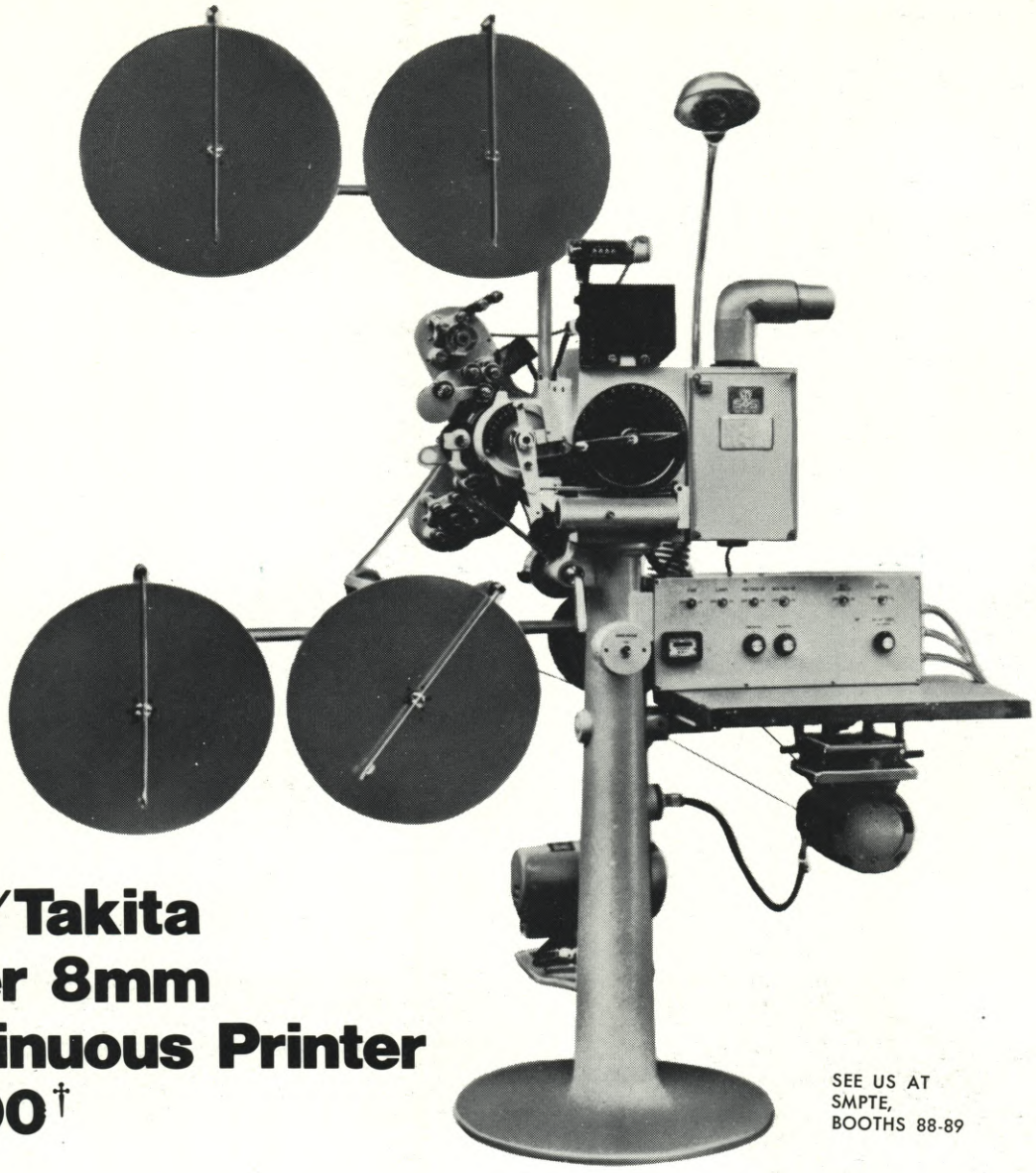
SEPTEMBER 1970

AMERICAN Cinematographer

International Journal of Motion Picture Photography and Production Techniques

UNDERWATER CINEMATOGRAPHY



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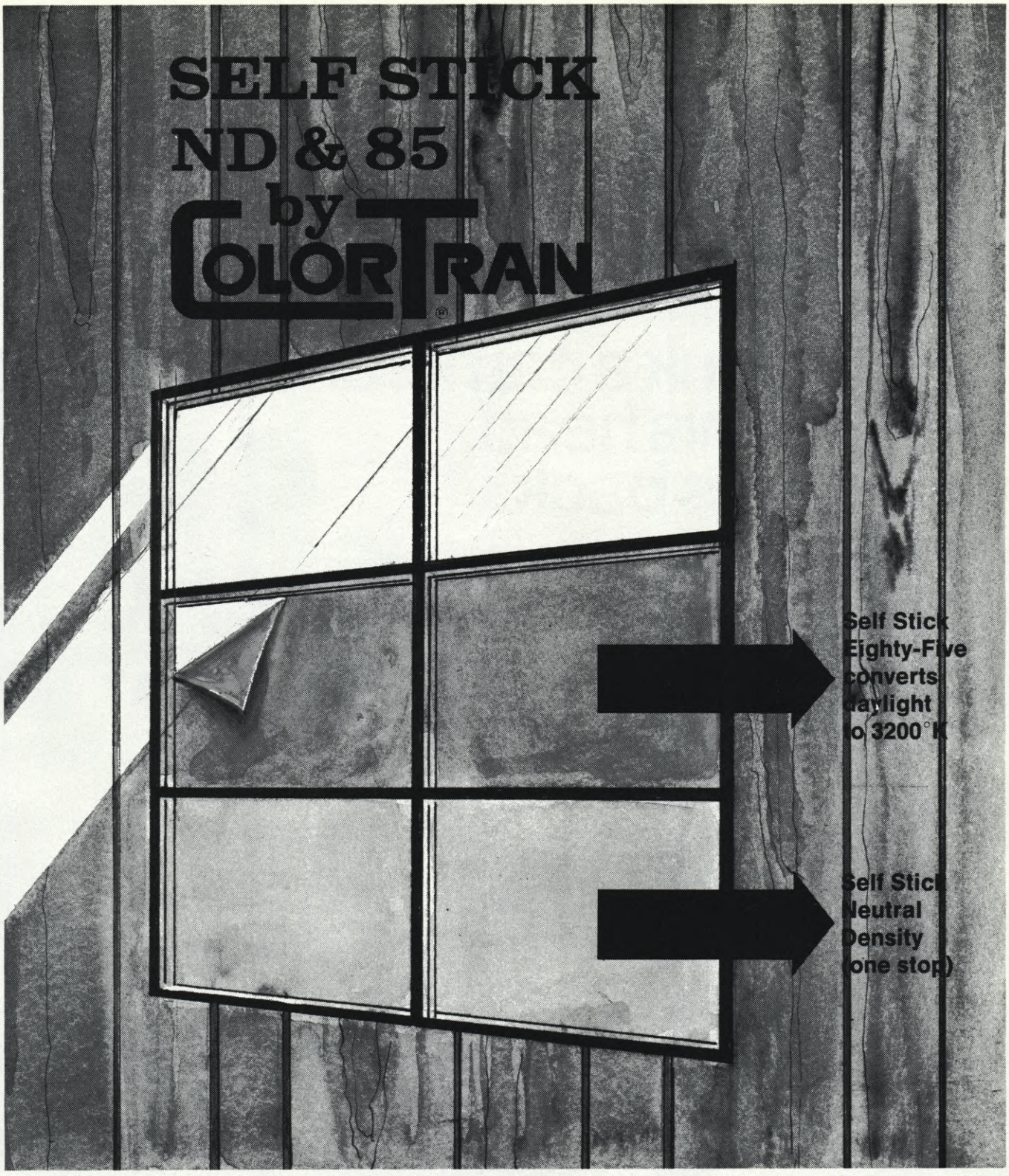

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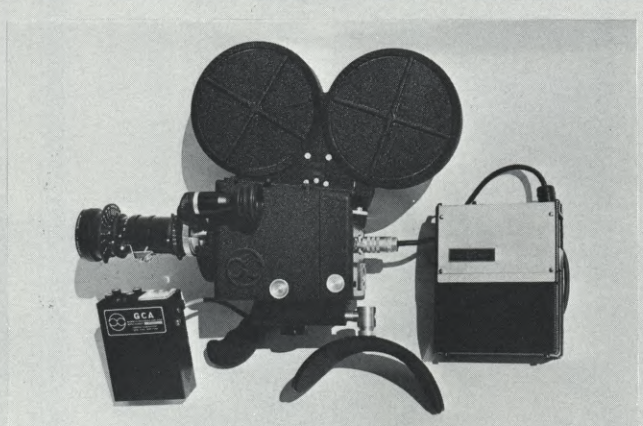

THE SSIII SYSTEM: GCA amplifier, SSIII, G.C. mini-finder, G.C. lightweight 400-ft. magazine, G.C. cine-pod, GPS-6 crystal power supply.

AMERICAN Cinematographer

International Journal of Motion Picture Photography and Production Techniques

SEPTEMBER, 1970 VOL. 51, No. 9

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• FEATURE ARTICLES

ON THE COVER: Highlight photographs from stories in this issue. Clockwise from Top Left: The incredible "SEA-SEE", U.S. Navy underwater research vessel. (Page 836); Greg MacGillivray shoots camera from surfboard for "WAVES OF CHANGE". (Page 864); Jeb Gholson films in the deep with his self-contained underwater camera and lighting rig. (Page 886); Cameraman surrounded by school of small fish attracted by lights during shooting of scenes for "THE PRIVILEGED WORLD". (Page 844). Cover design by Don Record.

AMERICAN CINEMATOGRAPHER, established 1920, in 51st year of publication, is published monthly in Hollywood by ASC Agency Inc., 1782 North Orange Drive, Hollywood, California 90028, U.S.A. **SUBSCRIPTIONS**: U.S. and Canada $6.00 a year; foreign, including Pan-American Union, $7.00 a year (remit International Money Order or other exchange payable in U.S.) **ADVERTISING**: rate card on request to Hollywood or New York office. **CHANGE OF ADDRESS**: notify Hollywood office promptly.

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Fouad Said's Cinemobiles and Arriflex 35:

Academy Award Winners combine to slash costs

Cinemobiles, the complete movie studios on wheels, are revolutionizing location production while lowering costs. "The output of the Cinemobiles," stated their creator, Fouad Said, "is now more than any single studio in the world." It's understandable, in view of the vehicles' system of getting personnel and equipment to location as a single unit, doing the job more efficiently, and moving on quickly to the next location.

One would think that the Cinemobiles' practicality and stunning success would have been obvious from inception. But when seeking underwriting from the majors five years ago, Mr. Said found his concept was too radical to win their confidence. The turning point came when he met Sheldon Leonard, in the process of planning his "I SPY" TV series. "Sheldon wanted the total authenticity of location shooting," continued Mr. Said, "and he saw the potentials of the Cinemobile right away."

Mr. Said built his Mark I Cinemobile, a 16 foot Econoline modified with eleven access doors and customized compartments for all of the equipment. Its contribution was startling. "We could move locations up to eight times a day, compared to the usual two . We were able to shoot 13 pages of script daily, compared to the usual average of six."

Now proven, requests for Cinemobiles began to pour in from major producers. "They are confident we save them 20 to 30 percent in costs," relates Mr. Said. Thus an entire family of Cinemobiles has thrived, 23 in operation by mid-1970, including the awesome Mark V that carries actors and crew of 38 in its top deck, and complete filming facilities below. Lightweight, fast-handling equipment is, of course, the substance of production hardware, including the new 28 pound Xenon lights which deliver more illumination than 135 pound Brutes: battery-powered sound recorders; and 35MM Arriflex cameras in profusion.

Fouad Said concludes, "Without the Arri, there just couldn't be any Cinemobile. It's the only camera with full professional features that can travel like this, and set up so quickly: that's versatile enough to do all the things required—hand-held shots, slow motion, small or big film loads, sync-sound shooting with lightweight blimps. It's really the common denominator of our fast-moving, go-get-it Cinemobile operations."

The Cinemobile has something else in common with the Arriflex: its recent endowment with an Academy Award of Merit for outstanding achievement. The Arriflex was honored with a similar award in 1966. Cinemobile and Arriflex—together they put fully professional, totally adaptable capability into the settings that really count.

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Director of Photography, Richard C. Glouner, and his crew testing the Cinemobile Location Studio for use on his next feature film.

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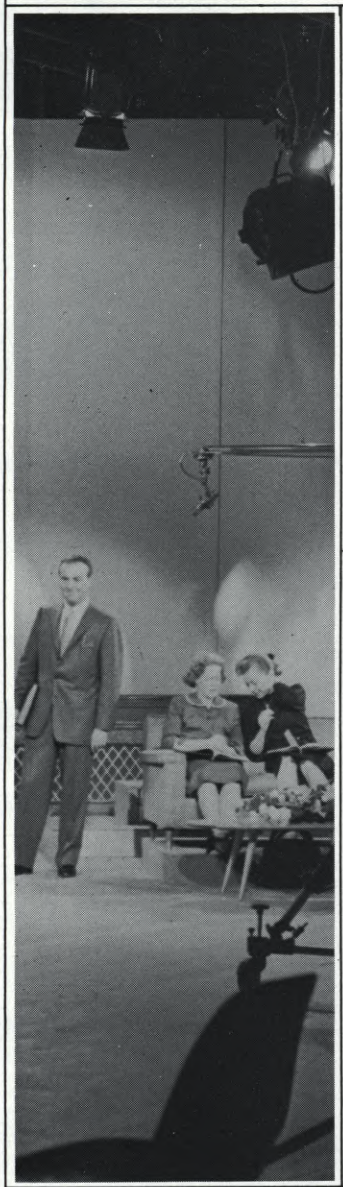
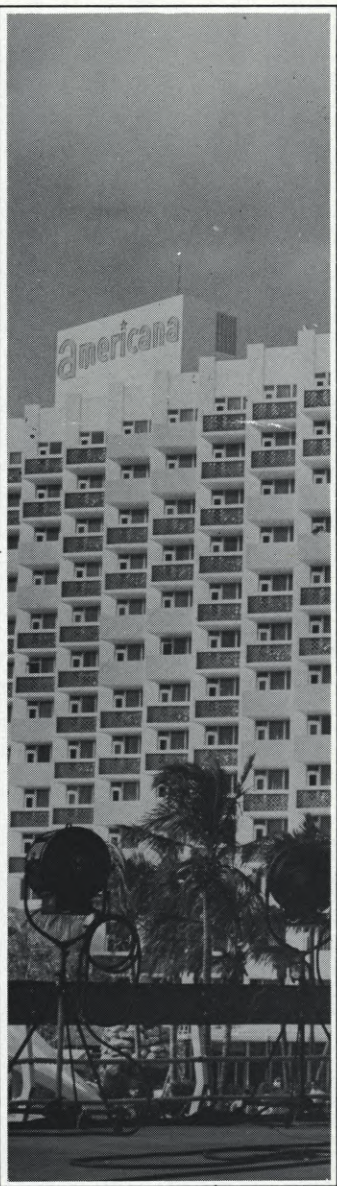
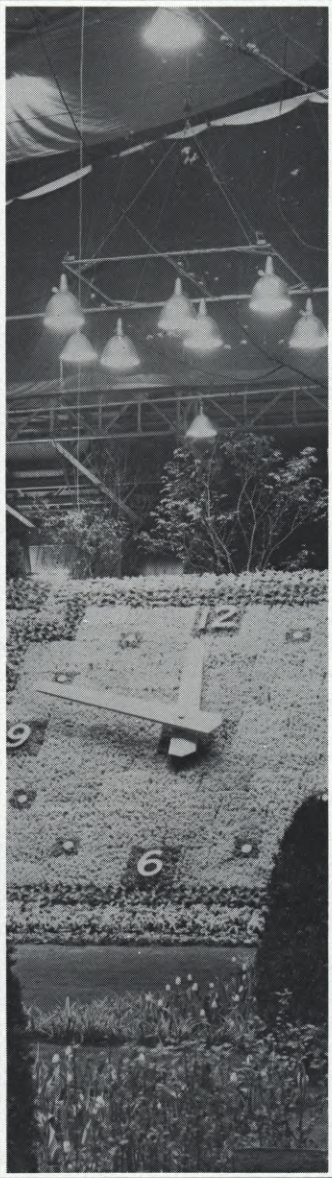


In 1956 thousands witnessed the *This Is Your Life* Network Show honoring Ernest Breech. Lighting was by Jack A. Frost.



Tons of Frost lighting equipment traveled to Havana for this 1958 Steve Allen TV Show. Today Frost experts are still lighting "the show" wherever temporary lighting and power are needed.



Frost has been creating artistic lighting effects for special exhibits, such as this Flower Show, for over a quarter of a century.

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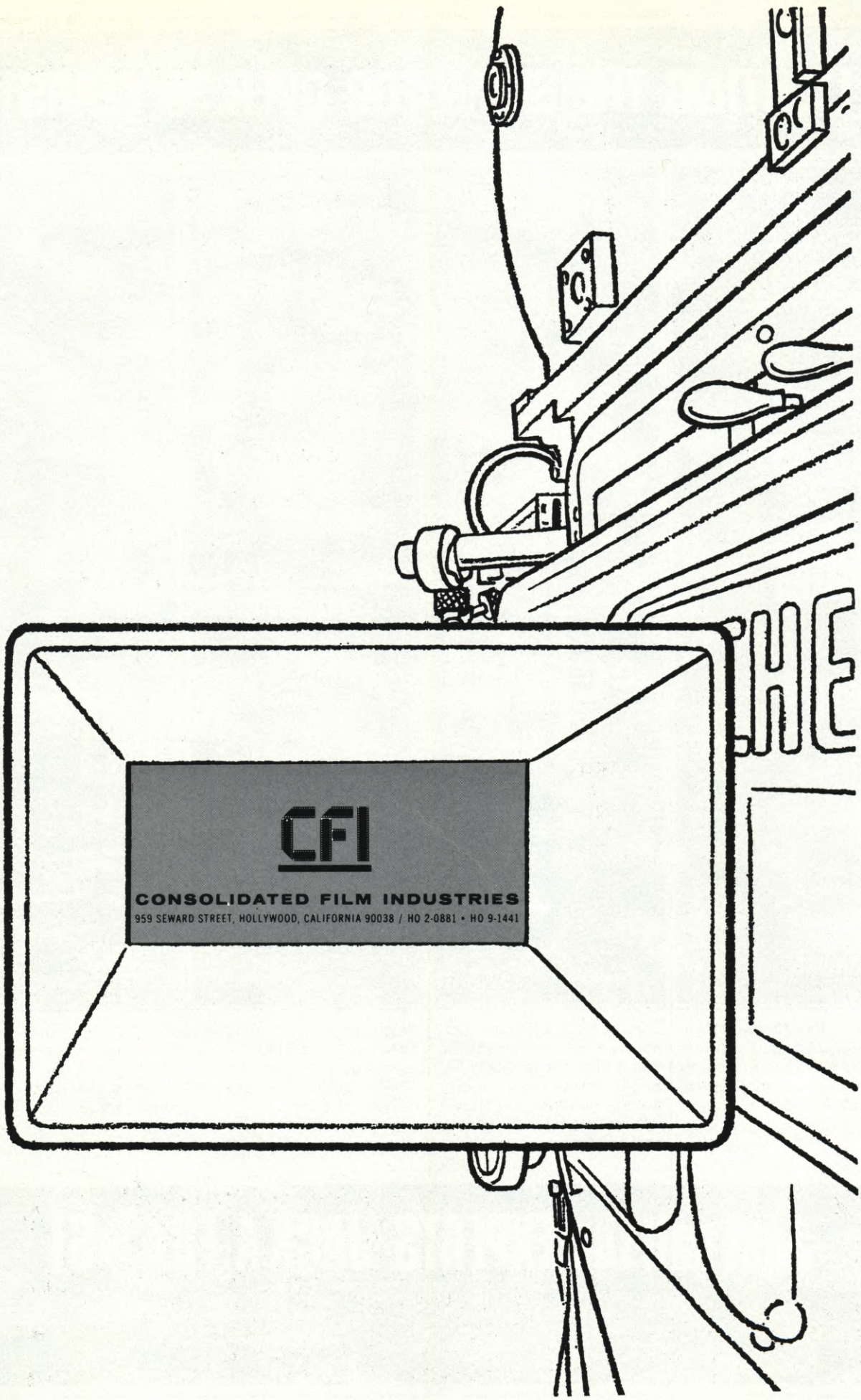
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UNIQUE UNDERWATER CINEMATOGRAPHY EQUIPMENT

TIME-LAPSE UNDERWATER CINEMATOGRAPHY SYSTEM

Sea Research and Development, Inc., of Bartow, Florida, has continued the development of a system designed and originally marketed by J. R. Bailey of Bailey Oceanic Systems Company of Toronto, Canada, known as the Movie-Marine[tm] system.

Sediment transport studies by geological oceanographers was the specific requirement for which the time-lapse capability was incorporated as a standard component of this system.

The present off-the-shelf system is built around the Bolex 16mm camera with 100' reel capacity, and is described as the MovieMarine 100/Sixteen. The second generation is in the final stages and will be known as the MovieMarine 400/Sixteen and will accommodate the 400' magazine.

The MovieMarine system housing is a rugged casting of the alloy al-mag 35. The "Lapse-Mate" which is a solid state lapse timer is mounted behind the camera and can be employed with any camera which is equipped with a single frame cable release socket. Weighing only 30 ounces (size: 2"x4¾"x5½") there are no cams, gears, or motors and the solenoid, which is the only moving part, acts through a cable release. Therefore no vibration reaches the camera.

The 24 volt, solid-state operation has a repeatability of ±2% with an infinitely variable range from 4 seconds to 3 minutes. An extended lapse range for up to 6 minutes is presently being developed. Power requirements of the 24 VDC component are 2 amps intermittent and 2 amps on the delay cycle.

Power for the lapse time unit, the camera motor and the accessory lighting components of the system is supplied by the 24v power pack which is an integral part of the MovieMarine 100/Sixteen system and is also contained in the housing.

A synchronization unit which is employed to perfectly synchronize the shutter opening with an electrical flash, strobe, or any other electrical counter that requires an electrical pulse to coincide with each frame of film exposed, is also in use with the system. The "Juba-Sync" can be used in a normally open, closed, or both circuit configuration on any camera that has a 1:1 frame shaft.

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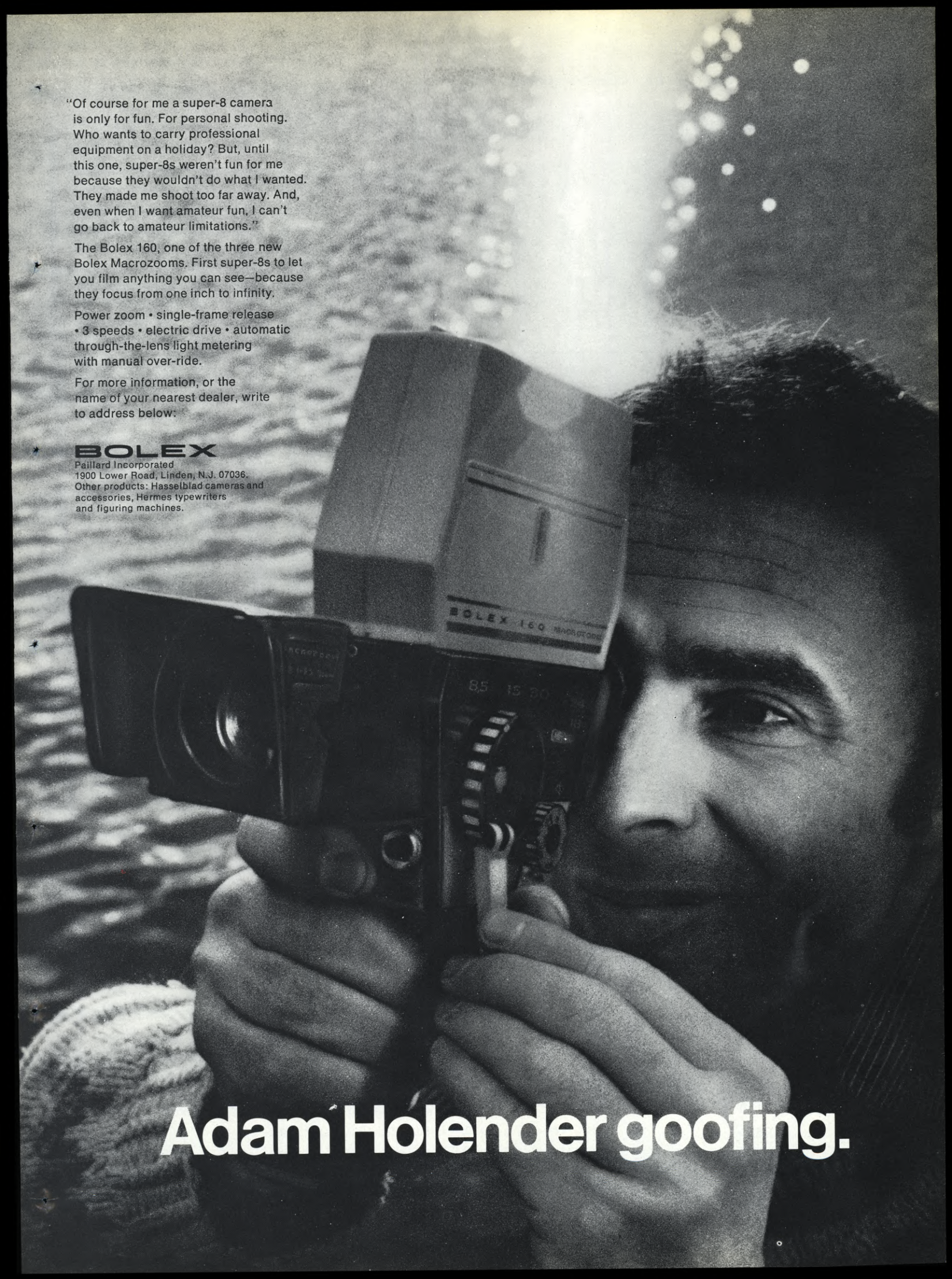

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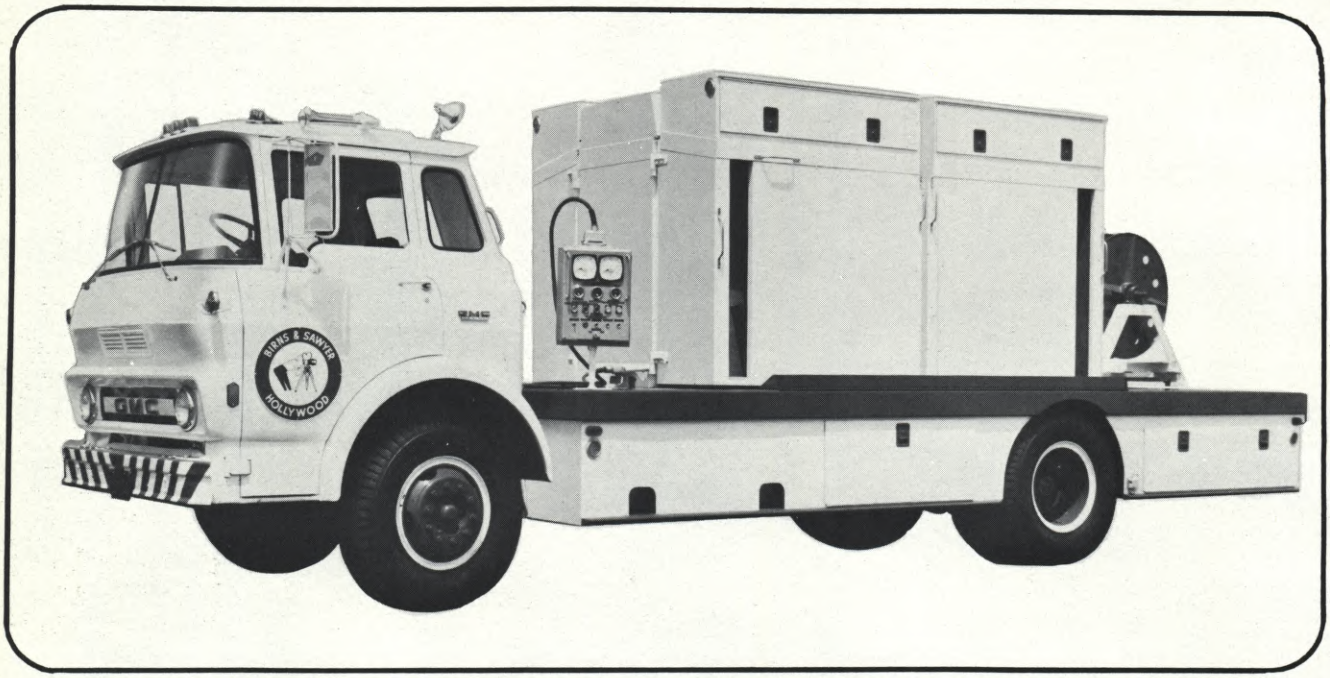

