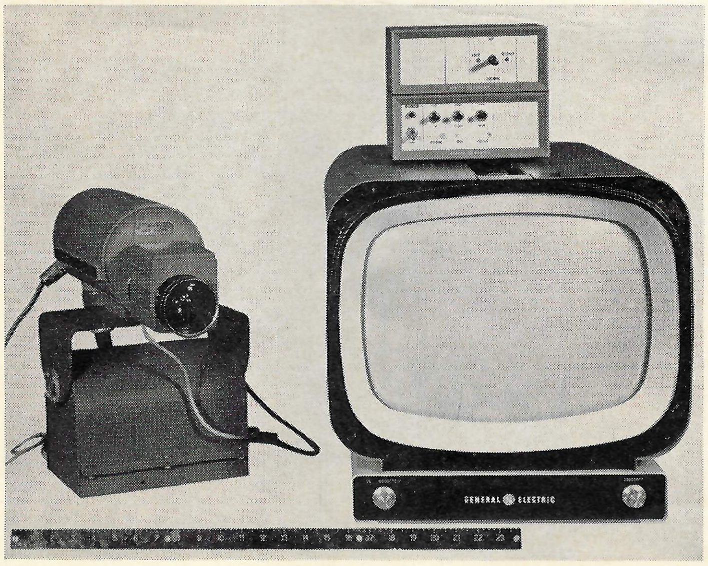

Fig. 8. General Electric video system.

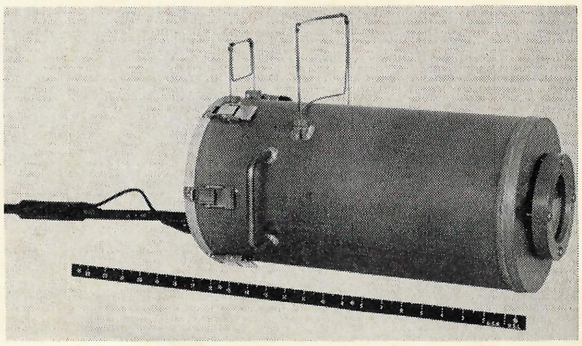

Fig. 9. Aluminum hand-held Norden underwater video unit.

simultaneously, when required, and to provide a backup unit during film-loading functions or in case of failure of one of the two units.

Monitor No. 3 (a General Electric unit) and a speaker, connected to the communications set, provided a one-way visual and audio link. This unit was installed in the crew's mess, to minimize visitations in the trailer and for topside morale purposes. All monitors were equipped with a switching control to change from Camera No. 1 to Camera No. 2.

Photographic Equipment

The Underwater Sound Laboratory designed and built an underwater housing (Fig. 14) for use with the Eastman Kodak K-100 camera. This camera, which has a 100-ft film capacity, has a spring capable of running 40 ft on one wind, with features for rewinding the spring-motor underwater. Photographic equipment also included a 35mm, Pracktina FX with a 450-exposure magazine capacity, electrically driven still camera, installed in an Underwater Sound Laboratory-designed housing (Fig. 15); a 50-ft capacity Fenjohn (Fenmore Johnson, Ardmore, Pa.) electric-drive motion-picture camera (Fig. 16); the two 16mm kinescope recording cameras; a motion-picture camera (Arriflex); and a still camera (4×5 Speed Graphic) for project documentation.

Because of differences in pressure, all underwater cameras, whether loaded in Sealab while on the bottom or in the trailer on the surface, had to be returned to their respective areas for unloading and removal of film.

Underwater Sound Laboratory manpower contributions consisted of one mechanical engineer who is also a qualified Scuba diver, one electronic technician, and two photographers. This combination of talent provided sufficient capability to take care of all problems involved in the installation, operation, maintenance and documentation, both video and photographic, of the USL equipment on a continuous basis, as well as to assist in many other functions, such as the recording of fish noises and other unusual sounds.

Summary

Now that Sealab has returned to port, our experience with this project points out the need for the following:

(1) combined video photographic systems of good design, capable of long periods of continuous operation;

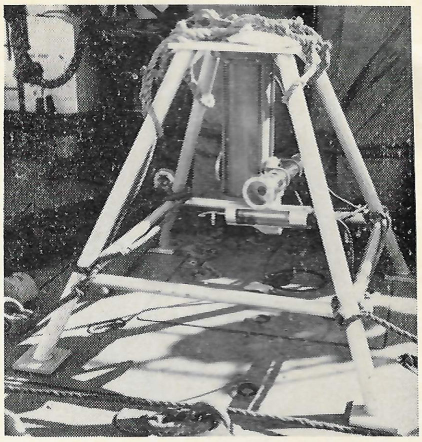

Fig. 10. Oceangraphic Engineering Corp. video unit.

(2) more ruggedly built equipment;

(3) improved reliability of video tubes and components;

(4) underwater tripods with pan-and-tilt mechanisms;

(5) video units operable by separate battery supply to eliminate shipboard or generator power interference problems;

(6) need for all operating controls topside, such as zoom lens, focus and iris, azimuth and elevation;

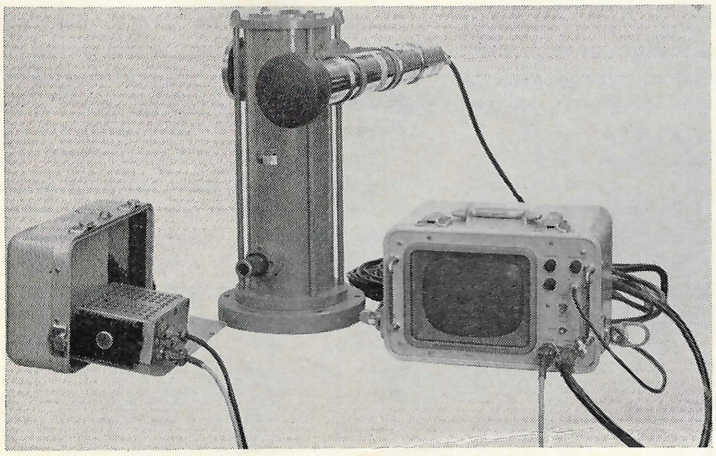

Fig. 11. OEC video camera No. 3, including monitor and power supply.