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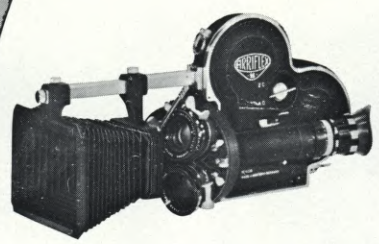
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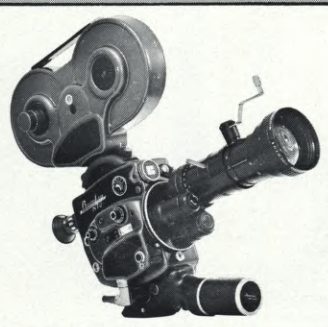
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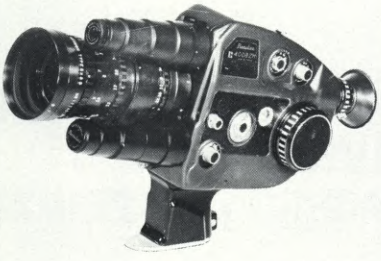
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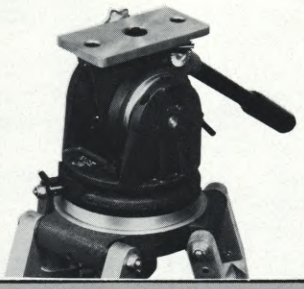
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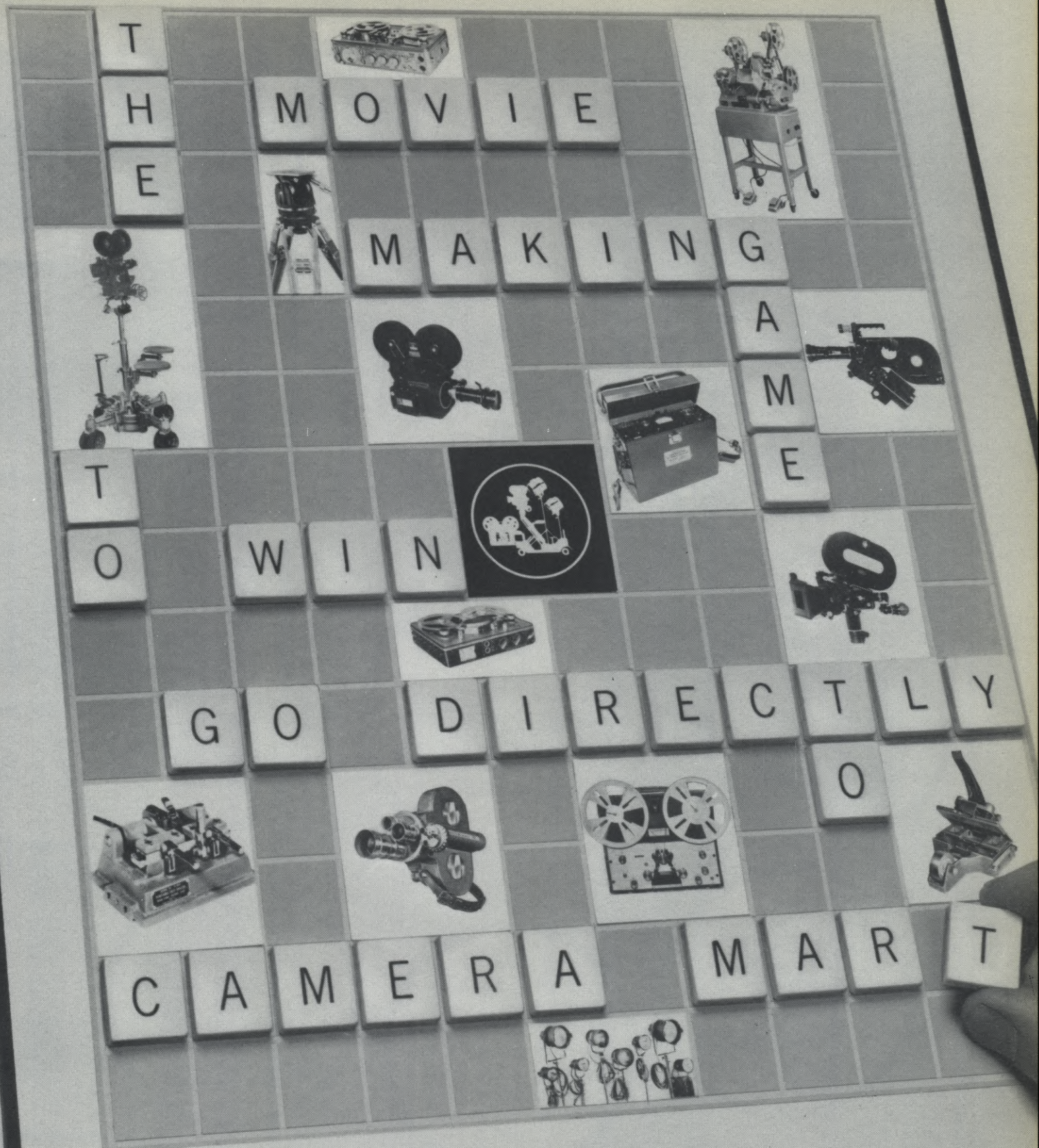

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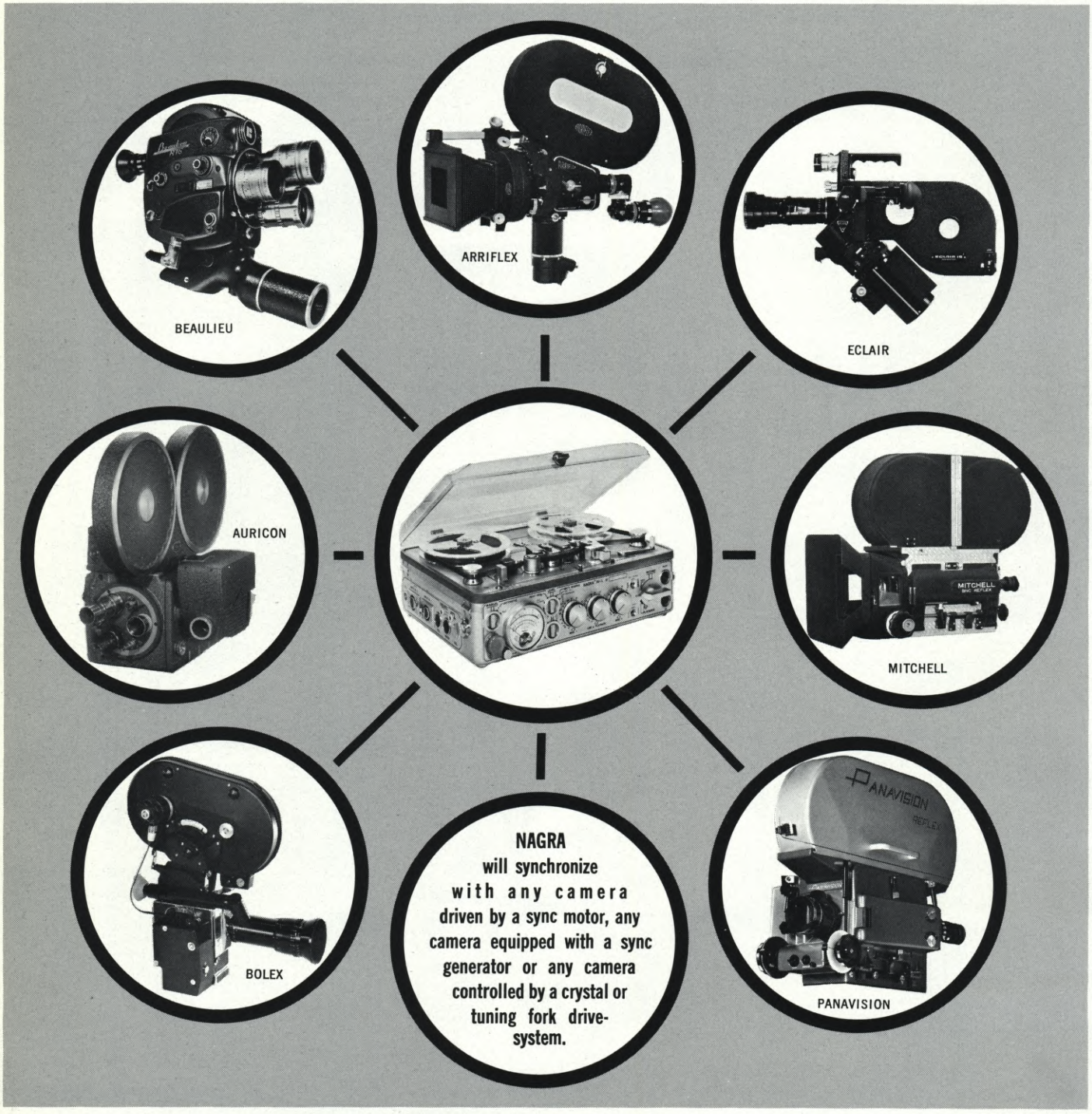

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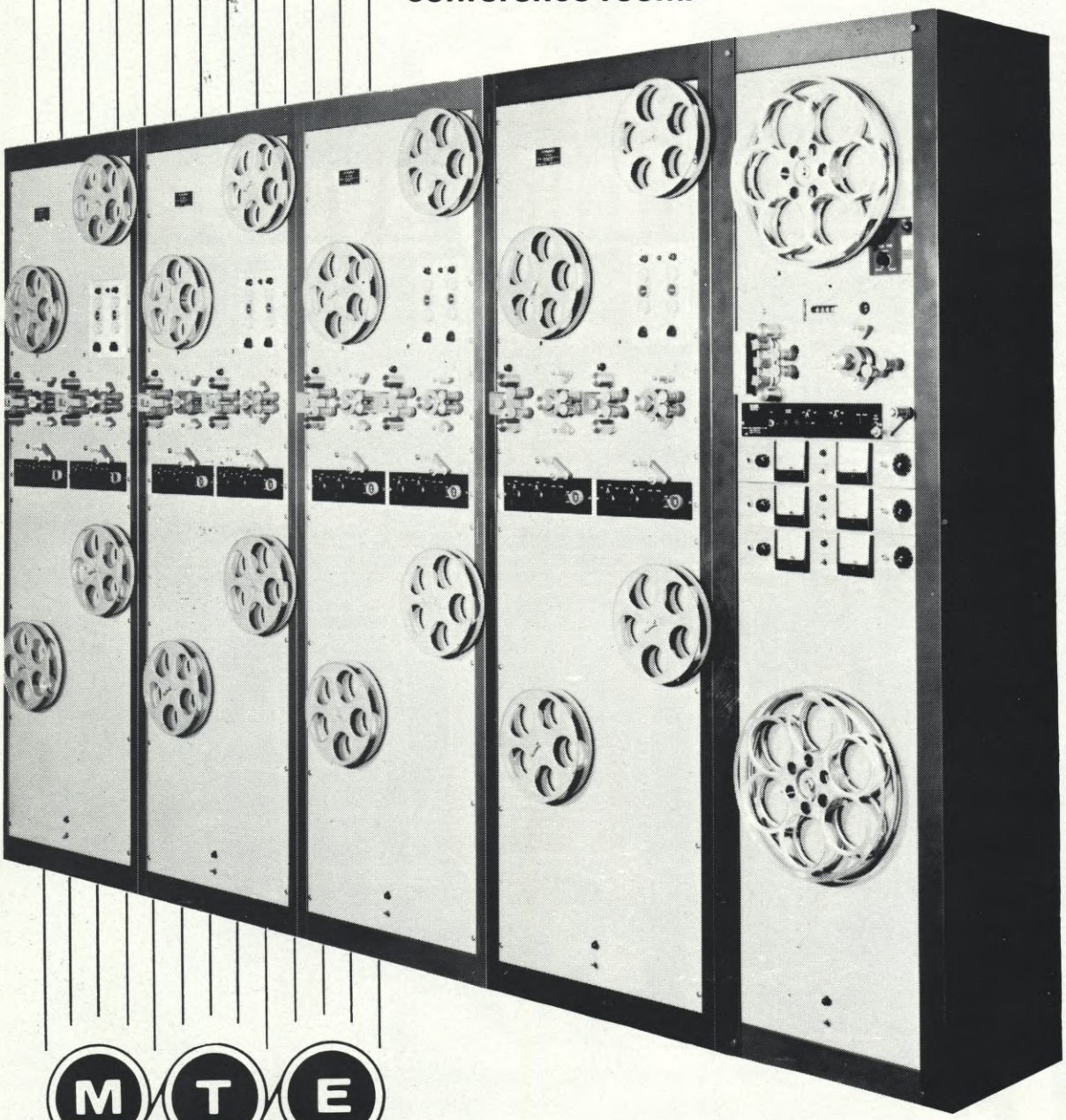

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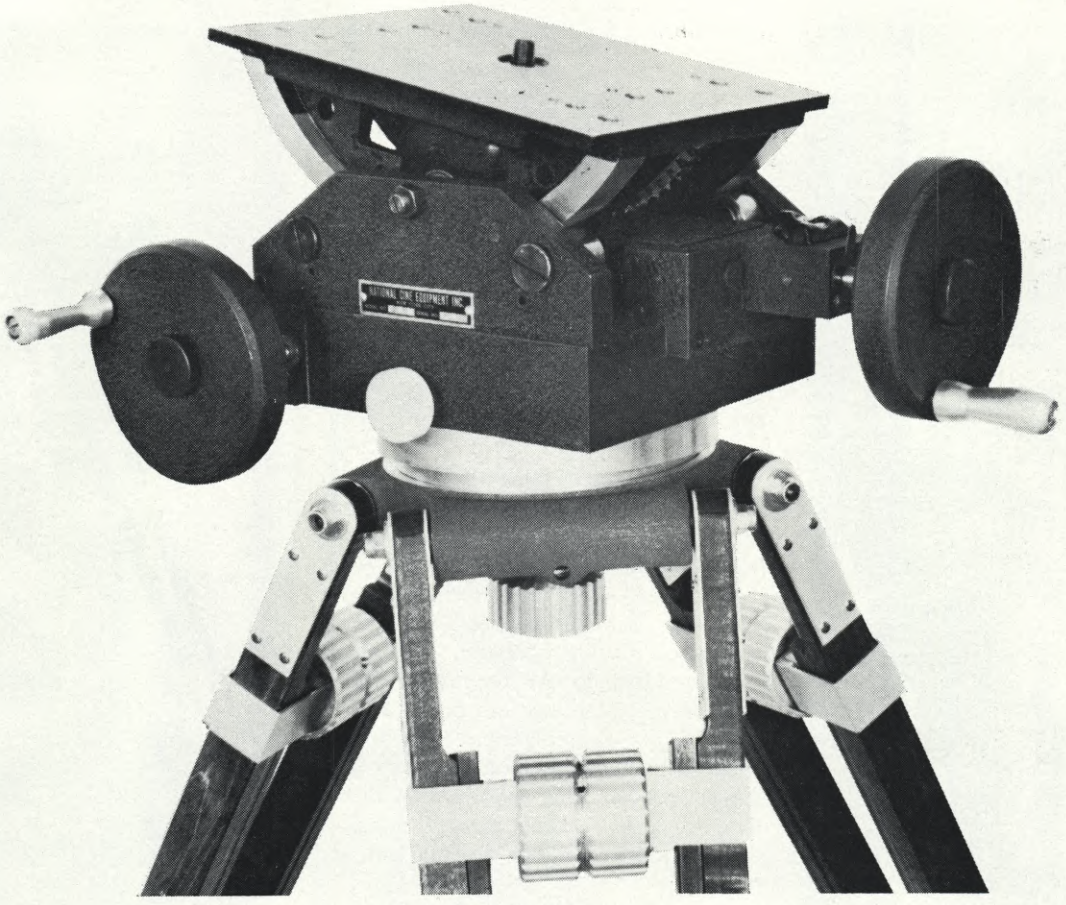

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THE INCREDIBLE "SEA-SEE"

American Cinematographer Editor, even more "at sea" than usual, boards the Navy's amazing undersea observation vehicle for the wackiest voyage since launching of the Good Ship "Lollipop"

By HERB A. LIGHTMAN

SEA-SEE "Skipper" Bruce Parks and producer/director/cameraman Frank Stitt suit up and check out their Rebikoff underwater cameras, prior to going over the side for a filming session.

The Isthmus, Catalina Island, California

The aircraft, a dear old thing just a few evolutionary steps removed from the original Wright Brothers Special, touches down at what passes for an airstrip at Catalina Island—but which is, in reality, the flat space created by chopping off the tops of two mountains. The pilot has to maneuver the ancient airfoil like a skateboard to keep it from falling off the opposite edge into the sea. (Takeoffs are even hairier. The runway isn't quite long enough to get the craft airborne, so it simply goes until it runs out of *terra firma,* then plunges a couple of hundred feet toward wave-lashed boulders before struggling up into the wild blue yonder. Truly an emotional experience!)

On board with me, and headed for the same ultimate adventure, is Leland G. "Lee" Collins, Western Technical Representative for Arriflex Corporation of America. Since we are both former Army Signal Corps combat cameramen and old hands at coming in on a wing and a prayer, the heart-in-the-mouth landing doesn't really faze us much—especially since we aren't getting shot at this trip.

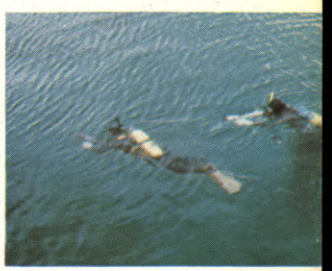
We are met by a Land Rover which trundles us down 45 minutes' worth of hairpin curves toward the narrow neck of Catalina Island known as The Isthmus. In former years the location for countless South Sea Island movie extravaganzas, The Isthmus boasts a combination general store-restaurant-bar, a few primitive habitations for the people who run it, a herd of buffalo, an indeterminate number of wild boar and a handful of resident humans.

Snugly billeted in a cluster of mobile home-type barracks nearby is a group of marine biology students from the University of Southern California, over here

Tom Garcia, with Arriflex on tripod, shoots scenes topside for a documentary film about the unique vessel.

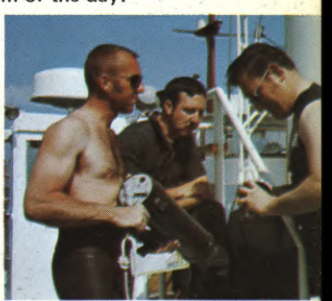
The SEA-SEE glides toward the open ocean off San Diego, California. Looking somewhat like a cozy catamaran houseboat, the vessel is actually a highly sophisticated floating research laboratory equipped with the most advanced navigational equipment.

(LEFT:) The "SEA-SEE" rides lazily at anchor off Catalina Island. (ABOVE LEFT:) Contingent aboard the vessel included underwater cameramen, divers, engineers, and a bedraggled editor. (RIGHT) Garcia shoots from inside the bubble.



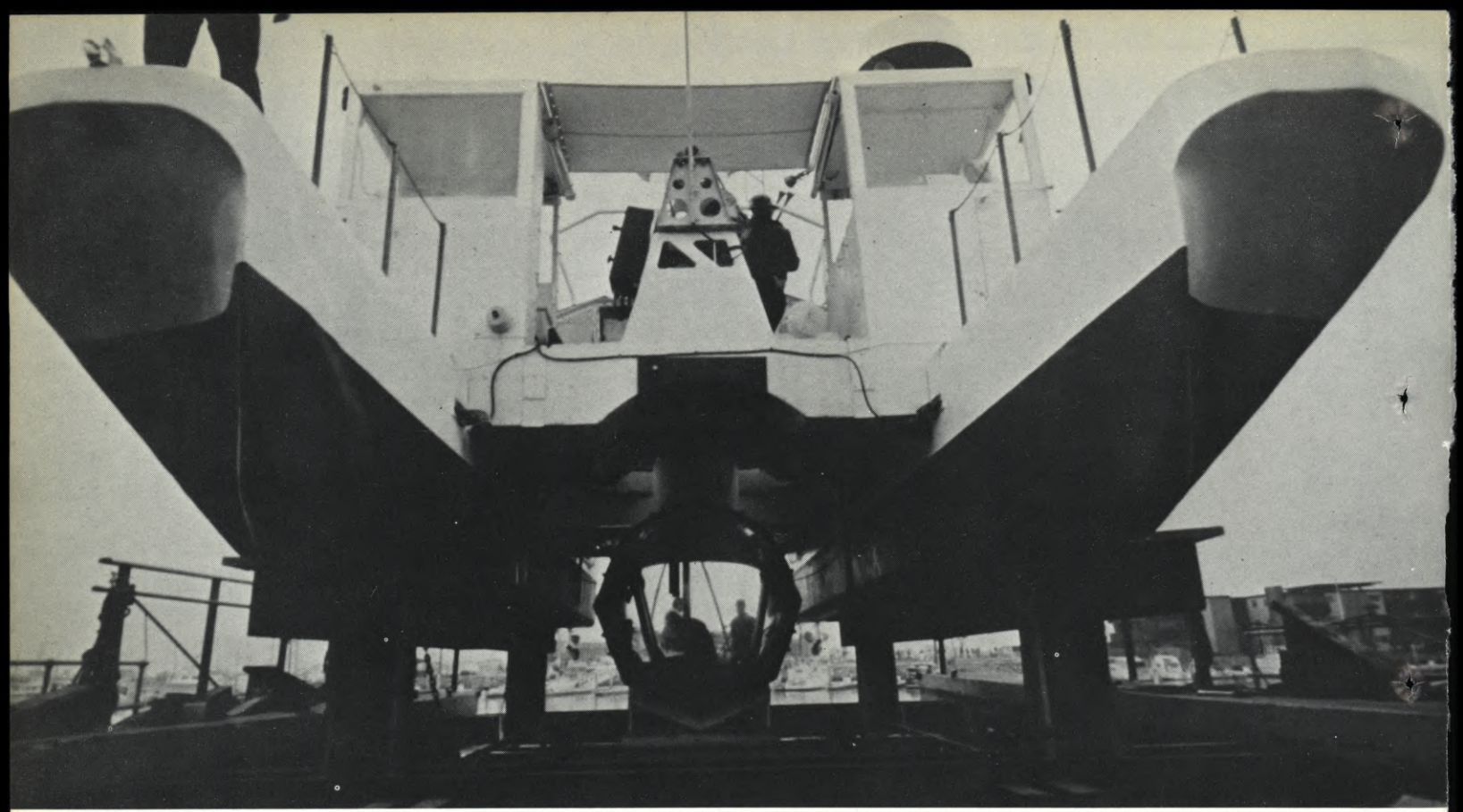
(LEFT) "Skipper" Bruce Parks, garbed in half a wet-suit, takes the wheel to move the craft out into the open sea. (CENTER) Sheltered in a Catalina cove, the "SEA-SEE" patiently awaits the call to duty. At upper left can be seen the University of Southern California's Marine Sciences Center. (RIGHT) Underwater cameramen move into position for a filming dive.

(LEFT) "SEA-SEE" designer Larry McKinley, Arriflex Technical Director Lee Collins and Frank Stitt shown on board. (CENTER) Moving through azure waters with his Rebikoff camera, cameraman stalks his subject. (RIGHT) Parks, McKinley and Stitt hold a strategy session to decide method of handling underwater filming problem of the day.

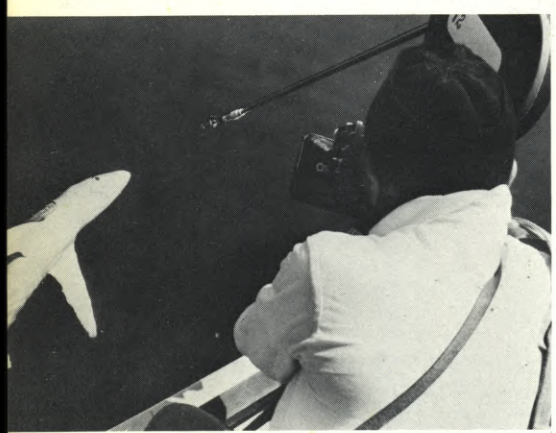


Stitt films sharks with Arriflex from inside bubble. "Shirt-sleeve" environment is comfortable and allows cameraman to give full attention to filming. Tube leading to bubble is open at the top, but extra air is pumped in for comfort. Intercom at right maintains communications between bubble and fore and aft housings.

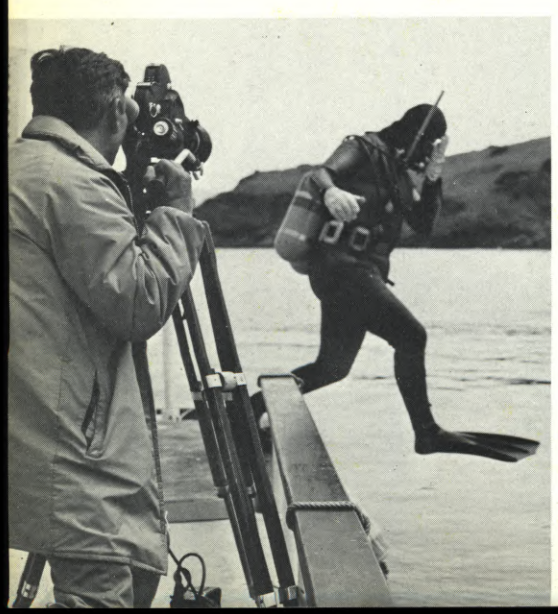
(TOP) The "SEA-SEE" in dry-dock, getting its annual face-lifting. (BOTTOM) At dusk, the lights of the craft come on and send reflections sparkling onto the sea.



The SEA-SEE under construction, with the bubble (in retracted position) clearly showing between the pontoons. Initial configuration was very basic, with housings and other accoutrements being added later.



(ABOVE) Blissfully unaware that he is about to be harpooned, a curious blue shark bellys up to the surface and smiles prettily for the camera. (BELOW) Frank Stitt takes the plunge.



to do field work at the university's posh Marine Sciences Center which is located just a halibut's throw on the other side of the mountain. There are, if my count is right, 14 lusty young knights of the sea, plus two comely coeds. They are a red-blooded, everyone-into-the-water crew, passionately devoted to the study of salt water crabs and other undersea exotica. We learn that we are to share their billets, which turn out to be surprisingly comfortable two-bedroom-and-bath suites.

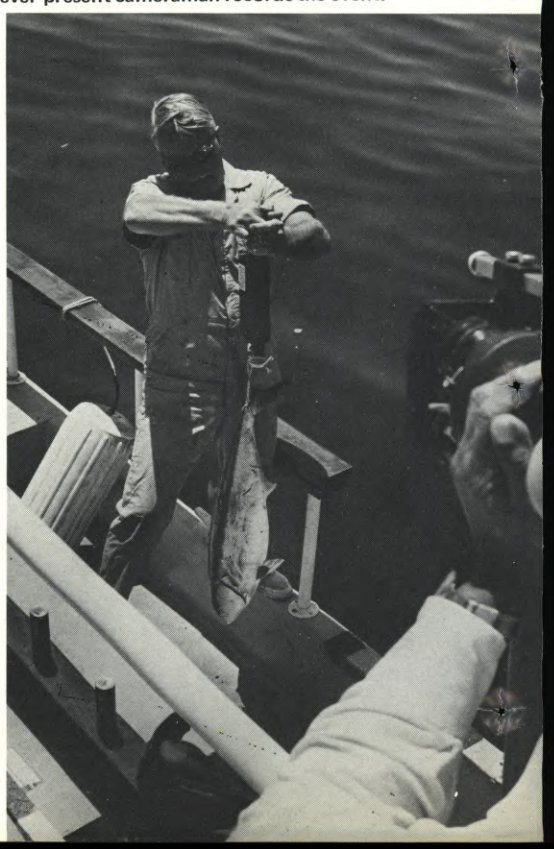
The reason we are here, Lee and I, is to spend several days aboard *SEA-SEE,* a new experimental research vessel designed and developed at the Naval Undersea Research and Development Center (NUC, for short). Our interest in this craft is focused on the fact that it provides a unique underwater "platform" for the virtually unrestricted viewing (and photography) of marine mammals and fish.

SEA-SEE comprises an octagonal compartment, installed on a catamaran, that extends 10 feet into the water and permits 180 degrees of visibility fore and aft. The compartment is 7.5 feet long with clear plastic hemispherical ends. It accommodates two observers and also permits photography and sound recordings of mammals and fish. The eye-level of the occupant seated in the compartment is about 6 feet below the water surface.

The shallow-draft vessel has been anchored in kelp beds for close-up viewing of shallow-water marine life, and has also been used to observe dolphins, whales, sharks, and sea lions at sea. Shallow-water bottom and reef surveys have also been successful.

The catamaran is 50 feet long and 20

First Mate Bob Hester weighs yellowtail that obligingly made itself available for lunch, while ever-present cameraman records the event.



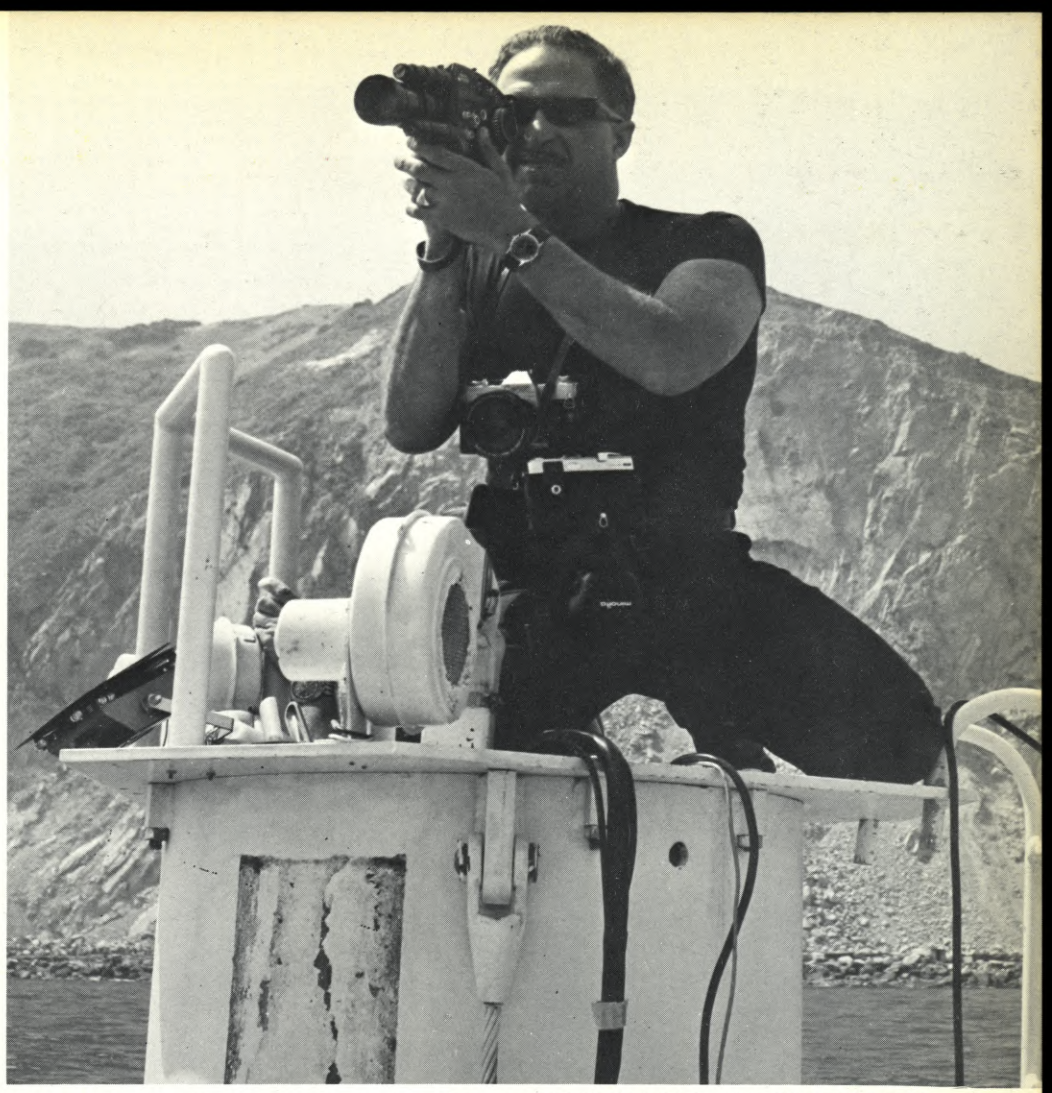
feet wide. It draws 3.5 feet with the compartment raised between the pontoons and 10 feet with the compartment extended. The range of the vehicle is 300 miles. Maximum speed is 7.5 knots with the compartment raised and 3 knots with it extended. Electronic equipment and a self-contained electrical generator allow *SEA-SEE* to undertake unescorted coastal navigation. *SEA-SEE* allows observers to follow underwater action without gaps in the field of view.

The vehicle can sleep four—a crew of two and two scientists—has a galley on board, a head, and an instrumentation console. The normal working complement is four scientists, two crew.

Home port of *SEA-SEE* is NUC, San Diego.

Future plans for the vehicle include behavioral studies of the natural populations of delphinoids, with emphasis on social structure, radio tagging, and tracking. Operations with fish and game authorities to evaluate the behavioral responses of fish schools to various designs of commercial and developmental fishing nets have been planned, along with studies of the feeding behavior of pelagic sharks and open-ocean evaluation of an NUC-developed anti-shark screen.

Lee and I have heard wondrous tales of *SEA-SEE*'s unexcelled capabilities as a mobile platform for underwater cinematography, and we are looking forward to giving it our own private shakedown along those lines. The voyage which we have been invited to join will not involve any of the Navy's technical projects, but will be devoted exclusively to the filming of a documentary about *SEA-SEE* itself.



The author, atop the tube which leads down into the SEA-SEE's bubble, runs off some Super-8 footage for his own unofficial documentary of activity aboard the unique craft. In the background is Catalina Island, actually a mountain range rising from the sea.

Parks moves toward the bubble to wipe off its surface with a wad of soft mesh material, insuring a clear view for the camera lens.

Shortly after arriving at The Isthmus we are introduced to the rollicking characters who will be our shipmates (boatmates?) for the next several days aboard *SEA-SEE*. They include the following:

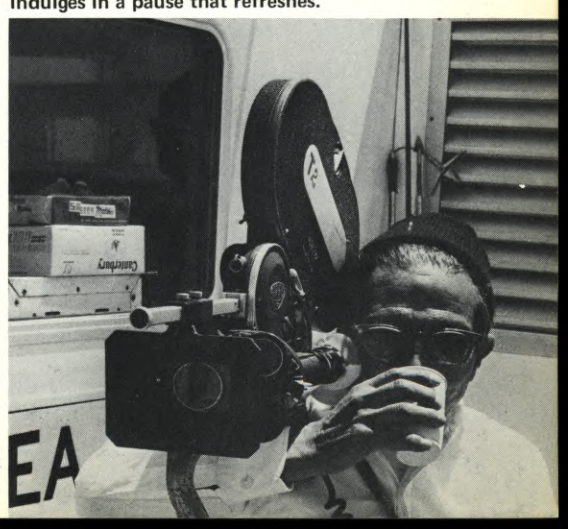
TOM GARCIA—Producer/Director/Cinematographer and Associate Head of the Motion Picture Branch at NUC, he shoots topside and from inside the bubble aboard *SEA-SEE*. A genial veteran film-maker who has tackled just about every type of assignment in the course of his career, he works "close to the edge" when something cinematic develops, and talks like falling into the drink with an Arriflex on a shoulder-pod is all in the day's work.

FRANK J. STITT—Producer/Director of motion picture productions for the Motion Picture Production Section of the Naval Undersea Research and Development Center. A former Navy underwater cameraman, Frank is an expert SCUBA diver. Together with Roy George, Head of NUC's Audio-Visual Division, he is responsible for much of the documentary photography actually shot in the water for projects involving *SEA-SEE* and others. A jolly wet-suited giant, Frank undertakes the most perilous projects with professional expertise and unfailing good humor.

L. E. "LARRY" McKINLEY—*SEA-*

Continued on Page 896

Too busy to remove the camera from his shoulder, dedicated cameraman Tom Garcia indulges in a pause that refreshes.



THE UNDERSEA WORLD OF JACQUES COUSTEAU

How the most famous of all underwater explorers hunts the denizens of the deep with aqualung and camera, and shares his adventures with a world-wide audience of spellbound TV viewers and armchair divers

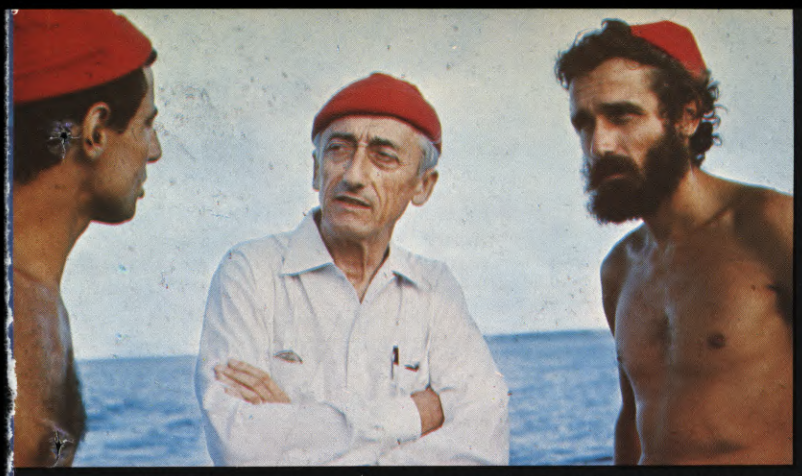
By CHARLES LORING

(TOP RIGHT) Philippe Cousteau, son of famed Capt. Cousteau, explores deep water with the Cousteau camera, assisted by Capt. Philippe Sirot. (BELOW LEFT) Exploring a sunken Japanese submarine off the island of Truk. (RIGHT) Thousands of tiny curious fish swarm about underwater cameraman preparing to shoot scenes of a sunken wreck for Cousteau TV special. (BOTTOM LEFT) A Humpback whale and calf, photographed from below, float lazily near the surface.

■ For the past 30 years, the most famous name in undersea exploration has been "Cousteau"—Jacques-Yves Cousteau, to be specific. His is a name that is synonymous with adventure, and for the last few years he has been sharing that unique type of adventure with a world-wide audience by means of the television medium.

■ In January of 1967, Capt. Cousteau began one of the most ambitious projects of his colorful career—a three-year around-the-world voyage during which he would film 12 hour-long specials in association with MPC (Metromedia Producers Corporation) and ABC-TV. The initial four specials, telecast during the first year under the general title of "THE UNDERSEA WORLD OF JACQUES COUSTEAU", included: "SHARKS", "THE SAVAGE WORLD OF THE CORAL JUNGLE", "SEARCH IN THE DEEP" and "WHALES". These programs drew glowing praise from the nation's critics and educators, as well as enthusiastic response from the public.

■ Such response was not really surprising, because Capt. Cousteau, having co-invented the Aqualung (and thus freed divers from being chained by umbilical cord to surface vessels), was one of the true pioneers in achieving underwater cinematography of professional theatrical quality. His films,



(LEFT) Capt. Jacques-Yves Cousteau briefs Chief Diver Christian Bonnici (left) and son, Philippe, on board his flagship, the *Calypso,* prior to the start of a new undersea adventure for his popular series of ABC-TV hour-long specials. (RIGHT) Capt. Cousteau suits up for an exploratory tour of the depths near Truk, and jokes with Philippe and diver, Jean-clair Riant.

(LEFT) Philippe Cousteau started out to be a pilot and actually graduated from flight school before deciding that the undersea world of "inner space" held a more rewarding promise of adventure combined with constructive achievement. (CENTER) A photograph taken from atop the 95-foot mast of the U.S. Navy research yawl, U.S.S. *Saluda,* by Philippe, while he was aboard filming porpoise research conducted by scientists of the Naval Undersea Research and Development Center in San Diego. (RIGHT) The intrepid cameraman, after taking picture at left, is photographed sliding down rope by Jacques Renoir, *Calypso's* topside Director of Photography.

(LEFT) Bernard Delemotte hitches a ride by holding onto the fluke of a 50-foot whale, as it ploughs through the deep. (RIGHT) Philippe Cousteau takes to the air over Truk waters, with hopes of spotting wrecks of ships to be filmed for TV special.

Cameraman films scene of the "Sea-flea" one-man submarine, while assistant holds cluster of two 750-watt lights, needed to bring out colors in subject.

based on his books ("The Silent World", "The Living Sea" and "World without Sun"), had won grand prizes in film competitions at Venice, Cannes and Paris, as well as three Academy Awards. In the course of making these films he had experimented with and perfected various cinematic methods and techniques of underwater filming which have since become standard.

At this writing, his company, *LES REQUINS ASSOCIES,* in co-production with Metromedia, has completed the first 12 specials contracted for and is well into creating the second dozen. As before, his floating base of operations is the converted former World War II American minesweeper, *Calypso,* which was purchased in 1950 and refitted as a revolutionary new type of research vessel.

The *Calypso,* 145 feet long and weighing 400 tons, is complete with sophisticated underwater research equipment, electronic apparatus, and other special features. These include:

—Two "Sea Fleas," one-man submarines capable of penetrating to a depth of 2000 feet.

—The "Mysterious Island," a broom-shaped laboratory more than 80 feet long. It can be floated to any given spot, its long hollow neck pointed straight down into the ocean floor to give scientists and divers a tunnel to the bottom of the sea. Filled with measuring devices and underwater portholes, it is topped by a control center and helicopter landing pad.

—Troikas, cine-sleds which film for 30 minutes at 15,000 foot depths. Towed by Calypso, the Troikas are designed to run in very rough, rocky landscapes without entanglement. They carry a 16mm underwater camera and electronic lights.

—Advanced diving gear with sonar devices for maintaining contact with other divers; two-way voice communication; helium and neon breathing apparatus. The equipment permits divers to descend to a depth of 300 ft.

—Self-contained suction pipe, a highly refined underwater vacuum cleaner, for archeological diggings.

—Shark cages, to enable divers to work submerged even when surrounded by hordes of man-killers.

—A close-up camera with two special lights, remote controlled by television from Calypso.

—35mm and 16mm underwater cameras, plus the most highly developed underwater lights yet invented.

—An underwater observation tower in the bow where cameras can record marine life in action in the lower layers of the sea.

During the almost four years that *Calypso* has been at sea filming the TV specials, its various divers and underwater cameramen have racked up a total diving time that is the equivalent of one man spending 16 months continuously under the sea.

Oddly enough, the cameramen do not shoot from formal scripts prepared in advance. They are simply given a subject (the behavior of a certain animal, a sunken treasure ship, etc.) and a general idea of how it should be handled visually. Then, with no actual plot in mind, they simply shoot and keep on shooting until enough interesting footage has been accumulated to cut a complete story.

For each individual special, an average of 150,000 feet of film is shot—to be later whittled down to a final 1800 feet. This is an enormous ratio of film shot-to-film used (probably the largest in the production of any TV series) and may seem to be extravagant. But one must understand that shooting takes place under all kinds of adverse and unpredictable weather conditions, that cloudy water often makes it next to impossible to shoot good footage and that the wide variety of sea animals photographed cannot be depended upon to do their thing on cue.

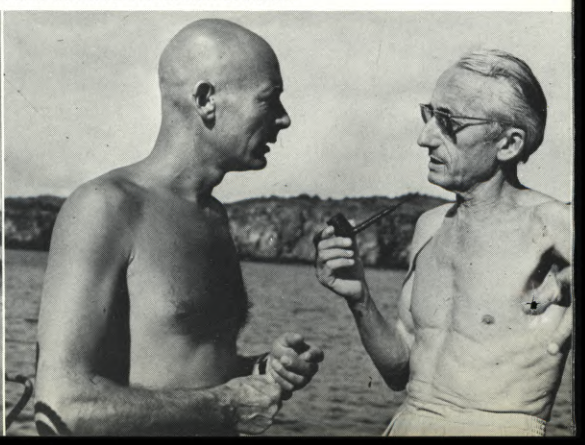
Editing is done in Hollywood with the multiple objectives of satisfying the sponsor, providing a vicarious true-life experience for the armchair diver, creating a learning tool for the scientist and entertaining a wide spectrum of the mass audience.

Whenever possible, filming aboard the *Calypso* is executed with sync-sound, using a Nagra recorder. The resultant tracks are rarely used in their original form as transferred. Instead, key sounds are isolated from these tracks and re-cut for mixing into a discriminating final track that eliminates extraneous background noises caused by motors, the wind, etc.

Exposed footage is rushed by plane to Hollywood, where it is processed by Consolidated Film Industries. The technicians at CFI are so well acquainted with the special problems, requirements and conditions under which this footage is shot that they automatically know exactly how to treat it. Lab reports on each processed shipment are sent back immediately to the ship by radio. If there has been a technical problem, it is isolated and a remedy suggested.

Occasionally, a flying team from the

(LEFT) Capt. Jacques-Yves Cousteau steers inflatable boat, while cameraman John Alonzo shoots Eclair camera. Arriflexes and Beaulieus are also used for topside filming. (CENTER) Cousteau "models" streamlined aqualung pack of his own design. (RIGHT) Andre Laban, shown here with Cousteau, is a key member of the team. He serves as production co-ordinator, liaison representative with Hollywood and also as underwater cameraman.



(LEFT) Diver from *Calypso* rides a "Scooter" underwater vehicle through the deep. (CENTER) The converted former World War II American minesweeper *Calypso,* now Cousteau's flagship, lies at anchor offshore in Alaska during recent filming expedition. (RIGHT) Cameraman and light-carrying assistant shoot scene of diver riding one-man "wet" submarine, so-called because driver rides in water, rather than inside water-tight compartment.

Calypso will leave the ship and travel by plane to a distant location for filming. This was done recently for shooting in the waters off Truk Island, scene of a massive battle that took place almost 30 years ago between Japanese and American warships. The assignment included underwater photography of the wrecks of more than 30 Japanese ships and numerous aircraft lying in waters ranging from three to 600 feet deep.

Data relevant to the cinematic techniques and equipment utilized in production of "THE UNDERSEA WORLD OF JACQUES COUSTEAU" is best provided by a key member of the film crew who, in the following dialogue, discusses these elements in detail.

PHILIPPE COUSTEAU (son of Jacques-Yves Cousteau)—Chief Underwater Cameraman aboard the *Calypso,* and Production Supervisor.

"Although I had been working in the sea with my father on most of his expeditions (and shooting 8mm movies of them), I did not originally think of this work as a possible career for myself. I wanted, instead to be a pilot, but, after graduating from flight school I discovered that I did not actually want to make flying my life's work. So I returned to Paris and spent a year at France's only government school of motion picture technique, the Ecole Nationale de Photographie et Cinematographie.

"After that I immediately started shooting on a National Geographic television special for my father ("THE EERIE WORLD OF JACQUES COUSTEAU"), filmed during the Conshelf III experiment. We lived at a depth of 335 feet for a month and worked there every day, out in the water. That one-hour picture was the first film we had on national television in the States and it led to the current series. I just stayed with it and kept on doing the same work, because the program was so well received by audiences that I was encouraged to persevere in that direction.

"The Cousteau underwater cameras which we have been using since 1954 are designed by our engineer in Monaco and built in our own workshops, utilizing some basic Bell & Howell Eyemo and Filmo elements. We build everything else, including motors and battery packs. These cameras are, in themselves, watertight—rather than being 'dry land' cameras enclosed in underwater housings. We have models in both 35mm and 16mm and they are being changed and improved in design all the time—which means that no two of them are alike.

"The cameras are kept very simple. They do not have interchangeable lenses and there are no electronics involved. A problem that everyone has is that cameras sometimes leak. This happens to us only rarely, but if a camera does leak, it can be taken apart, cleaned out with fresh water and alcohol, re-oiled and put back together within a matter of hours. We do not have to tie it up by sending it to a shop. Such simplicity is essential, because that's what keeps us shooting out in the boondocks where you can't even purchase a screwdriver for thousands of miles around.

"We use different types of lenses on the cameras, but most of them are very wide-angle. In 16mm the widest we use is the 5.7mm Kinoptic. The equivalent lens in 35mm is a 9.8mm. We now also have a fisheye lens that covers an incredible angle of 180 degrees, but it is rather slow—F/4.5, I believe. The water-correction ports are ground individually to the elements of each lens, which is one of the reasons why they are not interchangeable. All of our lenses under 16mm in focal-length are water-corrected.

"We use Taylor-Hobson-Cooke and Kinoptic lenses, mainly, and we have one Schneider lens on a 16mm camera. The Cooke lenses are really the best. They are fabulous in sharpness and the warmth of the images they record is fantastic. I don't like zoom lenses. They deprive you of the need to move. You simply move the lens instead of your body. I think that the quality on the screen, when everything is shot with a zoom lens, is pretty poor, no matter what everybody says. I like the three-lens turret better because the quality of the lenses is much superior—especially the Cooke lenses. Also, it forces me to move around and I figure that it results in a richer style of shooting. I think I'm the last one of the lot to stick to the three-lens turret.

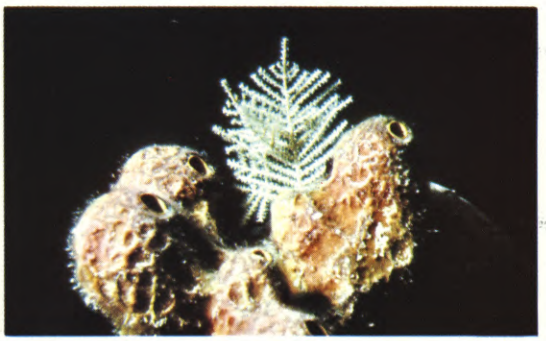
"Of course, in a lot of the shooting we do (especially topside) we have to use the zooms, because the action is so fast that you don't have time to change lenses. It's impossible. You have to film the whole thing as it happens, because it's not going to stop for you. So, in

Continued on Page 890

Calypso crewmen receive a jolting surprise when 50-foot gray whale they have been chasing suddenly turns and sounds directly beneath their rubber boat. They had been attempting to attach a buoy to the creature for study purposes.

George Krohn with lights and Tom Hall with camera descending to the bottom during filming of "THE PRIVILEGED WORLD", a beautiful undersea film by San Francisco production company, "The Film Works." Most of the filming was done off a deep ledge at Grand Cayman Island in the Caribbean. (RIGHT) Krohn coils cable for the initial lighting system used.

The waters around Grand Cayman abound with exotic creatures and formations. (LEFT) A very friendly trunk fish that visited the crew during filming. (CENTER) A miniature tree plant, surrounded by sponges. (RIGHT) A small, delicately colored squirrel fish, inside a large sponge.



(LEFT) The pale iridescent blue of a graceful tube sponge becomes visible under the lights. (CENTER) A sea anemone clings to the wreck of the *Balboa*, 45 feet deep in the harbor of Grand Cayman. (RIGHT) With camera at eye-level, Leroy French films various scenes around the sunken wreck.

"THE PRIVILEGED WORLD"

Excursions to the Grand Cayman Islands lead to the making of a film which, in turn, poses underwater lighting problems, eventually solved by means of an ingenious approach

Tom Hall of San Francisco production company, "The Film Works", swims over a coral reef with Kodak K-100 camera in housing, during filming of "THE PRIVILEGED WORLD".

For the past seven years a love of skin-diving in the clear Caribbean has lured Tom Hall and LeRoy French to Grand Cayman Island. For the past two years, however, their trips have had more significance. They were filming a movie.

"THE PRIVILEGED WORLD", a 20-minute color film, is a natural undertaking for both French and Hall. Tom Hall, who has been diving for eight years, is the executive vice president of The Film Works, a San Francisco film production company. C. LeRoy French, a professional diver for fifteen years, is the owner of the Bamboo Reef, a skin-diving store in San Rafael, and most recently has started Sojourns Ltd., a travel agency which conducts skin-diving expeditions around the world. For years French has been constructing plexiglass and aluminum underwater camera housings.

Their primary interest was illuminating the deep. Below 30 feet everything goes to a blue/green or grey color. They knew that there were beautiful brilliant colors there, but they could not be seen by the naked eye nor filmed. Both men were fascinated with the prospect of actually seeing as well as photographing the coral reefs, sponge growths, and the animal life below that depth. The only solution was to bring lights underwater.

The problems of underwater lighting are significant, and have to be carefully worked out. On their first filming trip, in June 1968, French devised a unique lighting setup. It was composed of a General Electric 100-watt, 110-volt system with four 1,000-watt aircraft landing lights. These were run by a portable generator on the boat, and connected by a 100-foot cable. All electrical connections were sealed with epoxy wherever the wires were spliced. They found, however, that on actual location, they were able to use tar for sealing whenever it became necessary. A metal bar joined the lights and, though there was a set of four lights, they used only two at a time and kept the others for back-ups.

The first year's filming was, in large part, successful. The footage they obtained was beautiful, the colors breath-taking. But the drawbacks of this lighting system were numerous. The lights couldn't endure the pressure below 40 feet, and their usage was limited to about a 60-foot radius. While the generator was running no one on the boat could touch metal because of the danger of shocks.

"They're not bad shocks," said French, "just unpleasant."

"The worst job on this project," Tom Hall explained, "was staying behind and watching the cable. We dove a lot at night and someone always had to be about 60 feet behind to keep the cable off the coral reefs. That meant swimming back and forth along the cable using one small light. The divers who were filming had the benefit of the large lighting system, but back there it got pretty lonely.

"We would dive at night with about five people in our company," French added. "They were all professional divers used to working together. Whenever we took amateurs down it was a disaster. At night it's hard to orient yourself and those who weren't used to it really got in the way. They'd keep bumping into us or kicking off someone's face mask.

"One incident I especially remember during a night was when the lights went out completely. It was the strangest feeling. The lights had attracted millions of little fish. When they went out all we could feel were the fish bumping into us—like thousands of small stones. The worst part was that in the absolute dark there was no way of telling which way

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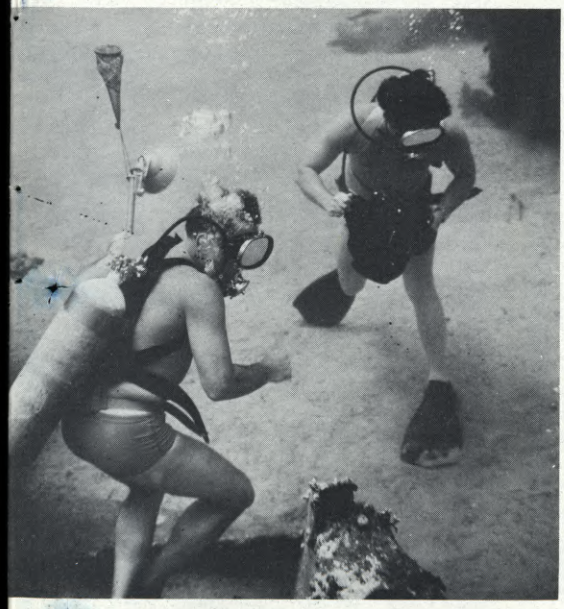
Tom Hall (left) and LeRoy French, with Bell & Howell camera, filming at 50-foot depth in the harbor at Grand Cayman, near the wreck of the ship *Balboa*.