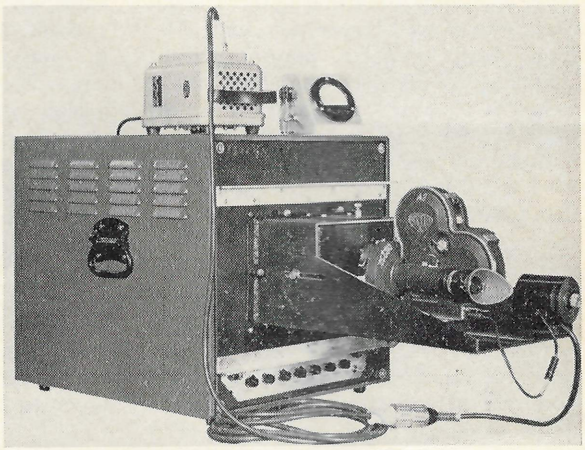

Fig. 12. Arriflex Conrac kinescope recording system.

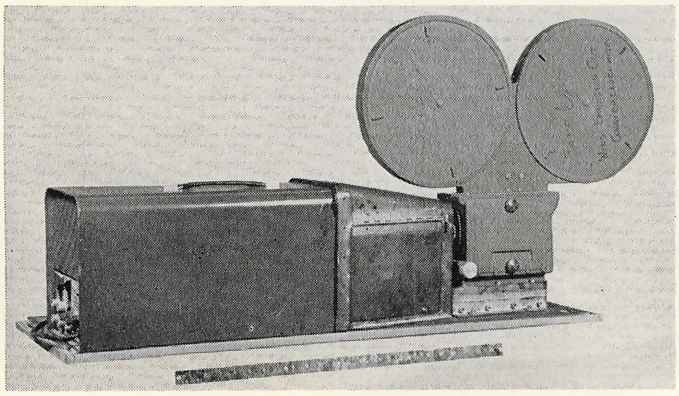

Fig. 13. Vare Industries kinescope recording system.

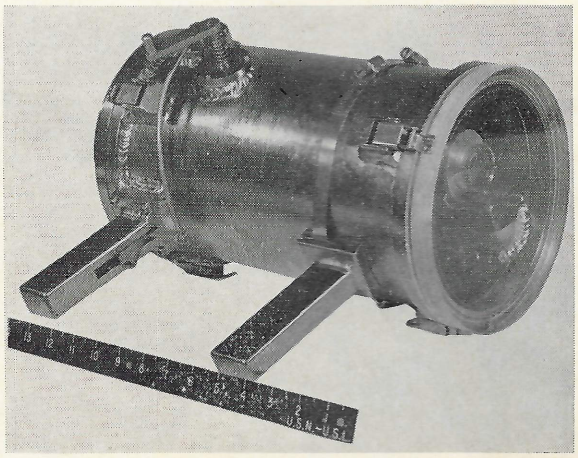

Fig. 14. Underwater housing for Eastman Kodak K-100 camera designed and built by the Underwater Sound Laboratory.

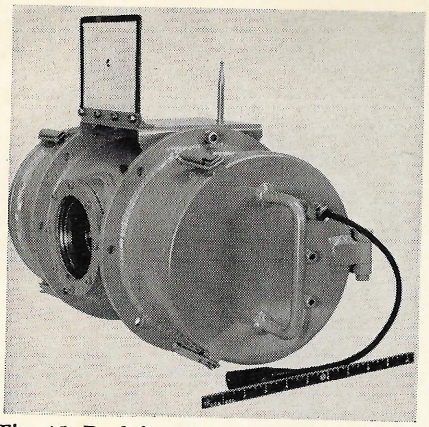

Fig. 15. Praktina FX camera installed in underwater camera case.

(7) viewing monitors to be in pressurized housings for use in underwater aboratory space; and

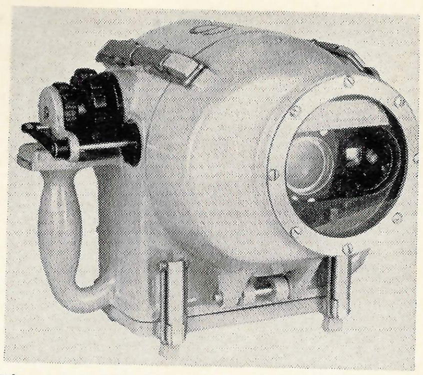

Fig. 16. Fenjohn underwater camera.

(8) study of effects and capability of equipment to operate under new environmental conditions of helium, oxygen and nitrogen, and at various pressures.

With the exception of minor difficulties, all equipment gave satisfactory performance. I believe that video coverage added greatly to the success of the whole project. The complete documentation of the life of the men living beneath the surface of the open sea will enable careful and detailed study of this first experiment so that better plans for future work can be made.

Acknowledgments: The four hydronauts who were involved in Project Sealab are Lt. Comdr. (Dr.) Robert Thompson, Chief Quartermaster Robert A. Barth, Gunner's Mate First Class Lester Anderson, and Chief Hospital Corpsman Sanders Manning.

All photographs are official U.S. Navy Underwater Sound Laboratory photographs.