George Krohn, holding aircraft landing lights, and Tom Hall, with the K-100 camera, in quest of subject matter for "THE PRIVILEGED WORLD".

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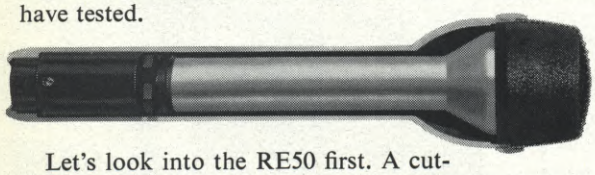

Let's look into the RE50 first. A cutaway shows that inside each RE50 nestles the familiar 635A, case and all. It's shock-mounted at top and bottom to the outer case. Even the connector is isolated from the actual microphone. And the problems of mass and resonance have been worked out (with the aid of our computer) so that contact noises and cable rustling never reach the Acoustalloy* diaphragm.

The result is remarkable isolation from all but air-borne sound, even in hand-held applications where microphone movement is uncontrolled. And when you add the extra protection of the built-in Acoustifoam* blast and pop filter, this is one of the quietest omnidirectional microphones you can find. Yet response, output level, and polar pattern are essentially the same as the 635A (one of the most popular professional microphones of all time).

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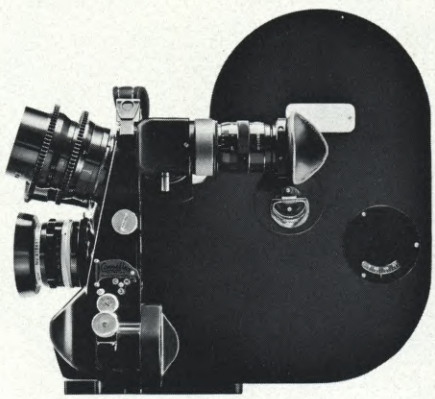
EUROPEAN CURRENCY REVALUATIONS HAVE CHANGED SOME CAMERA PRICES

So which is the least expensive, totally professional camera: the Arriflex 16S/B? No. The Eclair CM3.



What's more, the CM3 lets you change magazines in five seconds, plus...shoot 16 and 35mm with the same camera!

The Franc has been devalued; the Deutsche Mark has gone up. As a result, most French products, including Eclair cameras, have become less expensive on the U.S. market, while most German products have gone up in price.

With two 400 foot magazines, three lenses and constant-speed motor with sync-pulse generator, the CM3 now costs about $200.00 less than the Arri S/B GS similarly equipped. Not much less, certainly. But with all its features, you would expect the CM3 to cost a lot *more.* The Arri S, of course, is the least expensive Arriflex. It's the one with a body designed for 100 foot loads, to which you can attach a 400 foot magazine.

The CM3 is the Eclair camera that won an Academy Award for its design. In addition to its five-second clip-on magazine change and its unique capacity for shooting both 16mm and 35mm with the same camera body, same motor and same lenses, (different magazines), the CM3 gives you extremely bright and accurate reflex viewing, (simpler optics, groundglass at the film aperture), a viewfinder and eyepiece that each rotate through 360°, (any angle, either eye), three heavy duty bayonet lens mounts, (for critical seating of wide-angle and zoom lenses), plus a variable shutter, matte box and sound blimp.

You can also adapt the CM3 to shoot 35mm Techniscope in seconds, at no cost; and the CM3 accepts Panavision lenses. Most features are being shot wide screen, most commercials in standard 35mm, most industrials and documentaries in 16mm. The CM3 is the only camera that will shoot all three formats. What's *your* next job going to be? And the one after that?

For a CM3 brochure, write to Eclair Corp. at 7262 Melrose Ave., Los Angeles, 90046; or at 73 S. Central Ave., Valley Stream, New York, zip 11580.

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The Beaulieu R16B "Automatic" isn't the only 16mm reflex camera with a mirrored shutter.

But the other ones cost at least twice as much.

The mirrored shutter is one of the most critical differences between ordinary cameras and precision cameras. The Beaulieu's mirrored shutter is the guillotine type, angled at 45°. When it's open, all the light passes directly onto the film through the finest 12-120mm zoom lens made, the Angenieux. And there's no prism interfering between the lens and the film to cut down light intensity. When the shutter is closed, it's bouncing all the light through the reflex viewfinder. So your eye is getting the same brilliant, sharp image the film is. There are no parallax problems. There's no guesswork.

Monitoring the light is the finest automatic exposure control system ever built. The heart of it is a Gossen light meter, located behind the lens and linked electronically to a miniaturized servomotor that rotates the Angenieux's iris diaphragm ring. This system keeps the lens aperture constantly at the correct exposure setting, no matter how rapidly the light is changing.

Another advantage of the R16B "Automatic" is its weight, or lack of it. The 100 ft.-load camera body (less lens) weighs a remarkably light 4¼ lbs. And even when you load it up with a 200 ft. magazine, a sync pulse generator, and the Angenieux 12-120mm zoom lens, it still weighs only 10½ lbs., *including the battery!*

It's a nickel cadmium battery, and it's built right into the camera handgrip. Powerful? Beaulieu's 1000mA battery will roll 1600 ft. of film on a single charge. And you can replace it with a fully charged spare in seconds.

Not having to wear a battery strapped around your waist or swinging over your shoulder can make quite a difference when filming. Particularly when you want to hook up your Beaulieu with a professional recorder, like Nagra or Uher, for sync sound filming.

Wondering about the price? Then add up all the features of the camera—light weight, rock steady pictures, automatic exposure control, an electronically regulated motor, and a mirrored shutter. Then add to those features some rather important optional equipment—a 200 ft. daylight-load magazine, a sync pulse generator, an Angenieux automatic 12-120mm zoom lens, and a rechargeable nickel cadmium battery. The whole package comes to a little over $2,650—at least half the cost of any other precision camera with a mirrored shutter.

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THE SPECIAL DEMANDS OF UNDERWATER CINEMATOGRAPHY

Specialized techniques and equipment with which to meet the unique challenges of filming underwater

By CHRISTOPHER SWANN

The dramatic advances of the last few years in undersea technology have created a demand for qualified underwater personnel capable of carrying out any type of photographic assignment. Although at present the demand is a limited one, the ever-increasing interest of private industry in the sea can be expected to provide considerable impetus for the utilization of underwater photography and cinematography over the next few years.

THE UNIQUE CHALLENGES PRESENTED

Even under the best possible conditions filming underwater presents the cameraman with numerous problems not encountered on land. Owing to the far greater density of water as compared to air, light is rapidly absorbed—which results in generally low light levels. Light is further diffused to a greater or lesser degree, depending on conditions, by matter in suspension. This, of course, also affects visibility and can, in extreme cases, mean that a diver is unable to see even six inches in front of him. Suspended matter can be anything from small sand particles to microscopic organisms such as plankton. Matter in suspension can be a serious problem when artificial light is used since the individual particles reflect light back in the general direction of the source, causing what is termed "back-scatter." For this reason it is important to avoid flat, frontal lighting as much as possible. Much research is now being done in an effort to solve this problem, mostly with still photography, by groups such as the Naval Ordnance Test Station, Pasadena (NOTS), but it is still too early to look for any practical results that could be applied to general underwater photography.

Underwater cameraman using Arriflex 35mm camera inside Birns & Sawyer housing films sequence in Marineland of the Pacific tank while accompanied by curious Mola-Mola (giant sunfish).

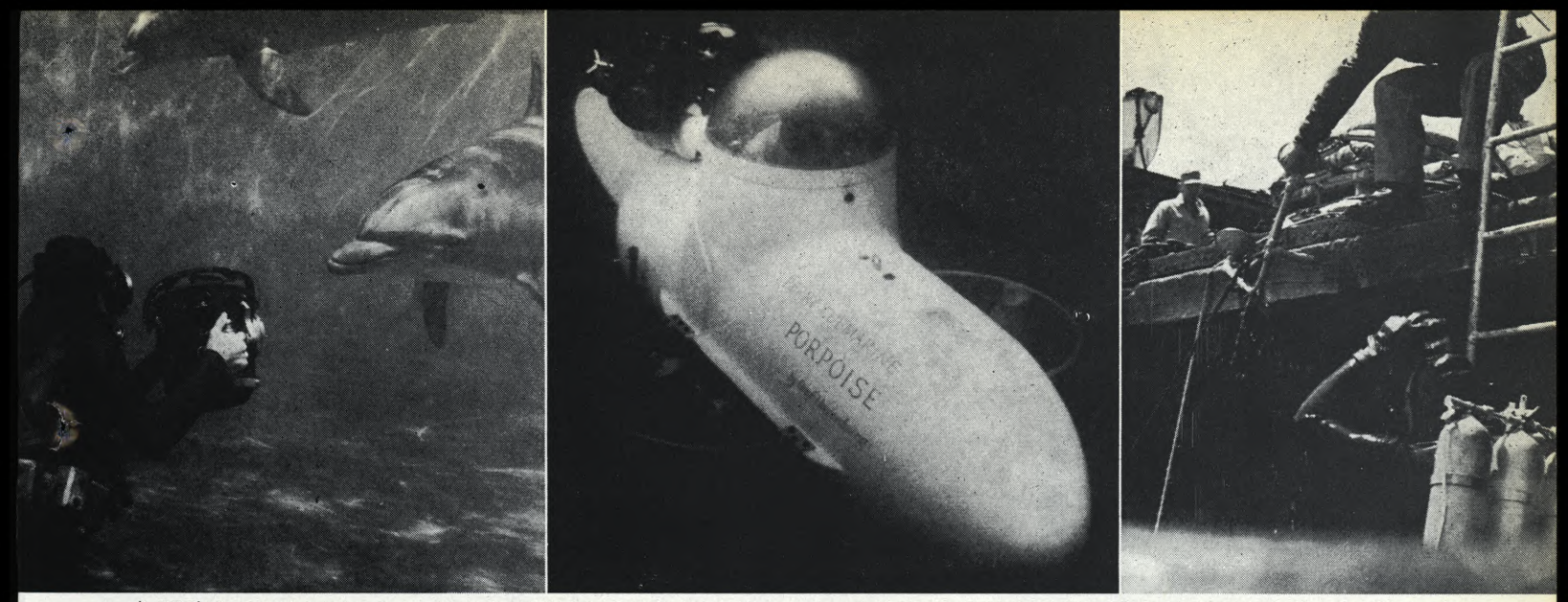
One further problem complicating color photography is that the warm end of the spectrum is rapidly filtered out by the water as depth increases. This means that red has been lost usually by ten feet of depth. At a depth of 60 feet the diver moves in a blue-green twilight world devoid of color. When one considers that light underwater is of a diffuse nature at best, it will be realized that gaining contrast is a problem. To counteract these problems of color and contrast an artificial light source must be used. Color correction filters (CC series) are of doubtful value in color work since one cannot hope to restore the original colors and the filter factors become prohibitive. In black and white work, contrast filters can be useful. Unfortunately most Panchromatic films are least sensitive in the blue-green region of the spectral sensitivity curve, which of course only aggravates the problem (this is in contrast to the human eye which is *most* sensitive in this region—a fact of no small fortune to divers).

Since the refractive index of water is 1:33, objects underwater appear closer by one third. For this reason it is necessary to use wide-angle lenses (it is impossible to use a long focal length lens and wide angle lenses become as normal lenses). Since visibility underwater is far less than on land, even under the very best conditions, the use of wide angle lenses also means that the amount of water between camera and subject is reduced, hence improving definition.

HOUSINGS FOR UNDERWATER CAMERAS

The elements play no small part in underwater photographic work. Currents that are frequently encountered off-shore make the use of bulky housings impossible, since they present a large surface for the current to act on. This usually means that the diver is unable to operate successfully. Housings that are unduly negatively buoyant are also prohibitive as the deeper one goes the more negative they become. For this reason housings should, ideally, be fitted with a variable buoyancy system. When working from a boat or barge even quite moderate seas can create difficulties in handling equipment and unless it is built to take some hard knocks it will not survive long. Also it is well to bear in mind that the average work barge or oil platform is no studio and that equipment may well have to sustain some rugged treatment.

The ocean has often been described as an alien and hostile



(LEFT) Cameraman using Bolex in underwater housing photographs porpoises at Marineland. He is wearing 80 lb. lead-weight belt and walks on the bottom of tank for stability. In open ocean filming, author recommends surface-supplied breathing apparatus as superior to SCUBA gear. (CENTER) Cameraman with Sampson-Hall housing hitches piggy-back ride aboard miniature one-man Perry Cubmarine. (RIGHT) A battery of quartz underwater lights is hoisted aboard barge following underwater filming session.

environment, and yet man has proved that he can successfully adapt himself to life under the sea and carry out useful work. The same is true of underwater motion pictures. The photographer finds that he must adapt himself, his techniques and equipment, to the underwater environment and still follow basic rules of film production if the end result is to be of acceptable quality. Most existing motion picture camera housings leave a great deal to be desired and this is largely because there has been little incentive to date for manufacturers to develop improved equipment. The market is, at present, a very limited one.

Both the Bolex and Sampson-Hall* (which are two of the most frequently used 16mm underwater housings) are limited to a 100-foot load and, in standard form, neither has electric drive. Repeated surfacing to change film is annoying at best and, when working deep, becomes impossible due to the decompression stops and the resultant interruptions.

Though the Bolex has several noteworthy advantages (ease of fitting the camera into the housing, worm and gear connections for f-stop control and single-action lever to seal the housing) it does not handle underwater nearly as well as the Sampson-Hall.

This is largely because of their comparative shapes: The Bolex housing is pretty well rectangular whereas the Sampson-Hall is cylindrical. In addition, the Sampson-Hall is better balanced and less negatively buoyant (this can of course be varied by the addition of weight to the underside of the housing or, conversely, by fitting a flotation collar). Another advantage of the Sampson-Hall is the very clear view finder which can be seen through the port at the rear. The diver thus places his face-plate right up against the port which helps him to steady the camera.

On the minus side, changing film with the Sampson-Hall is less convenient and more time-consuming than with the Bolex. It is necessary to undo six bolts in order to remove the chassis on which the camera is mounted, and to slide it back in, the f-stop and winding controls must be accurately lined up. With practice this can be done quite quickly but the fact remains that it is far from ideal. The f-stop control is too flimsy, consisting of a shaft with undersize gears and a thin metal band that connects it to the diaphragm ring on the lens. This can easily become disconnected. Obviously this shortcoming can be rectified by some intelligent modifications.

The Birns & Sawyer housing for the Arriflex (available for both 16mm and 35mm) provides both 400-foot film capacity and electric drive. However, in order to accommodate the magazines, the housing is very bulky and would prove impractical in a strong current or where any considerable distance had to be covered.

The aluminum housings have a maximum depth capability of 450 feet. However, this can be extended if the customer so desires. Fibreglass housings are generally engineered for greater depths—in excess of 1,000 feet. Here again housings can be built to the customer's depth requirement.

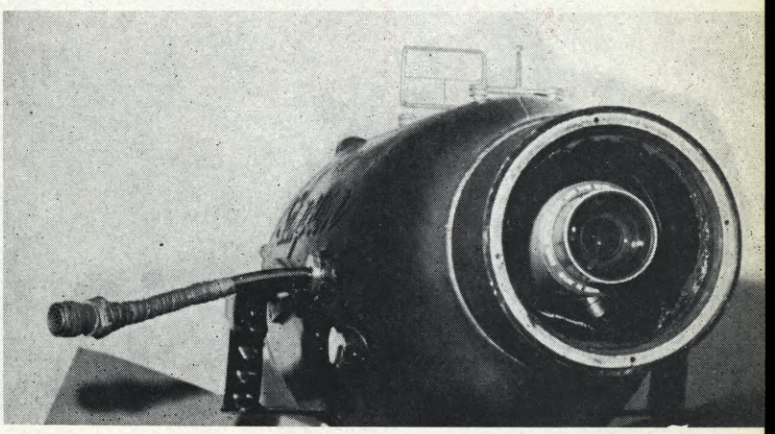
The question is how to reconcile adequate film capacity with a size of housing that can be used under a variety of working conditions. The fact is that the only way bulk can be kept down is by using a camera with a side-mounted magazine, such as the old Cine-Special Kodak. However this camera is no longer manufactured and the largest available magazine has only a 200-foot capacity.

It is worth noting that Al Giddings of the "Bamboo Reef" in San Francisco has designed a very fine housing around the Cine-Special. Indeed, many people either modify existing systems or design their own according to a specific need.

BREATHING APPARATUS FOR THE UNDERWATER CAMERAMAN

Although *scuba* gear is usually considered to be the most satisfactory diving equipment for filming underwater, we

The Sampson-Hall underwater housing, which accommodates most 16mm and several 35mm cameras. As pictured here, housing has been adapted by Gordon Enterprises to hold small television camera for Special Effects work at M-G-M Studios.



have found that for shallow work surface-supplied equipment is to be preferred. In this case, the diver wears approximately 80 pounds of lead and heavy shoes and walks on the sea bottom. Contrary to what many people think, a diver trained in the use of this equipment can move with great ease and rapidity and since his air supply is being fed to him from a compressor on the surface he can remain submerged for extended periods. The use of a full-face mask permits the installation of a telephone system, and in this way divers are constantly in contact with the surface, as well as with each other.

The advantages of such a system are immediately obvious. The cameraman is able to stand firmly on the bottom and obtain steady shots without worrying about any unwanted movement. The action can be directed by means of the telephone without loss of time caused by "actors" not understanding hand signals. Furthermore, since a constant air supply is available, shooting can be completed without the inconvenience of having to surface to change tanks. The depth to which one can go with this equipment is entirely dependent on the output of the compressor being used and the number of divers being supplied by it.

For deep work, or filming in open water, we prefer to use *scuba.* Extreme ease of movement and complete independence from the surface are important advantages of this type of equipment. There are some serious disadvantages, however. A diver's time at depth is relatively limited even with the largest available tanks, and also, no satisfactory wireless communication system yet exists. Therefore, *scuba* divers must still rely on hand signals or some form of audible code system for communicating, which has been found, for the purposes of filming, most inadequate. Added to this is the problem of nitrogen narcosis or "rapture of the deep" which renders a diver progressively less efficient as the depth increases. Although most people do not become seriously affected before 160-180 feet, filming in the region of 100 feet can still prove problematical. Average divers are slow in understanding signals and have difficulty in working out even simple problems. For this reason either direct reading light meters, such as the Sekonic or Spectra, should be used or else a card with equivalent f-stops should be placed in the housing so as to avoid making computations under water.

As yet, there are no practical solutions to these problems. Small high-pressure air tanks manufactured from special materials greatly extending diving time will undoubtedly become available in the near future. At present, however, the only solution is to use twin 72-cubic-foot tanks. They are bulky and extremely heavy out of water but are a necessity for filming at any considerable depth. The problem of nitrogen narcosis has long since been solved with the introduction of mixed gas equipment, in which nitrogen is usually almost entirely replaced with helium. However, self-regulating *scuba* units of this type are still for the most part in the experimental stage and are not generally available. Present underwater wireless communication equipment, as already mentioned, leaves much to be desired. It goes without saying, that an efficient system of this type would be most valuable in underwater film production.

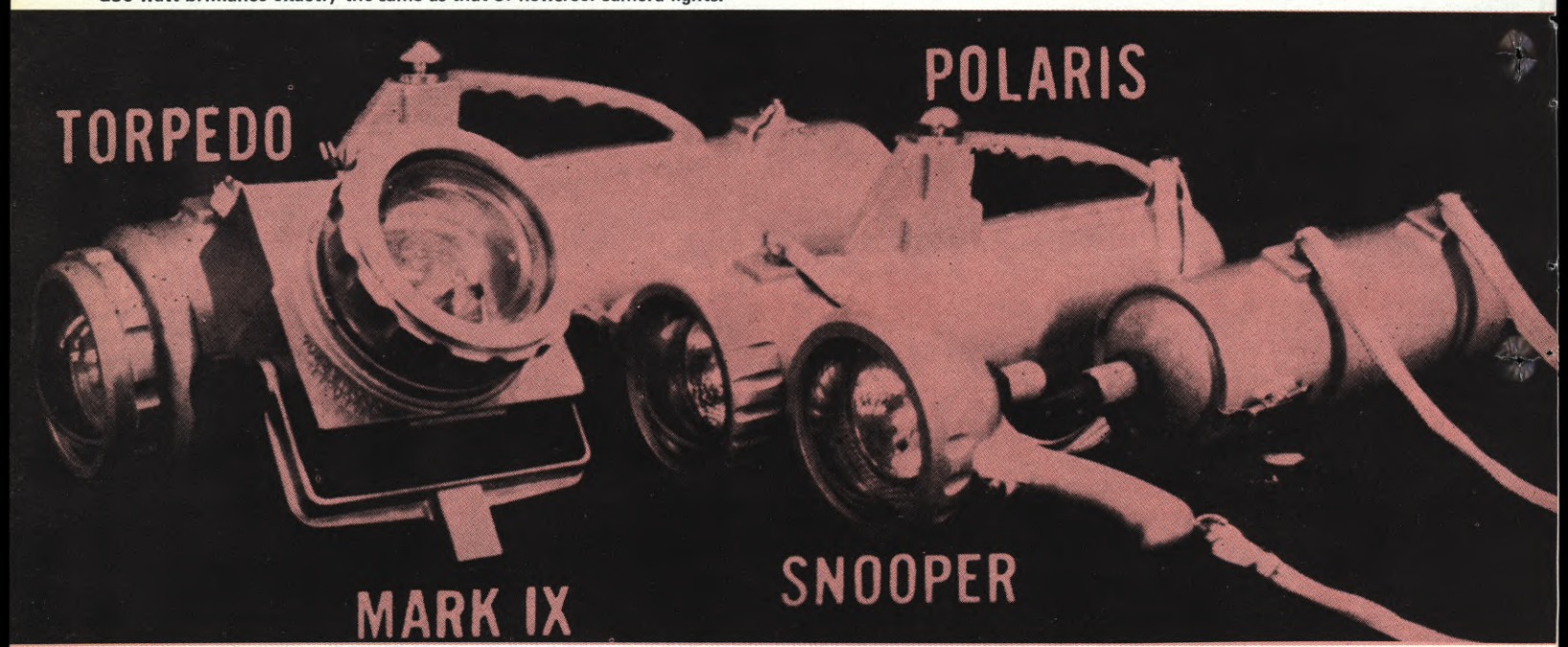
LIGHTING THE WORLD OF THE DEEP

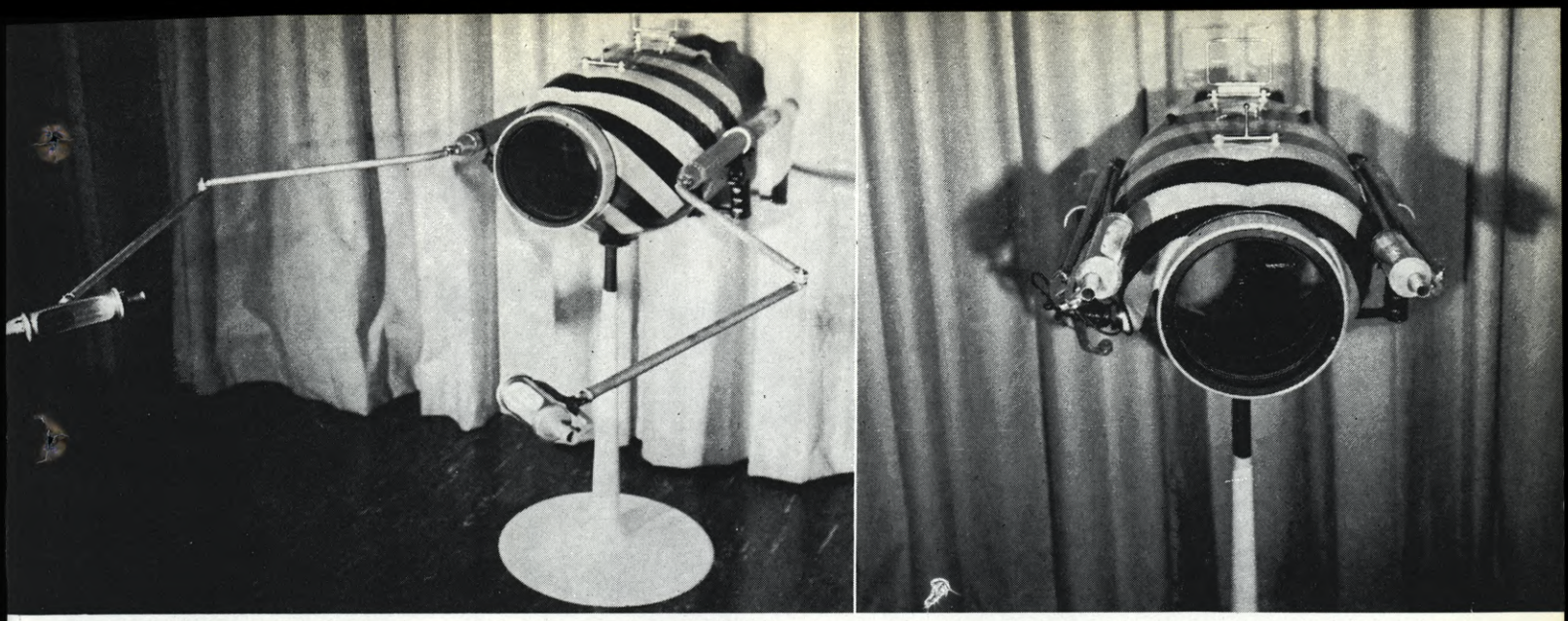
Artificial lighting underwater can be a great asset; indeed, often it is a necessity. Since the warm end of the spectrum is rapidly filtered out as one descends, it is necessary to take down an artificial light source if the true colors of underwater subjects are to be recorded. This filtering effect varies from area to area, but red is usually lost by about 10 feet.

It is amazing how much light one needs underwater, and for this reason D.C., battery-powered lights are hardly worth considering. With the Nickel Cadmium batteries they become intolerably bulky and, apart from putting out very little light (it would be hard to obtain much more than 8,000 Lumens from a 30-Volt unit), they will generally run no longer than 15 minutes to a charge. Add to this the fact that recharging is a lengthy procedure.

Quartz lights of varying outputs are available. These are mounted in stainless steel housings and are extremely compact. D.C. units can be run off the camera power supply when coupled to a Sampson-Hall housing.

A line-up of Birns & Sawyer SeAQUArtz underwater lights. TORPEDO is heavy-duty unit which delivers 28,000 candlepower from a 250-watt lamp powered by oversize batteries operating for 45 minutes at 3400° Kelvin. MARK IX, delivering 65,000 center-beam candlepower, operates down to 9,000 feet, was used in search for lost hydrogen bomb off Spanish coast, as well as on Sealab II project. POLARIS uses GE volta-bloc batteries of 22-minute capacity to energize 250-watt lamp at 3400° Kelvin. SNOOPER, with 30-volt battery in case attached to diver's air tanks, delivers 250-watt brilliance exactly the same as that of newsreel camera lights.





(LEFT) Jon Hall underwater camera housing equipped with light attachment. 1000-watt, 110-volt or 375-watt, 30-volt quartz-iodine lamps operating off same battery pack as camera can be used. Extending lights in this manner prevents back-flare of light into camera lens. Housing is of type being used by U.S. Navy to accommodate Mitchell Monitor 16mm high-speed camera. (RIGHT) Extension arms retracted for swimming when lamps are not being used. Lights may be detached or replaced under water.

Standard, sealed-beam, A.C. Quartz lights, without a protective casing can be used down to about 150 feet, in our experience, and we have heard of them being used down to 200 feet. These lamps can therefore safely be used in a medium depth range, say to around 100 feet, and since they are rated at 3200K (or 3400K) they are ideal for use with Ektachrome Commercial 7252. Two 1,000-watt lamps, putting out 33,000 Lumens each, mounted on a bar, make a handy set and the generator needed to run them is not too bulky for operation in a small boat. However, for work under low light levels where sufficient clarity exists for long shots, about double this amount of light would be needed. In this case, a key and fill should be used as too much direct lighting is undesirable. Small particles in suspension reflect light back into the lens of the camera causing a "snow storm" effect. The problem is the same as driving a car at night through fog.

Lights can also be used in shallow water as a fill, but reflectors would give a more natural and less harsh effect. This is especially true over a white sand bottom where advantage can be taken of the natural reflection.

When bare Quartz lights are used care should be taken to provide some shielding to protect the diver in case of implosion. A good way of doing this is to mount the lamps in strong metal reflectors. It should also be remembered that these lamps are not expressly designed for use underwater and therefore the depth at which they will implode may not be uniform. All connections must be well sealed and the cable should be regularly checked for cracks and weak points in the insulation. This is of paramount importance when working in fresh water. Fuses should be mounted on deck as a safety precaution in case of a runaway generator.

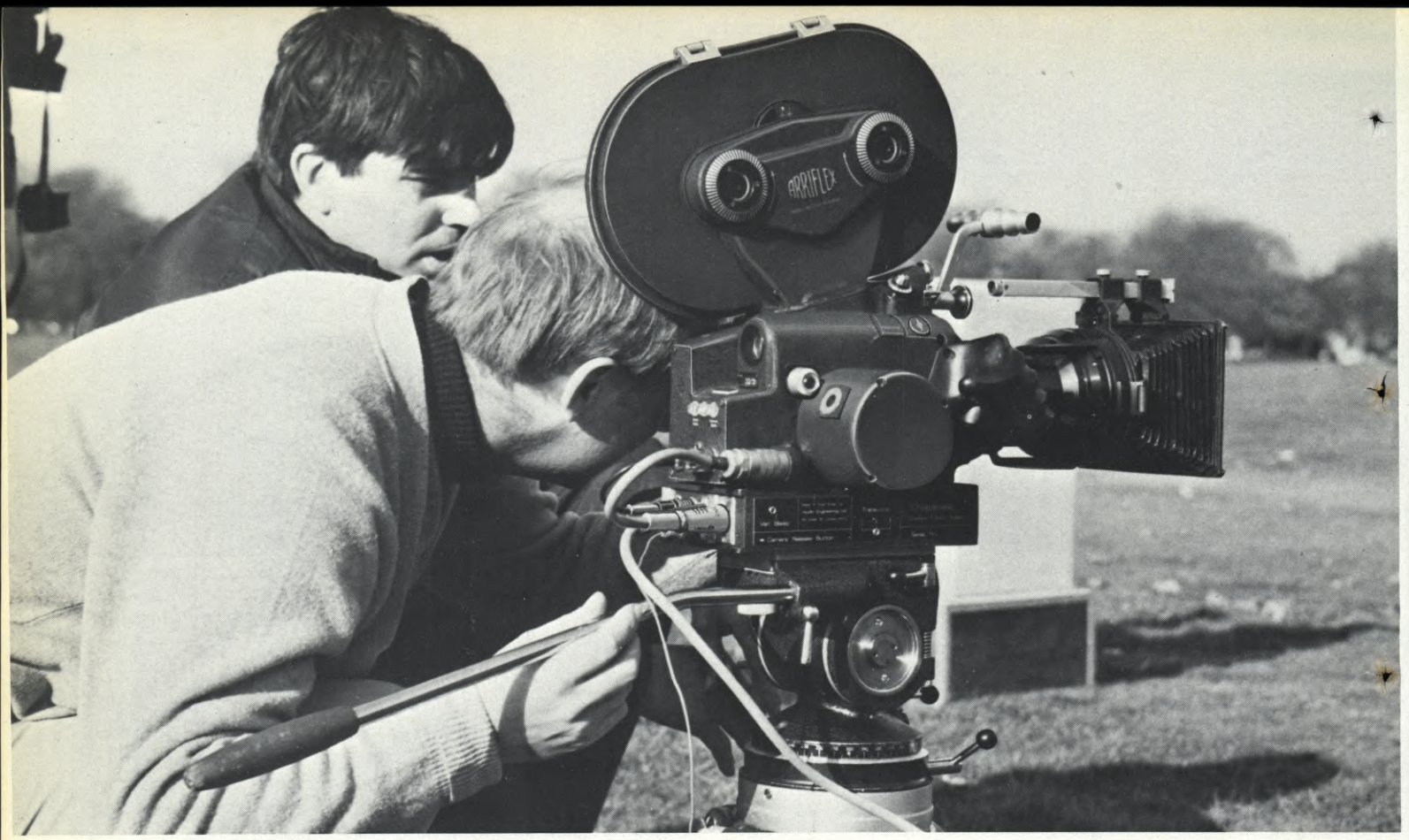
In general, we have used Ektachrome Commercial 7252 underwater for its fine quality. However, with a tungsten rating of 25 ASA one is generally working at wide apertures, which, together with the magnification, is one more reason for using wide-angle lenses underwater. While filming "Project Purisima" for Ocean Systems Inc. we found we were shooting around f/1.2 to f/1.6 with two 650-watt Quartz lights (25,000 Lumens each) at 110 feet. Naturally, the amount of light at any given depth varies with surface light conditions, time of day, the seasons and from one part of the world to another. The amount of matter in suspension also greatly affects the light level.

Ektachrome MS, rated at 64 ASA (dayight) is an alternative, but grain is more noticeable. The new Ektachrome EF, which replaced the old ER, has proved to be a good compromise. Primarily intended for color news work, the daylight stock is rated at 160 ASA and the Tungsten at 125 ASA (3200K)—80 ASA with 85 filter—and can be pushed to 1000 ASA if necessary. Despite its speed the granularity and sharpness are far superior to ER and color rendition has been improved. Westinghouse is using this film exclusively now in its cameras on the "Deepstar" submersible and have, reportedly, obtained good results.

CALCULATING UNDERWATER EXPOSURE

As already mentioned earlier, exposure control should be set up so as to avoid having to do any math underwater. Most meter housings are made of plexiglass, but these are less durable and pressure resistant than metal. The Sekonic Marine is a compact Cds meter capable of withstanding pressures to 300 feet. It is reflected light meter and is handy to use. However, we have found incident light readings to be superior, for a number of reasons. A reflected light meter takes a general reading and it is difficult to know exactly what it is metering—in many cases one would have to take close up readings of light and shadow areas to determine the exposure, which is not always practical. Also certain types of bottom, such as light sand, will falsify a reading by throwing up a great deal of reflection. If care is not taken subjects can thus easily be underexposed, depending on the position of the shot relative to the bottom. With incident light one simply measures the general light level at the particular depth and from this the f-stop is arrived at by taking into account the particular circumstances. For example, for filming against-the-surface shots, when a silhouette is desired, one would close down two stops from the general reading. For a straight down shot, open up one stop, taking into account the nature of the bottom. As always, the reading should be considered a guide from which correct exposure must be determined by judgment and experience.

Diving in general, and underwater photography in particular, are still in a fairly rudimentary stage of development when compared to the techniques of the Aerospace industry. However, things are now, finally, on the move and the ocean is already revealing itself as a challenging frontier, not only to the scientist but also to the film maker who sees it as a fine setting for his work. Equipment and techniques have far to go certainly, but a start has been made and the future is looking brighter. ■



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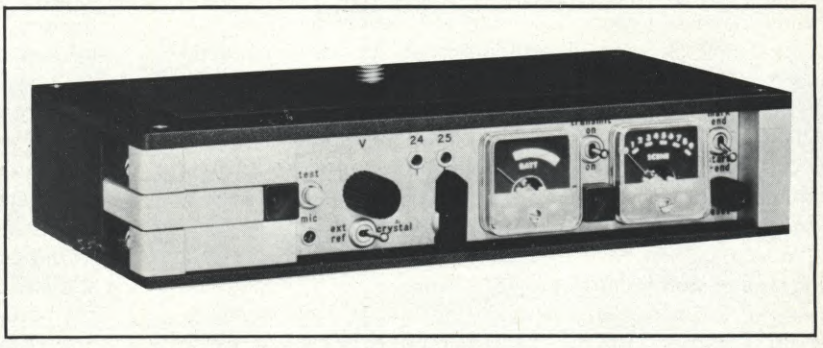

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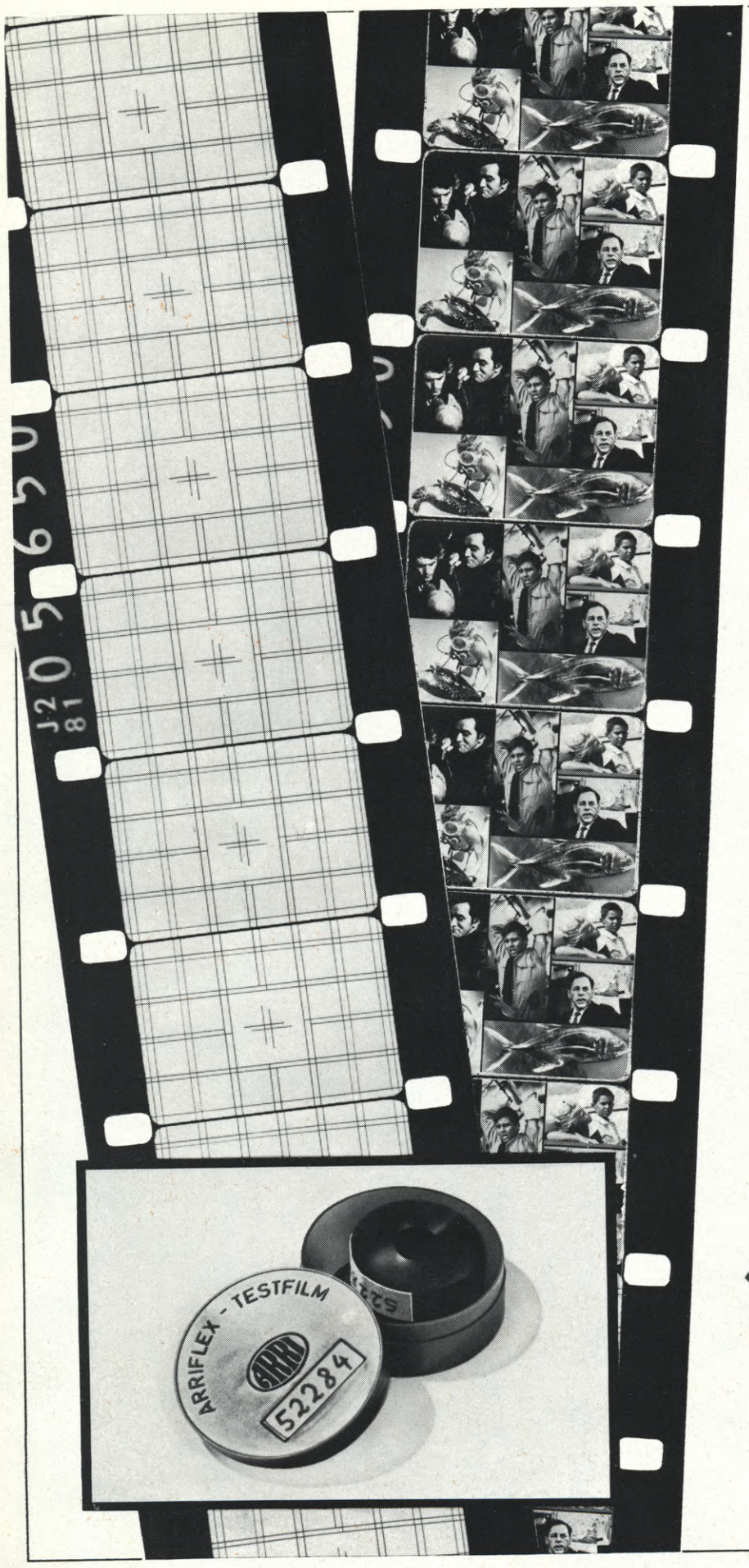

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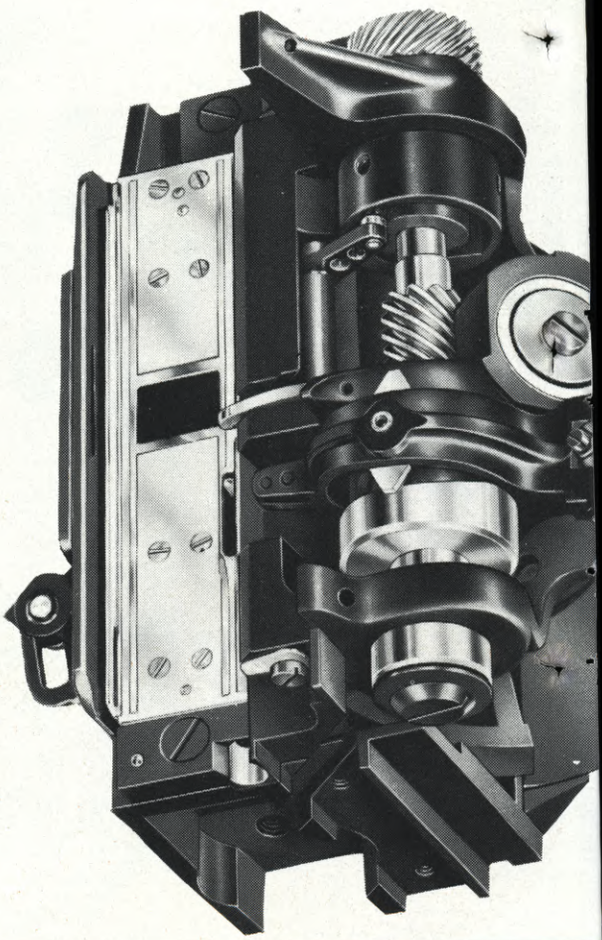

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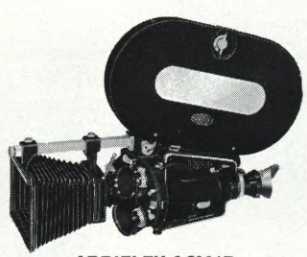

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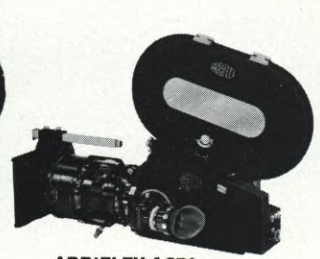

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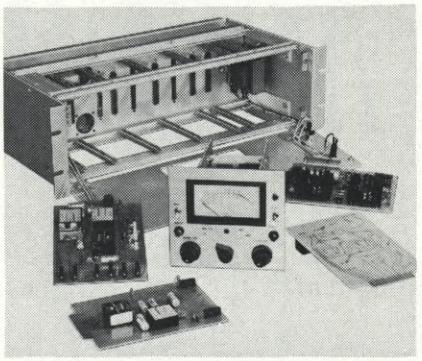

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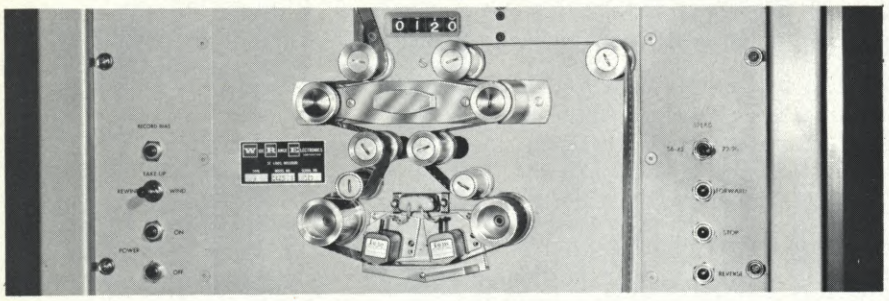

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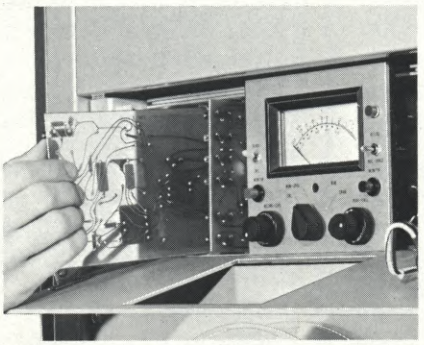

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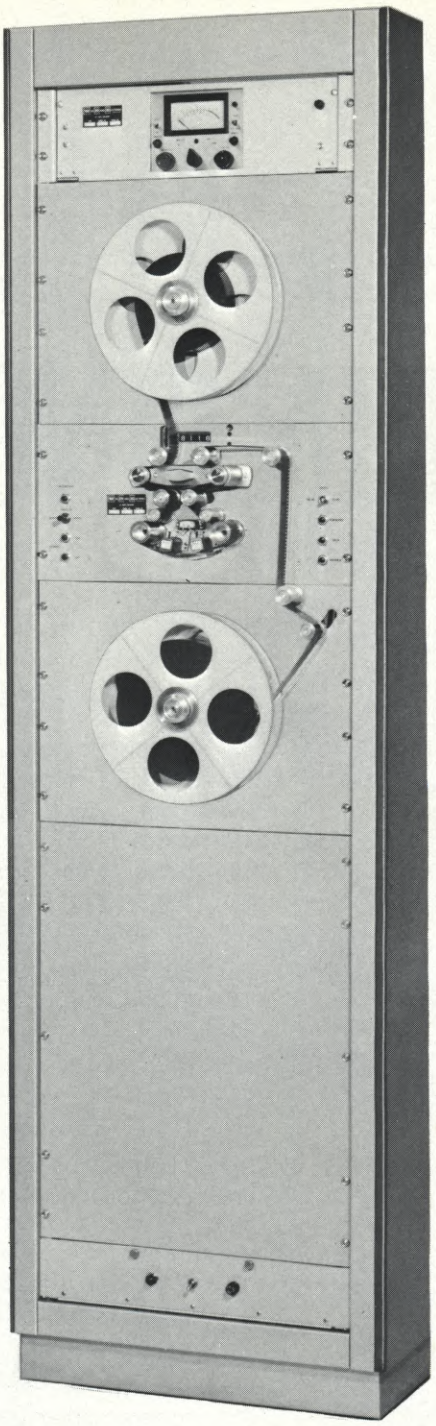

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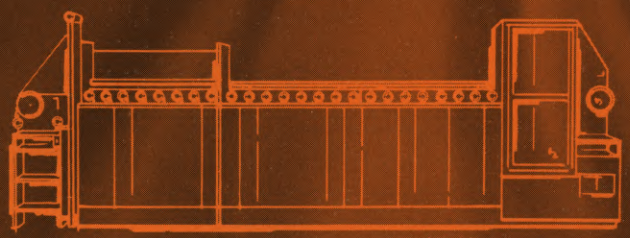
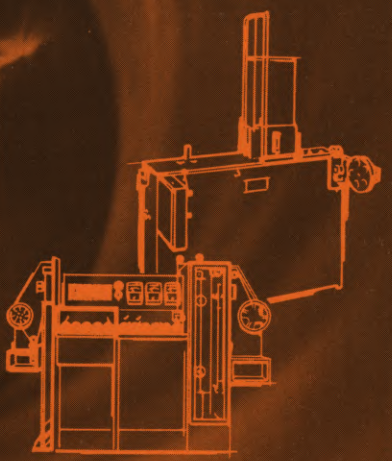


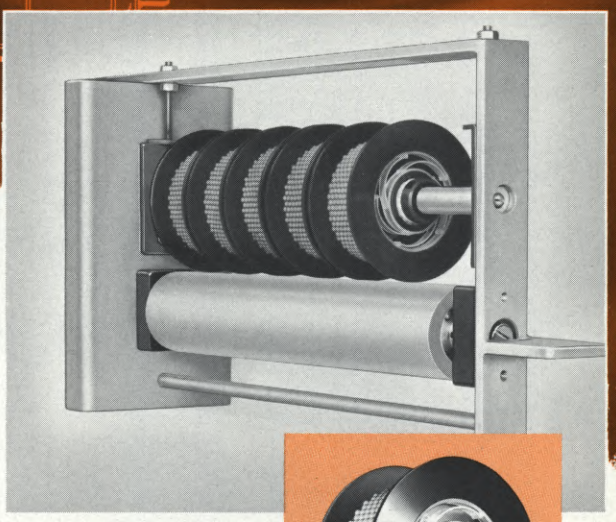


Now you can change film sizes ...and still maintain uniform tension and constant speed!

Any laboratory that changes film sizes frequently or plans to process multi-perforated film will find the new Treise Processors a dream to operate. They feature a revolutionary new type of demand-drive that assures uniform controllable tension and constant film speed throughout the processor.

The heart of the Treise SBR-Drive is a unique new film roller with a flexible heavy-duty 5-leaf spring insert. The spring bearing rollers (SBR) are mounted on a stationary shaft at the top of each rack and are free to rotate. An overdrive shaft is mounted directly underneath. As film tension increases (or decreases), the SBR contact (or pull away from) the drive shaft. The result is individual strand control! Due to the unusual construction of the Treise spring insert, the distance between the rollers and the drive shaft is so small that the slightest change in film tension creates a response and thus maintains a remarkable degree of equilibrium.

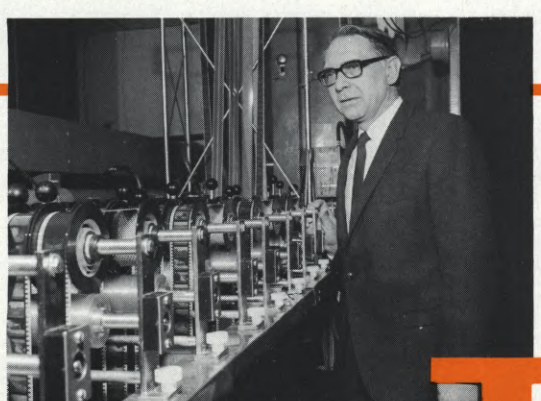
All SBR are equipped with "soft touch tires" that firmly grip the film and smoothly move it along without the slightest scratch or abrasion. Treise processors operate smoother, too, because they feature heavy-duty gear box drive and torque motor take-ups.



When using SBR-Drive, the elevator is kept at a fixed position less than an inch from the bottom of the tank, thus permitting full utilization of chemical solutions. SBR-Drive comes either in individual lift-out racks or as part of a complete unit lifted out by hoist, for quick easy servicing.

SBR-Drive includes an automatic braking system to stop the processor, in the event a film breaks due to some error in handling.

The new Treise SBR-Drive Processors feature stainless steel tanks, with hastelloy or titanium components in ferri bleach areas. Models are available to accommodate any film size from 8mm to 105mm, to handle any kind of process, and to operate at speeds from 30 fpm to 250 fpm.



Bill Smith, Allied Film President, checks over his SBR-Drive.

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THE INNERMOST LIMITS OF THE HOLLOW WAVE

A world-famed surfer-turned-filmmaker creates his own highly specialized equipment for the subjective photography of wild rides through tunnels of water

It is a balmy Indian Summer evening in Van Nuys, California. Outside the auditorium of Van Nuys High School mills a crowd of tanned, superbly healthy, athletically-built teenagers—the golden young surfers of California's Gold Coast. They are here to see a screening of a new surfing film called "THE INNERMOST LIMITS OF PURE FUN".

It would be hard to imagine a more wholesome, better-behaved group of young people. Yet, unaccountably, there are almost a dozen policemen stationed about the entrance to the auditorium—a pretty badly out-of-shape group, compared to the lithe surfers. Can it be that they are actually expecting some sort of riot?

As it turns out, the only riot that develops is a benign one of enthusiastic audience reaction to the exciting images that flow across the screen during the showing of the film.

George Greenough prepares for filming from a surfboard inside the giant tubular waves of the Pacific. Strapped onto his back is 35 pounds of special gear which (with the exception of the camera) he designed himself. Rig includes an over-the-shoulder camera mount, fiberglass camera housing, portable twin quartz lights and battery packs for both high-speed camera and lights.

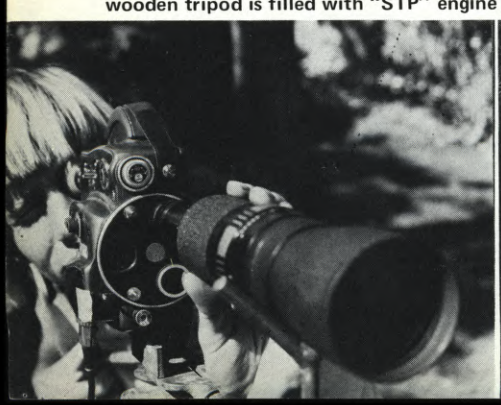
Inside the auditorium, running the 16mm arc projector and riding herd on the pulsating original rock score that accompanies the picture, is a figure who looks like the archetype surfer—lean and fit, barefoot, with a shock of hair bleached almost white by sun and salt water. He walks with the characteristic gait that echoes the rhythms of the sea. When he talks his speech reflects an intelligence so keen that his words have a hard time keeping up with its lightning pace.

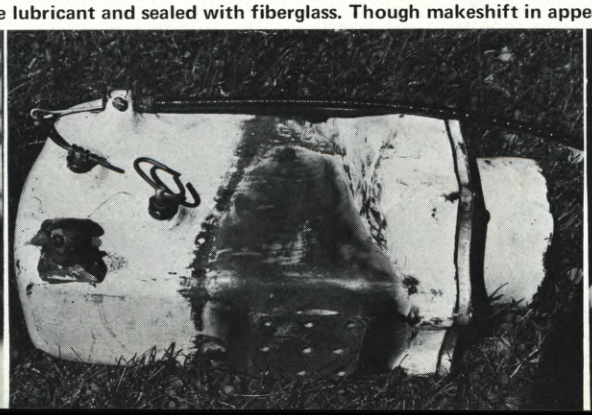
This is George Greenough, a living legend in the very special world of surfing. Mention his name at any surfers' beach from Malibu to Perth, Australia, and the reaction will be one of awe. He is the surfer's surfer, officially one of the ten best in the world. There are those who consider him the greatest of them all—in a class by himself.

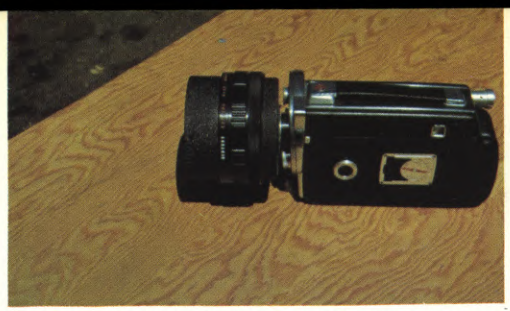
But this 28-year-old native of Santa Barbara, who looks like a salty Huckleberry Finn, is far more than simply a surfer. He is a world-renowned designer of surfboards (his designs have revolutionized the technique of the sport), a highly-skilled designer of yachts, and now, a film-maker who has done what no maker of films has done before: ridden inside the tunnel of the hollow wave with a camera mounted on his back to capture on film that special mystique that drives surfers, like lemmings, into the sea.

"THE INNERMOST LIMITS OF PURE FUN" is Greenough's first feature-length production—and it is *his* film all the way. He produced it, direct-

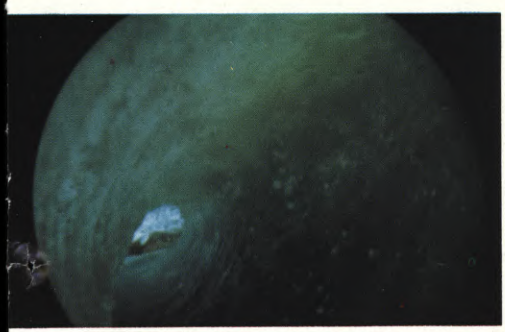
(LEFT) Greenough shoots from shore with telephoto-mounted 16mm Beaulieu camera. Its versatile features make it ideal for surf filming in the water, but since it is his "most valuable and expensive camera," he is reluctant to risk losing it in the "wipeouts" that often occur. (CENTER) Fiberglass housing for Kodak K-100 camera includes pull-cable for start-stop and external winding lever. (RIGHT) Homemade fluid-head on old wooden tripod is filled with "STP" engine lubricant and sealed with fiberglass. Though makeshift in appearance, it works perfectly.

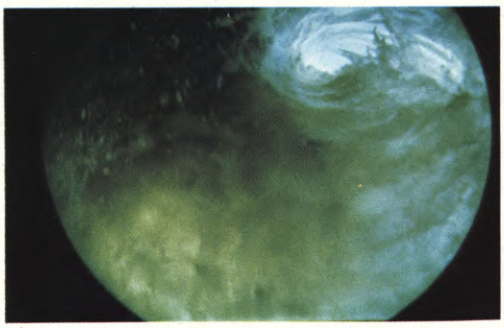


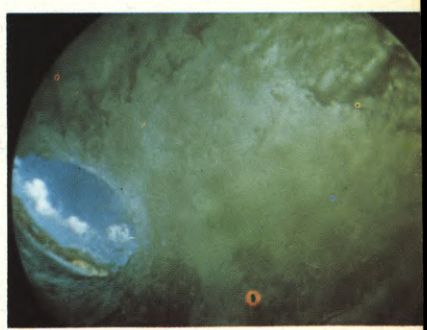




(LEFT) Greenough demonstrates use of rifle-stock mount with Bolex in underwater housing. He uses this while simply sitting on his surfboard in the water to shoot closeups of other surfers whizzing by. He usually has a 75mm lens mounted, sights through the reflex viewfinder, and follows focus. (CENTER) The Eastman K-100 camera with new ultra-wide-angle lens built to Greenough's specifications by Century Precision Optics, Inc. (RIGHT) The new lens is F/1.5, has a focal-length of 3.5mm (covering an angle of 165 degrees) and has some barrel distortion, though not nearly as much as a "fisheye." It is extremely sharp to the edges.

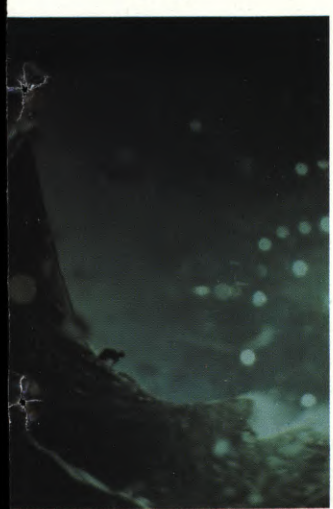






Frame blow-ups from the final "Coming of the Dawn" sequence in Greenough's first feature film, "THE INNERMOST LIMITS OF PURE FUN". He is the first cameraman to film sustained runs through the hollow, tubular waves—actual tunnels of water which curl over, completely surrounding the surfer. It requires the utmost degree of skill and control to ride out such a wave from one end to the other. Greenough finds tubes ranging from six to ten feet in diameter to be ideal for filming.

A



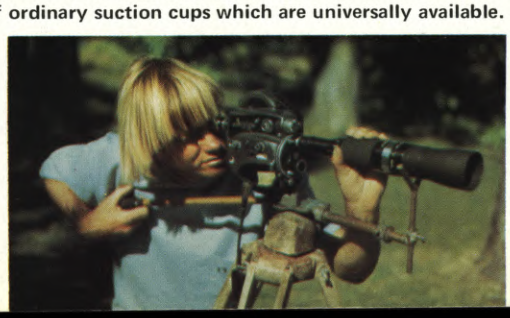
B

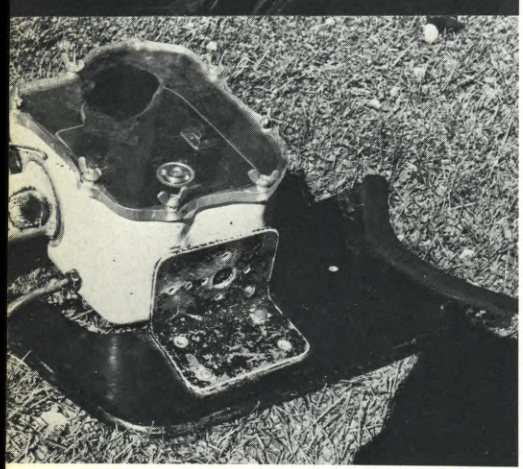
C

D

(A) Dwarfed by the mountainous wave, the tiny surfer speeds along at an incredible rate, hoping to escape the tons of water that could crash down upon him. Giant waves such as this are found on Oahu's North shore in the Hawaiian Islands. (B) High-Speed camera, a modified Bell & Howell Filmo, shown with front plate of housing removed. (C) Greenough mounts the camera on his back by means of a harness of the type usually used to support SCUBA air tanks. (D) Mount is adjustable, permitting lens to show just the wave or Greenough's head and shoulder, as well.

(LEFT) Section of an inner-tube strapped around his waist makes a water-tight case for battery packs used to run camera and lights. (CENTER) Beaulieu 16mm camera with long telephoto lens mounted is used on fluid-head tripod, which Greenough designed and built himself, to get closeup shots from shore of surfers in the waves. (RIGHT) Short, spoon-shaped bellyboard is ridden in kneeling position by cameraman. Greenough's own design and highly maneuverable, it has greatly influenced the manufacture of standard boards for sport surfing throughout the world. Camera is shown securely mounted on the board itself by means of ordinary suction cups which are universally available.





(TOP LEFT) High-speed camera is modified Bell & Howell that will run at 200 fps and is electrically driven by a 24-volt motor. (CENTER) Kodak K-100 camera, shown in housing, has variable frame rate from 24 to 64 fps. (BOTTOM) Bolex on rifle-stock mount, for hand-holding with long lens while sitting on surfboard or air mattress.

ed it, photographed it, edited it—and now he is *projecting* it, just to make sure it gets onto the screen in exactly the way he intended it.

Greenough has been shooting film seriously for less than two years—but during that time he has designed and built a fantastic array of equipment for this specialized form of photography: watertight camera housings, a fluid-head tripod, a bank of quartz lights that fits onto a shoulder mount and a rifle-stock mount for filming telephoto shots from the water. He has also prodded others into building for him cameras and lenses so exotic that they were, heretofore, considered to be in the realm of the impossible.

His first contact with professional film production came a year and a half ago when he was contracted to do some filming for and appear in a sequence of the 35mm Techniscope feature, "THE FANTASTIC PLASTIC MACHINE" (See *American Cinematographer,* May, 1969). What rubbed off on him from that encounter was a determination to become as professional as possible in applying the basic principles of filmmaking, but to use those acquired skills for the purpose of telling it like it is within the innermost limits of pure fun—the very special world of the surfer.

The film that he projects onto the screen this evening is the first tangible result of this developing skill—and its success is evident in the reactions of the young surfers who sit enthralled as their wildest dreams of becoming one with the waves assume reality before their eyes.

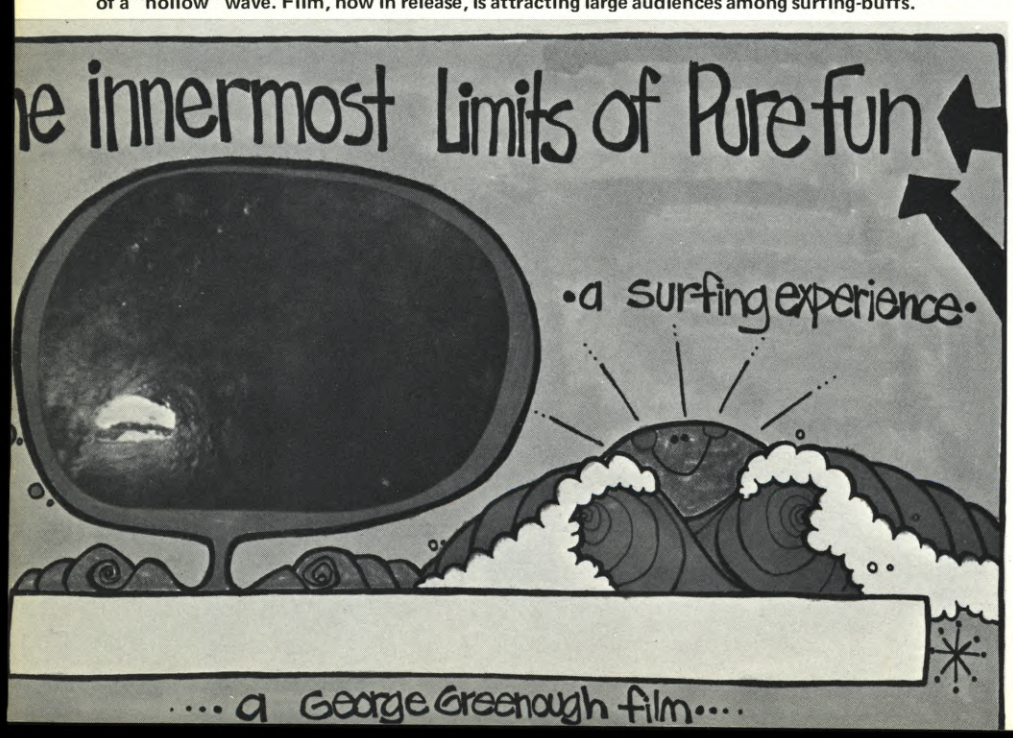
George Greenough, now a full-time filmmaker, spends at least four months of the year on Australian beaches, searching out the big surf.

About 15 minutes prior to the end of the film, a title appears on the screen: "THE COMING OF THE DAWN". The sequence begins in almost-darkness. The camera is gliding down the tunnel of a hollow wave, but only the glint of light reflected from the curvature of its walls lets us know that we are, vicariously, riding within this fluid tube. Then the sun surfaces in sudden splendor out of the sea and the sky grows lighter. The pace accelerates and we are zooming endlessly through swirling tunnels of water. The music on the sound track increases in beat and volume. There are no special effects, no opticals, no camera trickery, no fancy high-contrast solarized images, but we are utterly involved in what is happening on the screen. Someone has caught us up and put us where we can never hope to actually be—inside the hollow wave—and we are borne along on a sweet ride that is a trip and a half. When it reaches a peak that is almost too beautiful to bear, the entire aura explodes in a crescendo of sight and sound. Shades of "2001"!

There is a moment of echoing si-

Continued on Page 925

Poster for Greenough's first feature-length production, "THE INNERMOST LIMITS OF PURE FUN", is stylized Pop Art, incorporating frame blow-up of scene photographed from inside tunnel of a "hollow" wave. Film, now in release, is attracting large audiences among surfing-buffs.



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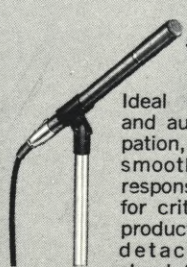

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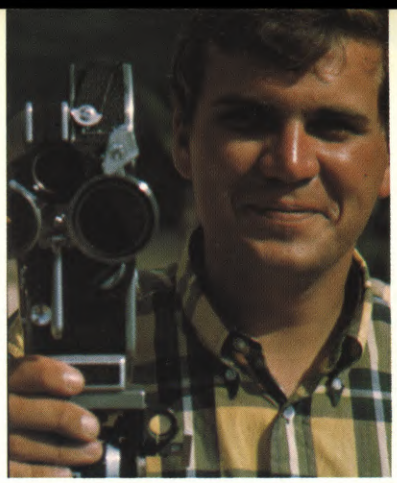
Hand-holding his camera while riding the surfboard on his knees, Greg MacGillivray, moves in close to an expert surfer for a tight shot of his fancy footwork on the board. He must control his own board skillfully, while keeping pace with the subject and running the camera.



The namesake partners of MacGillivray-Freeman Films: (LEFT) Jim Freeman, who shoots from the shore, filmed the only 3-D surfing feature ever made. (RIGHT) Greg MacGillivray, who shoots from the surfboard, made his first full-length surfing film at the age of 17.

(LEFT) Freeman photographs beach-based scenes for the partnership's latest release, the spectacular "WAVES OF CHANGE". (CENTER) Freeman's defocused lens turns the lights of Honolulu into glowing spheres against the silhouetted background of Diamond Head at dusk. (RIGHT) A surfer races ahead of the cresting wave for a scene in the film. "WAVES OF CHANGE" almost literally puts the audience on a surfboard in order to communicate the mystique of this uniquely exciting sport.

(LEFT) Freeman, an expert helicopter cameraman, hovers close to the ground while filming comedy sequence of a car which somehow finds itself running on railroad tracks. (CENTER) The two young film-makers appear all slicked up for a Miami TV show. (RIGHT) A daredevil surfer zooms down the center of a mountain-like wave at Sunset Beach on Oahu's North Shore. These scenes were filmed from a helicopter which dipped close to the crests of the giant surf.

The romance of the surf scene. (LEFT) A softly silhouetted girl waits on the sand at sunset, while her young sea-god companion (RIGHT) carries his board toward the surf in hopes of catching that one last perfect wave of the day.

MacGillivray speeds through the surf with his camera fastened to the nose of his board. He began by making amateur films for the entertainment of his surf buddies, but the response was so great that he turned "pro" soon afterwards.

"WAVES OF CHANGE"

Two highly-skilled, energetic young film-makers pool their talents to form a unique film production unit and shoot a spectacularly entertaining surfing movie

Purists, prone to splitting hairs, may argue that the photography of a surfing film cannot accurately be classified as "underwater" cinematography—but those who do their filming from a surfboard have good reason to argue that point. When a wave wipes them out in mid-scene and they go "over the falls" (as the hang-tenners say), they most certainly end up under the water—and so does the camera. Moreover, in order to protect the camera against total immersion in hostile salt water, it must be encased in a watertight housing similar (except in pressure-resistant characteristics) to those used by honest-to-God underwater cameramen.

We think that's close enough—so we are including in this special "Underwater Cinematography" issue of *American Cinematographer* a couple of articles about several highly skilled young cameramen who happen to more or less specialize in the photography of surfing films.

Shortly before this issue went to press, the Huntington Hartford theatre in beautiful downtown Hollywood was the setting for the World Premiere of a new surfing film entitled "WAVES OF CHANGE". The mixed bag of an audience included jaded critics from the trade press, middle-aged spectator sports types, bright-eyed teenagers and a sizable contingent of expert surfers. Diversified as they were, they responded as one to the tongue-in-cheek humor and spectacular action of the superbly photographed images that swept across the screen. The audience reaction was incredible—turned on all the way.

"WAVES OF CHANGE" is the latest production created by a team of extremely talented young California filmmakers, Greg MacGillivray and Jim Freeman. In 1966 this pair joined forces

Continued on Page 897

Jim Freeman lines up a shot of sunset waves with a high-powered telephoto lens, while shooting scenes for "WAVES OF CHANGE" in Hawaii. Other locales include California, France and Portugal.

In a high-camp tableau, perhaps symbolic of "Tomorrow the World", Greg MacGillivray and Jim Freeman pose with their trusty Arriflex and a mound of used ECO film cartons.

(LEFT) Champion surfer David Nuuhiwa crouches low inside the tube at Hawaii's popular Tracks Beach in a scene from "WAVES OF CHANGE". (RIGHT) Expertly riding the surfboard on his knees, MacGillivray hand-holds bulky camera housing, as he veers in close for tight shot of surfers piling up. Precise maneuvering was required to keep from joining the pile-up.

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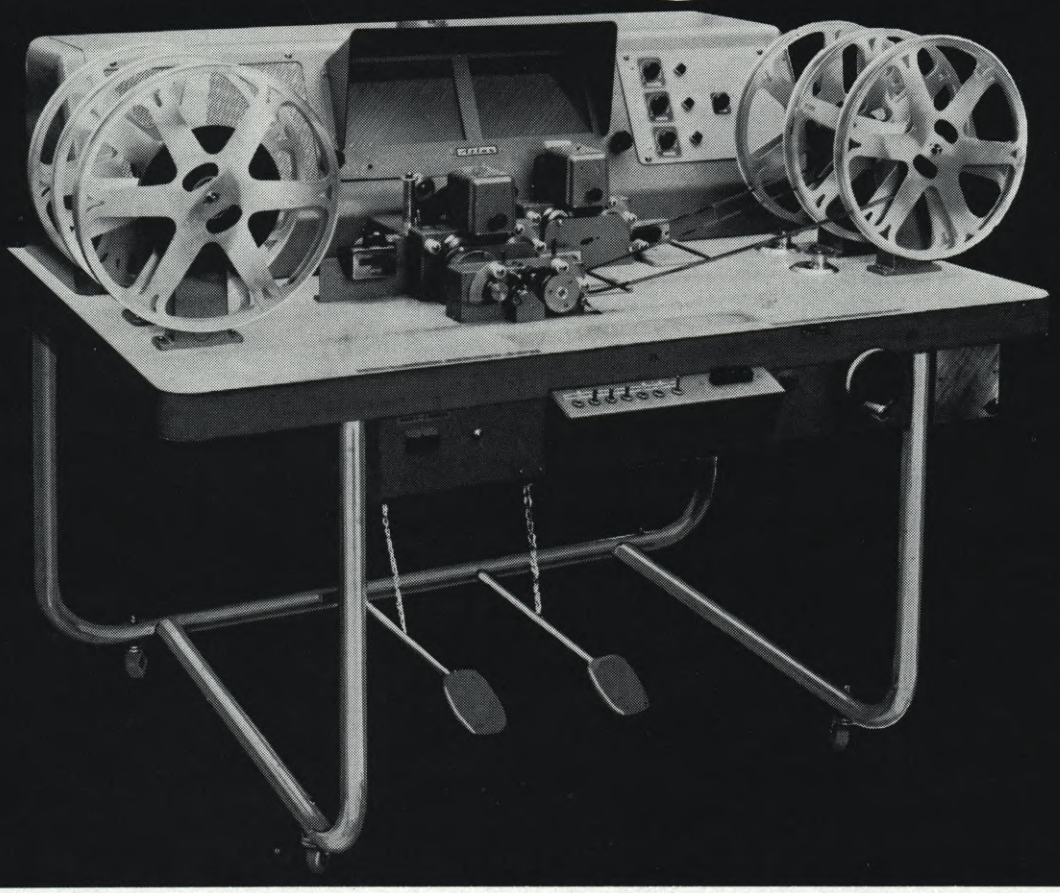

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DEEP WATER CINEMATOGRAPHY

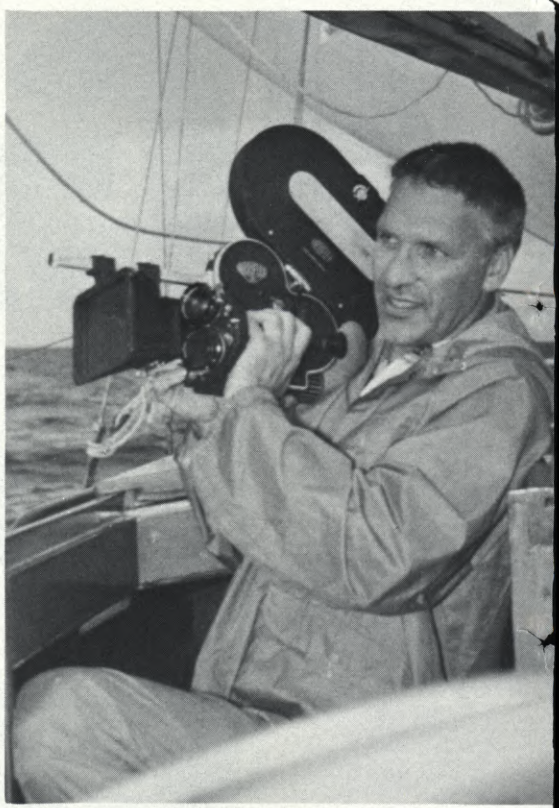
The open sea offers a new dimension to underwater cinematography—a dimension that makes shallow water filming as alien as aerial photography

By RICHARD WINER

There are two basic categories of deepwater cinematography. One is done at extreme depths with cameras operated remotely from surface vessels by scientists or technicians. The other is filming at any depth, but in water where the bottom is beyond the diving capability of the average diver . . . 200 feet plus. The latter is what we are discussing in this article.

Presently most underwater filming by professional cinematographers is done in water with a depth of less than 35 feet. There are several reasons why shallow depths are used in the average underwater film. They include the need for maximum sunlight, the diving ability and limitation of the cameraman, the diving capability of the actor(s) in front of the camera, equipment capability, the length of time required for filming (the greater the depth, the less "bottom time" allowable per day), etc.

Why film in waters of great depth or in the open sea? There are a number of reasons, including the fact that the open sea offers a new dimension to underwater cinematography, a dimension that makes shallow water filming as alien as aerial photography. It wasn't very long ago that anything filmed underwater that was in focus, halfway decently exposed, and had pretty colors was considered spectacular and raised "ohs" and "ahs" from the audiences. With a few exceptions, if you've seen two or three underwater film sequences, you've seen them all. Basically, coral reefs are coral reefs, moray eels are moray eels, barracuda are barracuda and, in general, the shallow waters of the sea are more or less the same the world over with the exception of climatic differences. In fact, shallow water ship wrecks have been so stripped by salvagers and souvenir hunters that they no longer resemble anything more than a heap of scrap metal. Most deep wrecks, except for the fact that some previous diver may have removed the bell and navigation lights, still bear some similarity to the way they looked when they were sunk.



In unaccustomed situation topside aboard a sailing vessel, Winer shoots some footage with the Arriflex.

The author shown filming aboard the deck of the deep-probe submarine "Ben Franklin" at a depth of 160 feet. In the background is his safety diver, John Carpenter. The sub was moving slowly, requiring him to wrap both legs around a deck fitting and to hold on with his left hand while operating the camera with his right. When one is anchored in this way, and the body is in the right position to the movement of the water, the flow tends to steady the camera.

Sea life in the deeper waters is quite different from that of the shallows where the larger species have been nearly fished out. It is the rule rather than the exception to find large fish on reefs 100 feet deep, whereas, on a shallow reef a few hundred yards away, there exists hardly a fish over a few inches long. In the Virgin Islands, for example, one of the greatest hazards while filming on the shallow reefs is a direct result of previously uncontrolled conservation—the sea urchin. This creature, with its numerous spines, each capable of penetrating a wet suit or even the thick bottom of a flipper, abounds on the reefs around St. Thomas and St. Croix. In fact, some of the coral formations are virtually black with them, making film-

ing almost an impossibility. The adult Caribbean lobster devours ten to twelve sea urchins a day which, in a normal situation, would keep the reefs fairly clear of them. But over the years divers have nearly cleaned these waters of lobster. Thus, to avoid the sea-urchin-infested reefs, one must seek out the deeper reefs in depths of around one hundred feet.

Then, of course, there are instances where deep water is the only place where your subject can be filmed. This would include filming submarine and other undersea vehicles, documentaries on oceanographic subjects, the need for clear water when windswept seas have rendered the clarity of shallow waters nil, shooting up at large ships passing overhead, filming sharks and other large creatures that rarely venture into the shallow waters of the North American continent . . . fish that won't flee at the first sound of the camera motor. Probably no other natural environment offers so great a possibility of special effects as the waters of the open sea combined with the depth-penetrating rays of the sun. Of course, open sea diving does have its drawbacks, among which are hazardous conditions. However, one can control these to some extent.

Suppose you receive an inquiry as to your availability to film in the Bahamas or the Caribbean. You are told that you'll be working from a 120-foot research vessel. The size of the vessel arouses your curiosity. How deep is the water? The producer hems and haws, admitting that he is not sure, but that the location is to be about five miles off shore. Your subject is to be an oceanographic research submarine. If you've never dived deeper than 50 or 75 feet, forget the assignment—unless you have several weeks in which to prepare yourself, for there are many potential problems that never occur around shallow inshore waters. Most common are severe pains from not being able to equalize the pressure in your ears, sinus pains from sinuses you never knew you had, nitrogen narcosis (which could not only end your movie career but also your need of paying any more insurance premiums), the bends from working too deep and not decompressing on the way back to the surface, a sudden increase in negative buoyancy resulting from your wet suit's sponge-like absorption of water at deep depths, tricky and unpredictable currents that could sweep you far from your boat, unknowingly swimming down deeper than you had planned, dangerous sea life . . . and there are many authenticated cases of divers having been maimed or torn to pieces by sharks. If you spend most of your time behind a desk or in a studio where the grips or assistants perform all of the strenuous work and you are just plain out of shape there is the danger of a heart attack from over-exertion, for deep water diving is hard and strenuous work.

Let's say, though, that you are in reasonably good health and the money looks good. What next? Most important is your safety diver. His presence may be a matter of life or death to you. At

Continued on Page 900

Alone in shallow water (60 feet), Winer films claw mechanism of research submarine being tested. With a self-contained camera such as this Rebikoff, he is able to maneuver easily into almost any position. The larger the camera, the more difficult this is to do. Though very compact, the camera accommodates a 200-foot load and is electrically driven by two nickel-cad batteries.

(ABOUT THE AUTHOR: Richard Winer has, for the past 15 years, been an award-winning cinematographer in Florida, the Caribbean and other locations around the world. He has filmed everything from orbit-bound astronauts to man-eating monsters from beneath the deepest reaches of the sea. He headquarters in Fort Lauderdale, on Florida's "Gold Coast" which is just minutes away from the Bahamas and Caribbean. He owns a 42-foot fiberglass diesel auxiliary sailing ketch and a two-man submarine, both of which are used for filming. For underwater cinematography he uses a highly sophisticated self-contained Rebikoff underwater motion picture camera with fully-corrected wide-angle lenses. He also has available a self-propelled camera unit, the Pegasus, which serves as an underwater dolly.)

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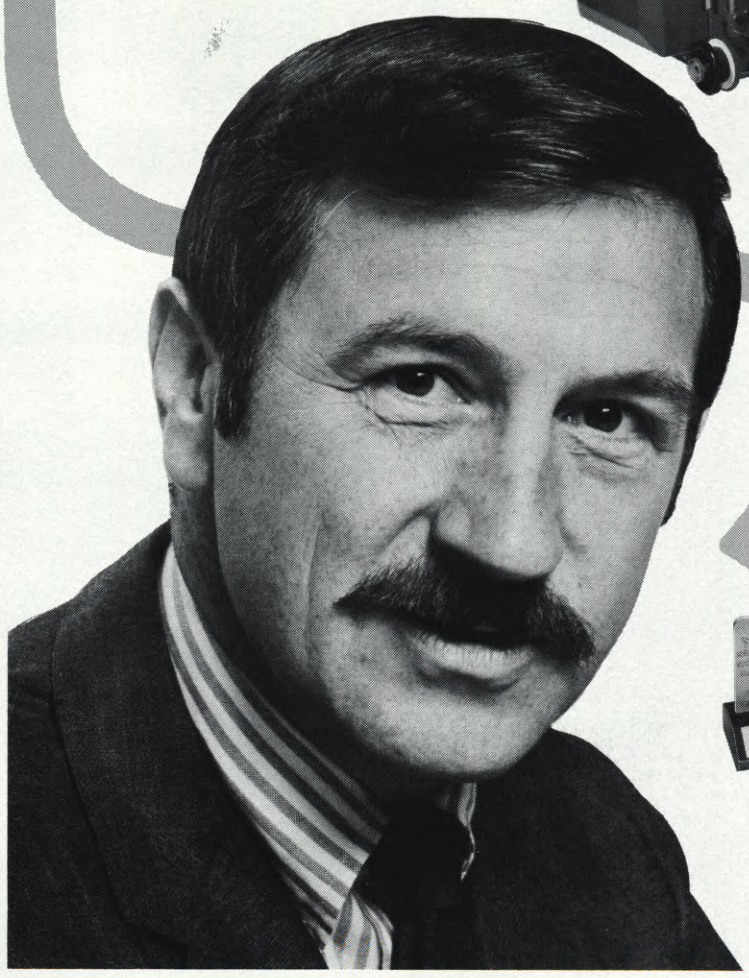

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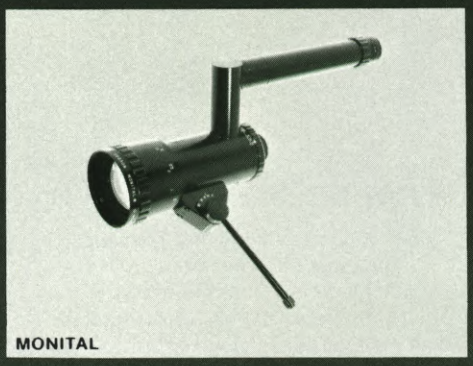

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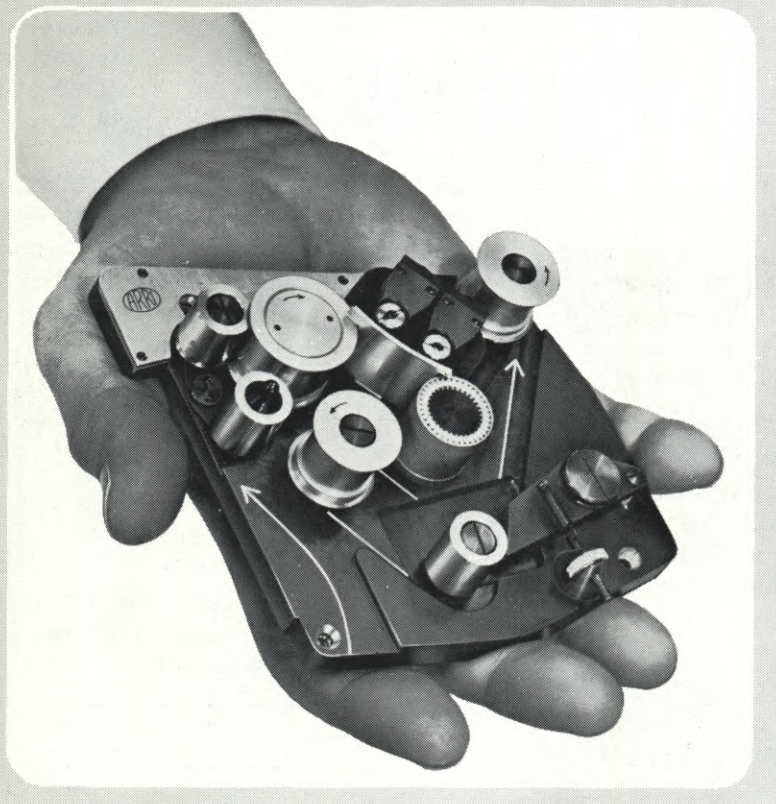

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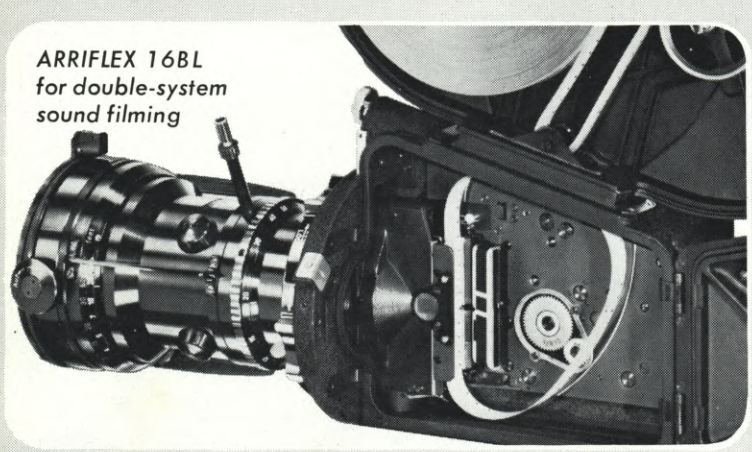

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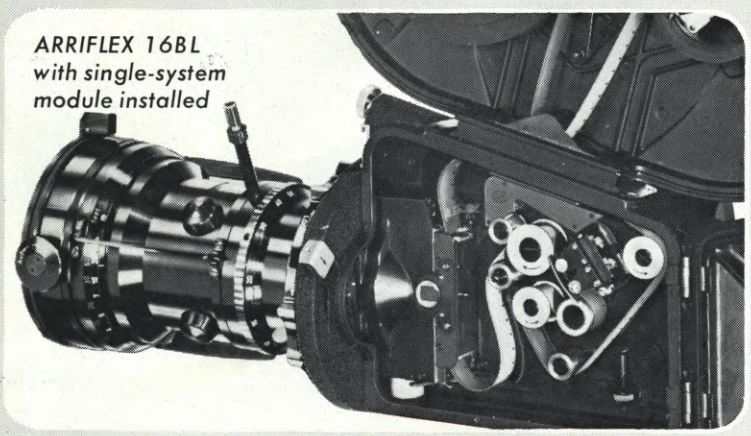

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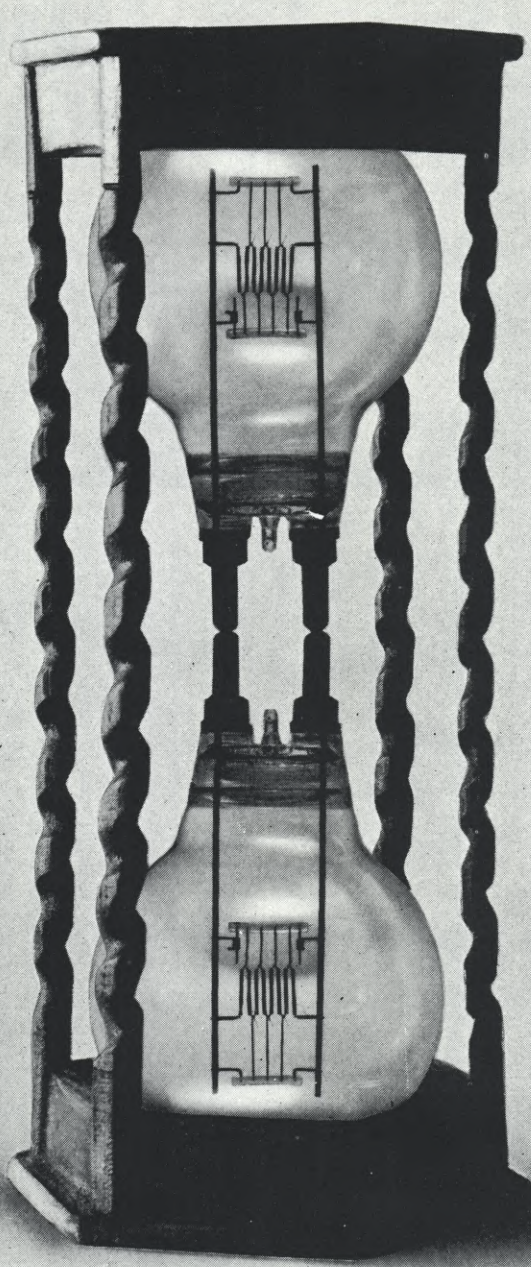

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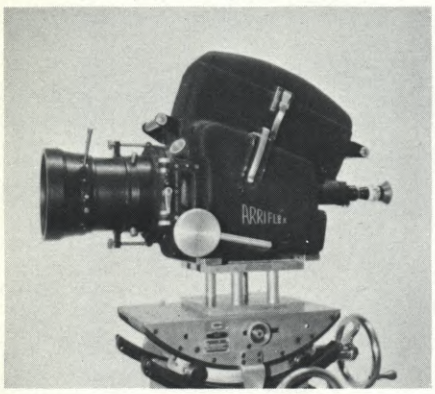

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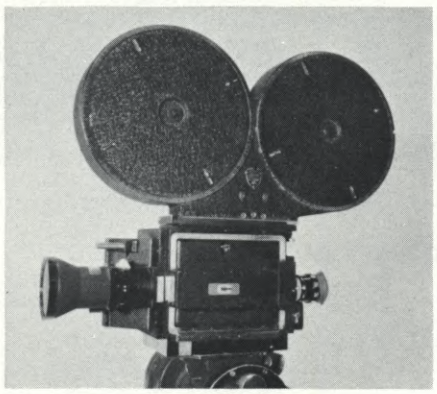

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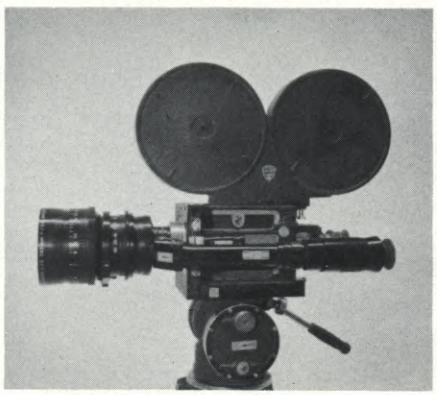

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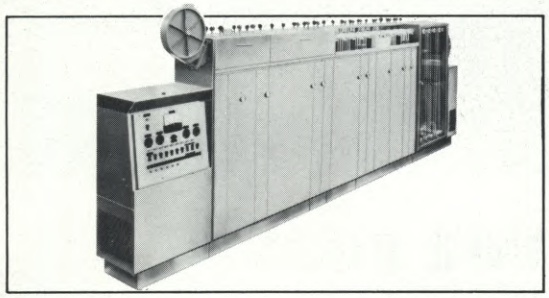

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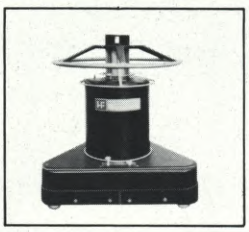

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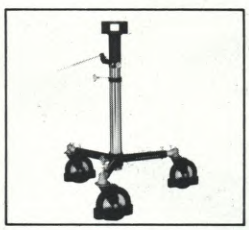

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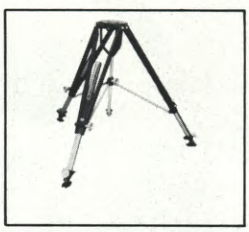

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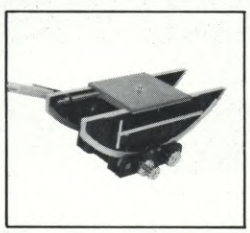

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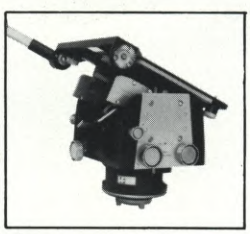

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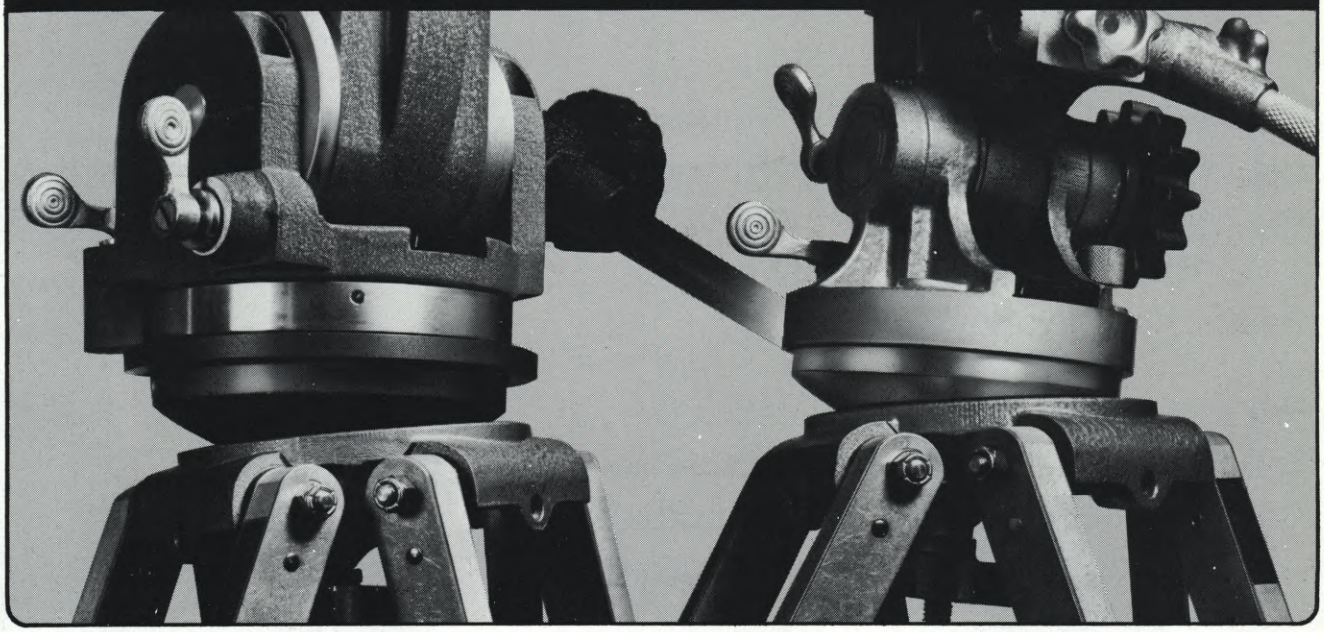

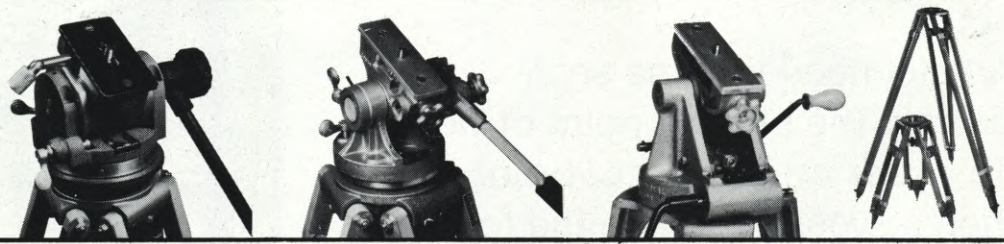

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n this photograph. He is a member of the IATSE Chicago local 666 and has been a first cameraman for 22 years.

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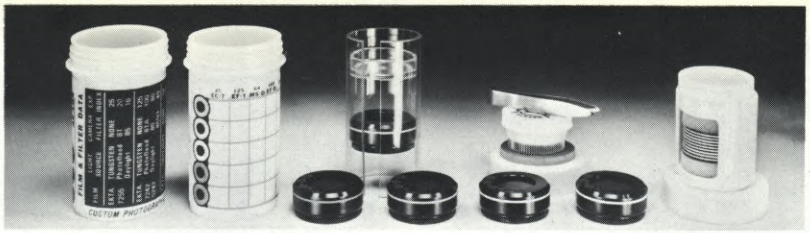

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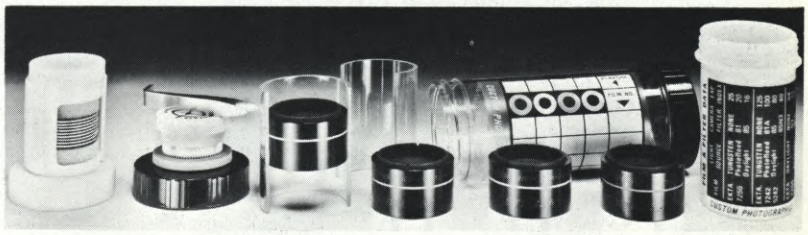

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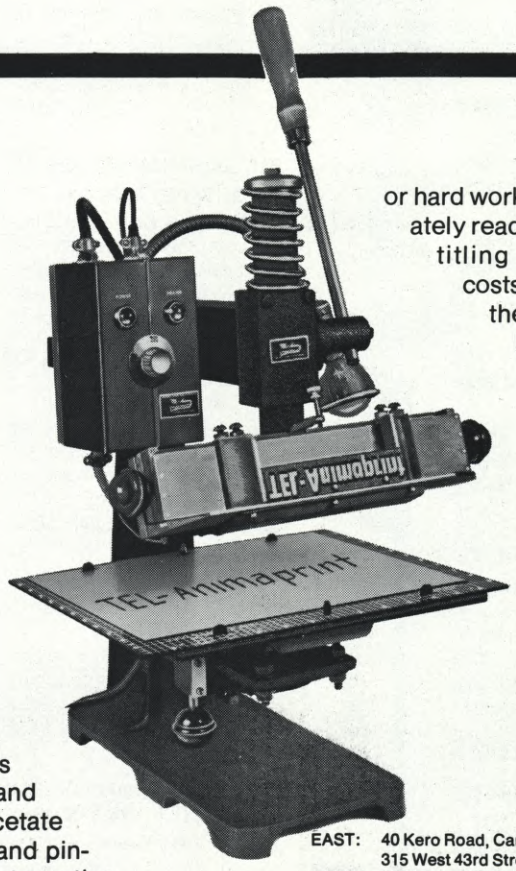

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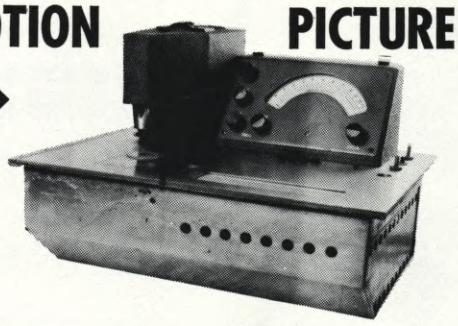

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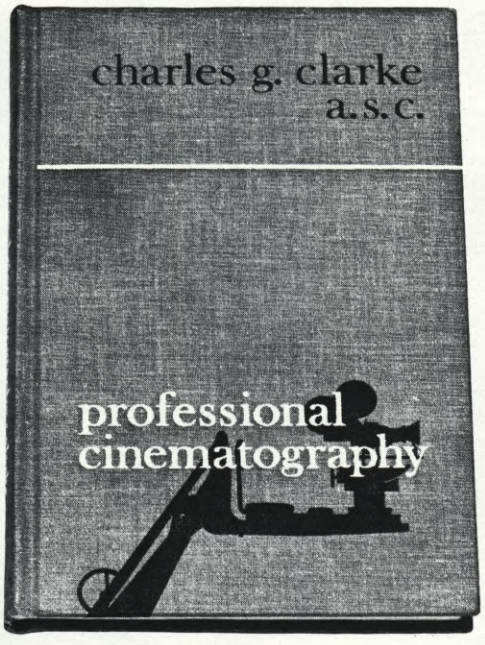

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ABOUT THE AUTHOR: Charles G. Clarke, ASC, a top Director of Photography at 20th Century-Fox for many years, and an ASC member, taught Advanced Cinematography at the University of California at Los Angeles, where he recognized a need for practical professional guidance for students striving to be the industry's future Directors of Photography. It is this need which has given rise to his publication of a book on the subject and subsequently the latest revised edition of Professional Cinematography. The first edition of this valuable book has become required reading at many universities and schools offering courses in cinematography.

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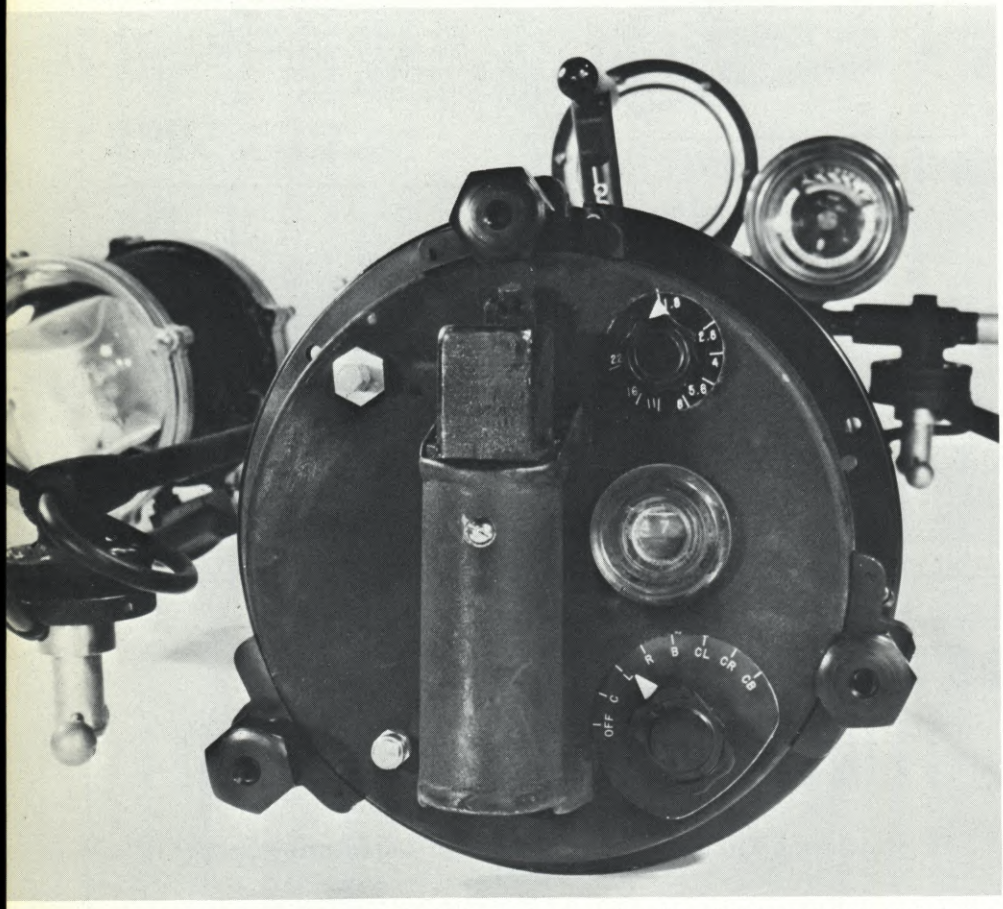
THE GHOLSON "2000" SELF-CONTAINED CAMERA AND LIGHTING UNIT

A compact underwater filming rig with extendable lights, that also doubles as a well-balanced shoulder-supported camera for shooting on dry land

By JEB GHOLSON

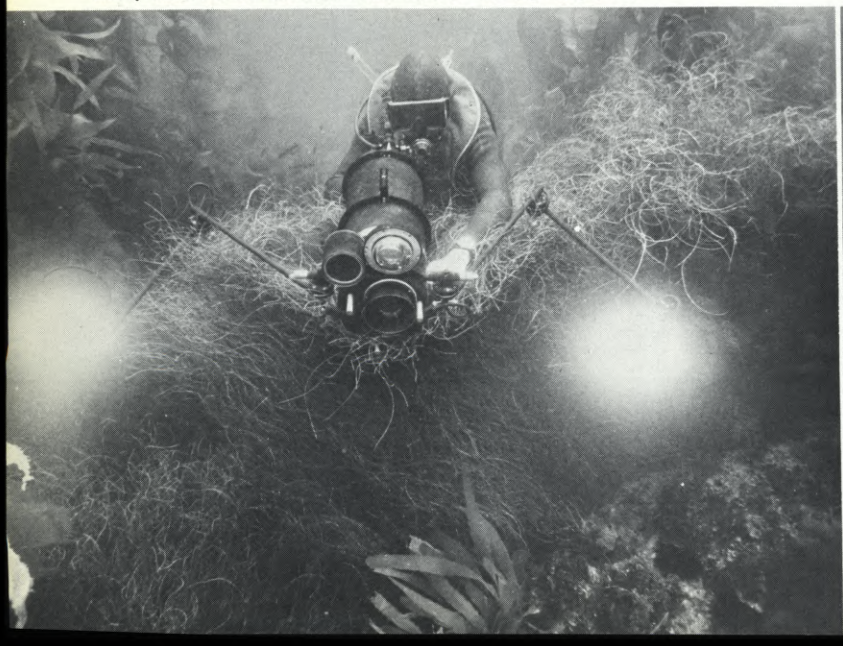


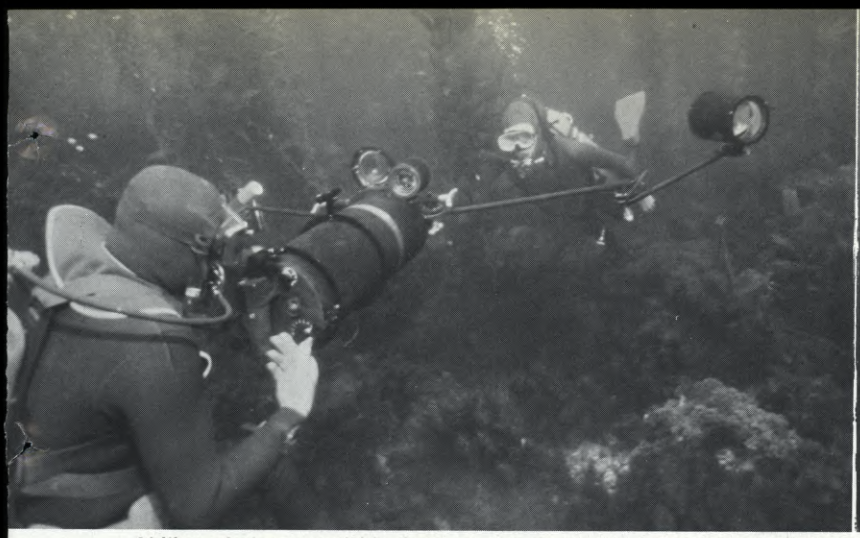
Frustration can be a great motivator and I was frustrated as hell when it came to underwater photography.

Why hadn't we been able to bring the full meaning of the word "photography" underwater? We could control composition. We had infinite control of camera movement, but we had almost no control of lighting unless we were in a static situation, and that was a hell of a lot of trouble. True enough, there were various battery-operated lights on the market. Some of these were quite powerful and some like spitting against the wind. However, most were meant for the use of a diver to see *where he is going* and not necessarily for photography. Using such units, "key and fill" lighting and any kind of modeling is impossible. The light pattern is usually spotty and uneven and backscatters so badly that you end up shooting through your own cloud, and you know how we all love flat, spotty and cloudy lighting.

The next bugaboo was optics. The closer you can get to the subject (without distortion), the clearer and sharper the image and its colors. There are several good cameras sold today which have excellent water-corrected optics.

(ABOVE) Rear view of the GHOLSON 2000 camera housing, showing aperture control, footage counter and dial that includes camera on-off switching, plus controls for a number of lighting options. (BELOW LEFT) Underwater cameraman moves smoothly through a kelp bed, with the hydrodynamically balanced camera easily maintaining its horizontal position. Tubular configuration for housing was found to be most effective in this respect, as well as for external pressure resistance to weight-of-housing ratio. (RIGHT) Standing on the bottom, SCUBA-outfitted cameraman easily controls the self-contained camera and lighting unit.





Ability of the extendable arms of the rig to place the lights far out beyond the camera lens to cross-light the subject effectively eliminates back-scatter, a prime bugaboo of underwater cameramen. Back-scatter is a condition encountered in dirty water when lights placed at the plane of the lens (or behind it) illuminate particles suspended in the water between the lens and the subject. The resultant reflection from these particles into the lens creates an undesirable cloudiness that tends to obscure the subject.

This means a wide-angle lens that has either been built from scratch or adapted with the use of a water-interfaced collimator and a domed water port that is coincident with the nodal point of the lens. These cameras are quite effective optically. However, I wanted a tool that could do even more.

Balance is often a problem with cameras that carry at least 400 feet of film. The magazine location causes uneven flotation of the housing, which means that a camera perfectly balanced for horizontal planes will strain your milk if you try to tilt it up or down! Hydrodynamics is equally important; the camera must be able to pass through the water easily in any direction.

There were also a couple of other factors that have little application for other cameramen, but do for me. However, these factors will become important, in the next few years, to many more cameramen—when the new frontier of oceanography really cracks wide open. I'm talking about unpressurized depth capability, and the ability to reload these cameras under great pressures in both underwater habitats and diving bells without danger of implosion of the lens elements or batteries. There is also the problem of sending the camera quickly to the surface after its having been opened in a dry chamber at sea-bottom pressure, without danger of having it explode upon or before reaching the surface.

All of this adds up to a heck of a lot of nasty little requirements that leave you with two choices—keep bitching, or build the damned thing yourself!

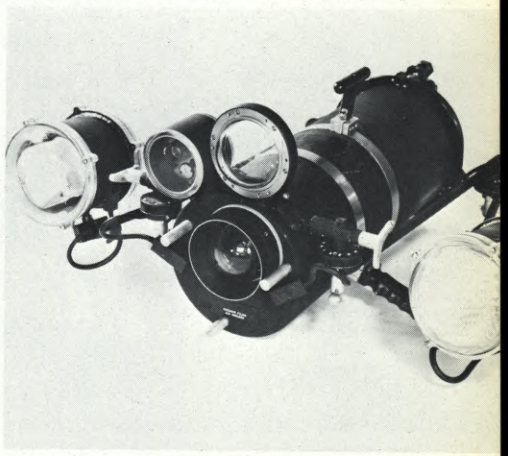
Don't try it unless you're single or plan to get that way, because wives just love it when you spend every waking minute, when not shooting, in some machine shop—days, nights, weekends—for months. Also bring lots of money! The word "prototype" means big bucks in machinist-land.

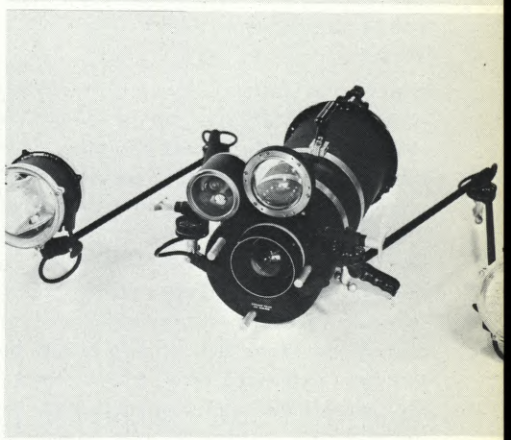
I found the tube to be the most effective configuration for both external pressure resistance to weight-of-housing ratio and hydrodynamic balance and flow. Terrific! That also meant I had to totally design a camera that would neatly fit into a small diameter tube. Not so terrific! I enlisted the engineering genius of Herman Galli, proprietor of Herman Galli Camera Service. We started with a good basic 16mm camera movement and built around it. We used 400-foot displacement magazines, rebuilt them so that they would feed from the end instead of the bottom. We used a sync motor, for dependability, with an easily changeable wiid motor as a standby. Torque motors on the magazines and heavy duty 12-volt Ni-cad batteries completed the picture of electrical stability.

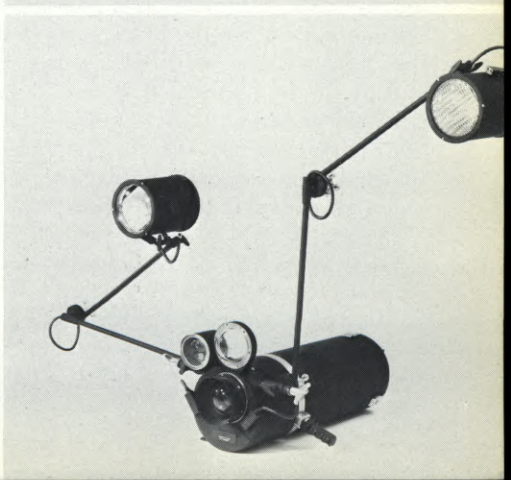
On occasion you find that while working fervently toward one goal you have achieved another one as well. This

On a recent assignment in Alaska, the author prepares his rig for underwater filming. Eye-level optical viewfinder located above the lens is water-corrected, as is the lens itself.

A series of photographs showing three of the many possible options for positioning of lights on the extendable arms. (TOP) Lights positioned close to the housing. (CENTER) Lights positioned at a medium distance. (BOTTOM) Lights positioned above and at a considerable distance from the housing.



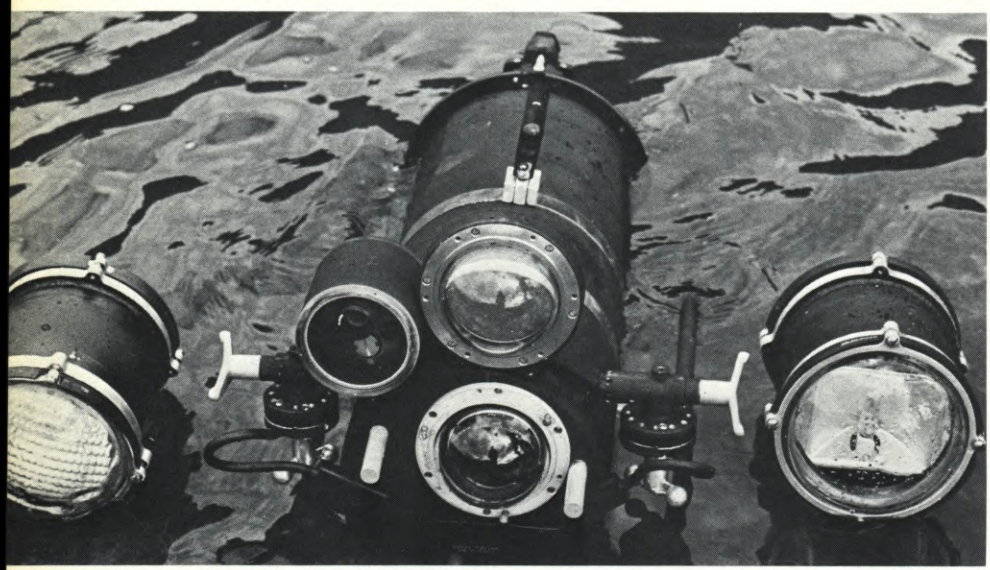




occurred as we stood back to admire our work and how perfectly the camera went in and out of the tube, when I suddenly hoisted it to my shoulder and found that it balanced perfectly. We hung on a zoom lens and a body-pod and a new, all-around camera was born.

We tried to work out a reflex system for underwater viewing but found it to be optically impractical. The only thing that did seem to work was picking up the optical image via television within the housing and playing it to a monitor visible from the rear. We rejected this idea because of the amount of electronic failure inherent in such a system. I found that an external optical finder that gives the cameraman a large image, works out quite well.

The author demonstrates how the basic camera, removed from its underwater casing and mounted on a shoulder-pod, functions as a well-balanced hand-held camera.



Double-ended light heads contain both sealed-beam incandescent (left) and tungsten-halogen (right) units for key or fill light. The cameraman can change types of lamps simply by spinning the head.

While the camera was under construction, I was simultaneously working on the combination housing and lighting system in another machine shop with the aid of Bob Dunn, machinist and underwater cameraman *extraordinaire.* The idea was to design a housing that would go to at least 2000 feet, since men have already made chamber dives to 1500 feet and plan to go further. It also meant that the camera could be mounted externally on a small submersible (submarine), and be operated remotely from within. My idea about the lighting system meant that you needed the least amount of garbage (hanging outside of the housing) that you could get away with. I worked the rather large 30-volt battery pack into a configuration that would allow it to slip into the housing alongside the camera, and hooked it up to a heavy-duty switch on the rear-access door of the housing.

This switch gives the cameraman control of left, right or both lights, as well as constant run of the camera in any of these functions. There is also a magnetic intermittent camera trigger in the rear pistol-grip.

The light heads were mounted on extendable arms that are universally jointed. This means that each light can move individually straight out, up or down. The lamps can cross-light, which is a must to eliminate backscatter, and even back-light when shooting close-ups. With the arms fully extended (nine feet, from light to light) you can dolly as fast as you want, in any direction, without any bouncing around of the lights. The entire unit is so balanced underwater that you can pan or tilt the camera with lights fully extended using just your wrist action while holding the pistol grip.

The light heads themselves took some time to develop. The need for

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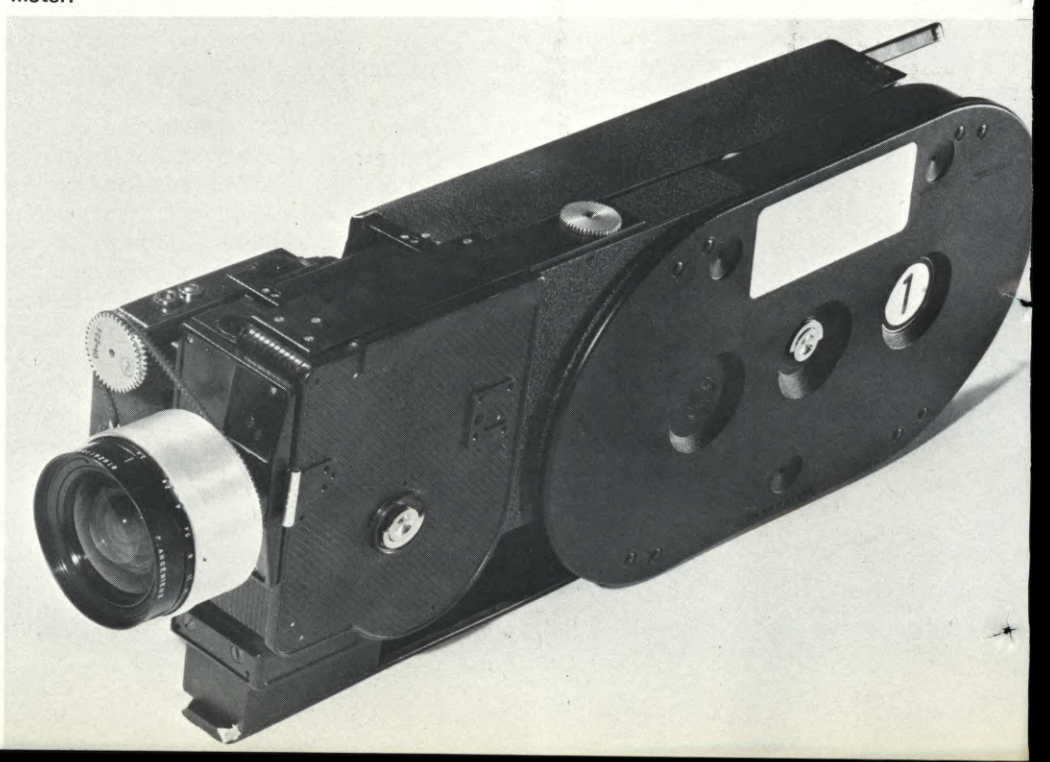
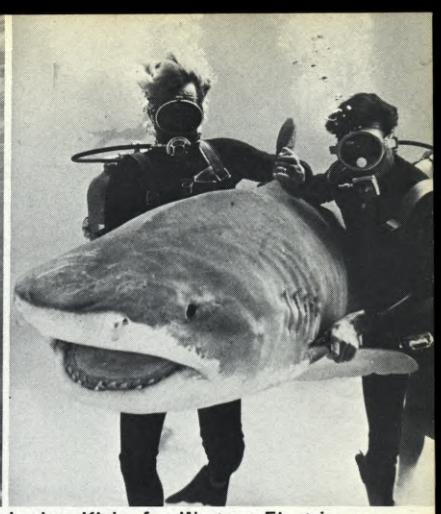
Camera is built around a good basic 16mm movement, with 400-foot displacement magazines modified to feed from the end instead of the bottom. Camera operates with either a sync or wild motor.





(LEFT) Sharks like this Hammerhead were featured performers in underwater TV commercial made by Jordan Klein for Western Electric. (CENTER) Shooting a children's favorite performer, the friendly and intelligent "Flipper," who was starred for a long time in his own TV series. (RIGHT) Before filming of Western Electric TV spots could begin, sharks had to be caught by hand and placed in an underwater pen.

WHY FILMING UNDERWATER TV COMMERCIALS IS SIMILAR TO CINEMATOGRAPHY IN SPACE

One of the world's most famous underwater cameramen reports on a highly specialized phase of his filming

By JORDAN KLEIN

Underwater, Inc.
North Miami Beach, Florida

People often ask what it's like to make color television commercials under water? That's an easy question to answer: Up to a point, at least, it's very similar to taking motion pictures in space.

Working underwater, the cameraman is as weightless as he'd be in space. So is his camera and other gear.

This is not a handicap. It actually helps him fully express his aesthetic and creative capabilities, both in the way of composition and subject matter.

For example, using Eastman Color Negative Film 5254, he can do the most difficult "dolly" shots with a hand-held camera by mere breath control. Or, without changing his position, he can make a multiplicity of shots, each looking entirely different from the others.

This, however, is not to say there is a total absence of problems for the underwater cameraman. Working in an inherently hostile environment, he has no horizon (in the topside sense) or man-made straight lines to guide him.

Obviously, therefore, he must know water well enough to instinctively record what he sees, which is to say he must know it intimately.

Underwater color TV commercial production involves considerably more than just camera work, however. It entails many elements one would never expect to encounter in space—like biting sharks, stinging men-o-war, pollution, unforeseen water craft encroachment, and the like.

Sometimes these occur by design, rather than by chance. An example is a TV commercial we made for Western Electric. Its featured performers were sharks.

They had to be caught and penned in advance of shooting the underwater footage. Sharks, you might be surprised to learn, are not the bravest creatures inhabiting the oceans. Once penned, however, they become exceedingly aggressive. Three men are needed to handle one of them.

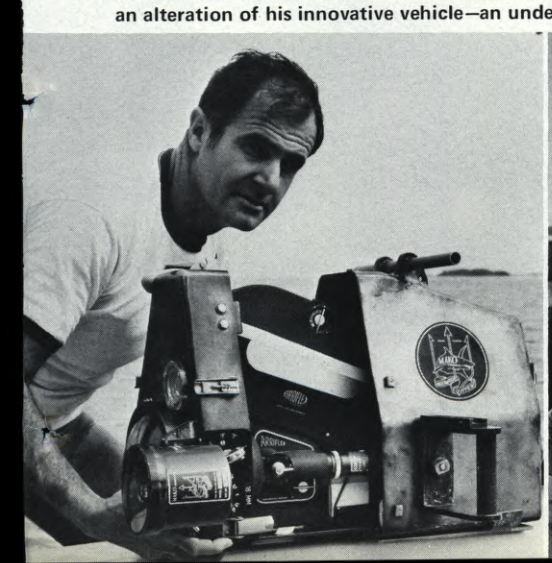
In making the commercial, cameramen had to work extremely close to the sharks. Not only were the sharks in an aggressive mood, but they were easily confused, and snapped at everything within reach.

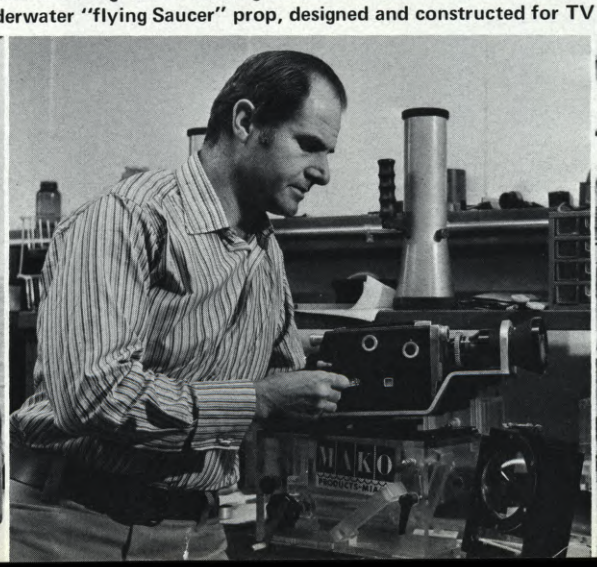
There were no casualties among the cameramen. But camera controls and housing projections took a shark-size beating.

We faced entirely different problems while filming an Atlantic-Richfield Oil

Continued on Page 894

(LEFT) The author guides Arriflex camera with 400-foot load into Mako camera housing of his own design. (CENTER) Klein inspects and readies his Eastman K-100 camera for some underwater shooting. Mako housing on bench is also of his own design and manufacture. (RIGHT) Klein directs an alteration of his innovative vehicle—an underwater "flying Saucer" prop, designed and constructed for TV feature film, "THE AQUARIANS".





LIGHTING FOR UNDERWATER CINEMATOGRAPHY

As oceanography becomes a vital science, proper lighting for undersea documentation assumes a more important role

By JACK BIRNS
President, Birns & Sawyer Inc.

Designing lights for use underwater—and especially for the highly specialized demands of underwater cinematography—involves problems and challenges that are unique and which are rarely encountered by those concerned with lighting subjects on "dry land"—a much less hostile environment.

When my own organization made its first underwater incandescent light back in 1961, using the "new" quartz-iodine lamps for the first time, our engineers decided on an approach which would utilize what we refer to as the "closed reflector" principle.

This basic principle was established at the outset of our design and manufacturing of underwater lighting and has been maintained through the production of a wide range of lighting fixtures.

As so many principles of physics support this position, it is inconceivable why any underwater lights exist at all in the open reflector or unprotected mode. First, let's define the terms and then discuss the advantages.

DEFINING THE TERMS

An "open" reflector is one which is directly immersed in and directly exposed to the sea water and which also is separated from the source lamp by water.

A "closed" reflector is encapsulated and protected from the environment by a glass lens cover, which also protects the source lamp.

As we believe we are the only exponents of the closed-reflector principle, at least in America, we should explain the rationale behind our engineering.

Simply stated, the closed-reflector "principle" in underwater lighting is: protect every underwater reflector and bulb from its hostile environment! Protection can be maintained for virtually every type of underwater lighting fixture, including quartz-iodine, diver helmet light, mercury vapor, thallium iodide, and collimated beam lights powered by gas discharge bulbs.

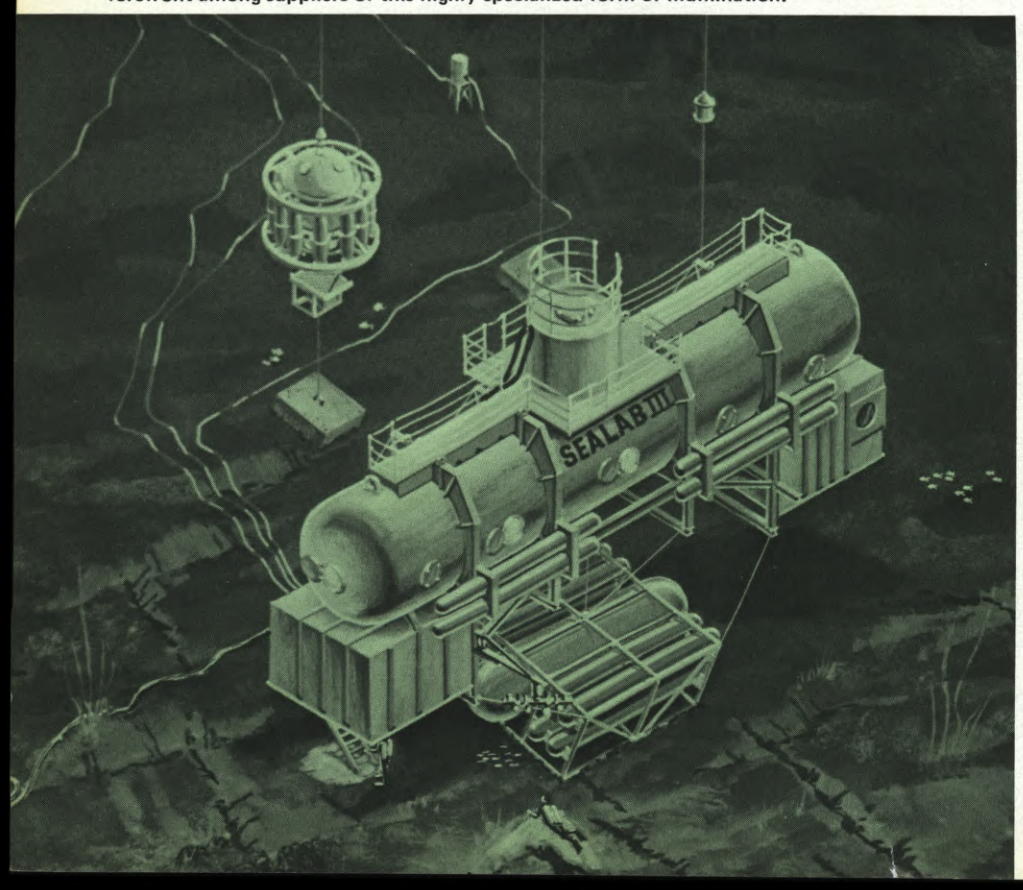
In comparison to closed reflectors, open-reflector lamps are easier and cheaper to manufacture, but they are relatively inefficient because the light from the bulb element must penetrate water to reach the reflector before reflecting back to reinforce the direct emission from the source lamp. And without efficient reflection, up to 70% of the light output from the source lamp may be lost. The limitations of the closed-reflector lamp are that it has a more restricted range of beam angles and the lens absorbs some light.

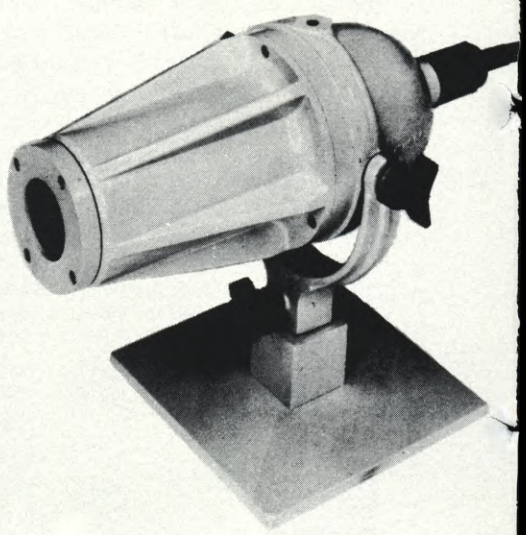
GREATLY REDUCES DRAG

In comparing the closed or internal reflector with the open or external reflector, factors such as drag, diver safety, corrosion, and water penetration are all important considerations. The closed reflector greatly reduces the high drag inherent in open-reflector systems. It effects a streamlined or hydrodynamically designed flow.

Drag is a most important constraint on the submerged cruise speed and

More than 40 Birns & Sawyer underwater lights, including 30-volt and 110-volt units, were ordered to meet the various lighting needs of the U.S. Navy's SEALAB III project. The development of its SeAQUArtz line of underwater lighting units has placed this company in the forefront among suppliers of this highly specialized form of illumination.





The B & S SeARC Spot utilizes a new type of gas discharge lamp which burns at 5500° Kelvin. It is useful for filming from deep submergence vehicles and produces an 18-inch spot 50 feet from the light source.

FILMING WITH 5254 ON LAND AND UNDER THE SEA

By JON LAWRENCE

Having become the industry standard 35mm filming stock, the fast Eastman color negative is also a boon underwater

Over the past couple of years, during which it has become increasingly more available, Eastman Color Negative film, 5254, has reached the point where it is now the industry standard 35mm filming stock.

Its adoption by the industry has resulted in a giant technical step forward and has created what amounts to a not inconsiderable revolution in production methods. Aside from its extended latitude and more faithful color quality, the new filming stock's doubled speed (as compared to that of 5251), plus its capability for being "pushed" one stop more in development without noticeable loss of quality, has made it practical for cinematographers to shoot at low-light levels that would have been considered impossible before.

The film stock's application to underwater cinematography, where murky water is a constant challenge, has been at least as rewarding as its usage on dry land. Both types of shooting were almost equally involved in the filming of the recently completed World Premiere feature, "THE AQUARIANS", produced by Ivan Tors Films, Inc., in association with Universal Television for the NBC television network.

Director of Photography Clifford Poland reports, in connection with filming the top-side sequences of the picture, that the use of 5254 made possible a 50% reduction in the unit size and power consumption of the lighting equipment employed.

"THE AQUARIANS" is essentially an underwater opus, with scenes filmed at the Ivan Tors Studios in North Miami, Florida, and in the Bahamas.

Overall direction was by Don McDougall, who in addition to several segments of NBC's World Premiere series, has guided "STAR TREK", "NAME OF THE GAME", "THE BOLD ONES", and "IRONSIDE".

Ricardo Montalban has the starring role in "THE AQUARIANS", which deals with man's attempt to conquer the ocean's depths. The picture features spectacular studio and underwater sets, including a deep sea laboratory com-

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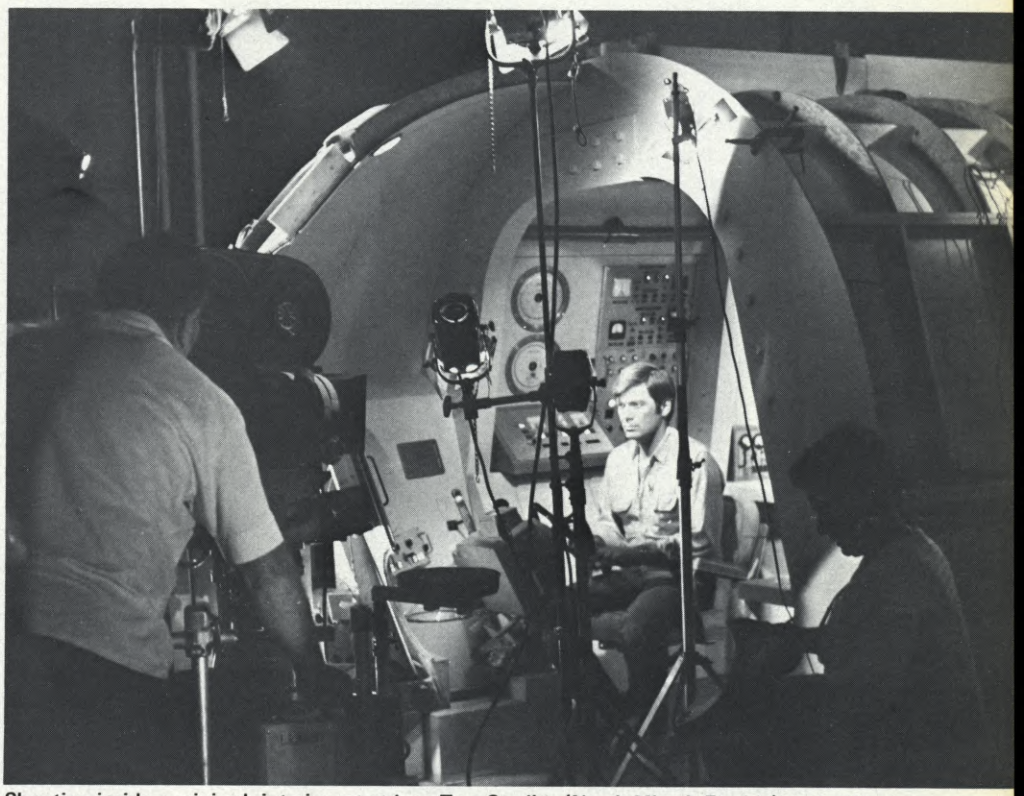


Shooting inside a mini-sub interior set at Ivan Tors Studios (North Miami, Florida) during filming of "THE AQUARIANS". Fast 5254 negative required light level of only 100 foot-candles for lens stop of F/4.5.

Jordan Klein photographs sequence for "THE AQUARIANS" with "flying saucer" submersible which he conceived, designed and built. Klein functioned as Associate Producer on this film, as well.

JACQUES COUSTEAU

Continued from Page 843

cases like this, we use the 12mm-to-120mm Angenieux zooms much of the time.

"As far as underwater lighting is concerned, we occasionally use 150-watt quartz lights at shallow depths. But most of our deep work is filmed with 750-watt quartz lights that we run from the ship's generator. At times we go down with 15 or 20 of these, in sets of two or three. These lights have been manufactured for us by the E.G. & G. Company in Boston. Since about a year ago, however, we have been designing our own lights and improving them tremendously. We are now working on several new systems.

"The problem of back-scatter, the reflection from particles in the water, is a serious one, but the simplest way to avoid it is to place the lights as distant as possible from the camera—preferably at an angle of from 60 to 90 degrees. We very seldom have a light mounted on the camera. The exception is a portable battery type of light that is used occasionally—but only in very clear water.

"Most of the divers aboard Calypso *are trained to hold lights at the command of the cameraman. He usually has two or three divers handling lights for him. He briefs them in advance as to how far away they should stay from the camera and the subject and what kind of angle he wants. He directs them under water by means of hand signals.*

"Some of the lighting problems are quite difficult. For example, how do you light a 50-foot whale that's cruising at five knots? The last time we shot whales we didn't light them at all. But I'm going to shoot some more footage of the Humpback whales, and this time I will try to light them by hanging lamps all along the side of the ship, hoping I can coax the whales into coming close.

"There is another kind of lighting problem encountered when you film in very shallow water—on a coral reef, for example. The direct sunlight gives you very brightly lighted areas, but also very deep shadows and it takes a great deal of light to fill those shadows.

"Some people think that they can shoot with just the available light because there is so much of it, but this doesn't work. You can't bring out the colors, and you end up with a kind of mottled pattern that's not good.

"We use lights all the time—that's one of the secrets of this whole underwater filming business. Anybody who tries shooting underwater without artificial light is doomed to a green screen—even in 10 feet of water.

"The first film that I did for this series was on sharks. If you have just one or two sharks, that's one thing. But if you have a frenzy of 150 sharks around you, how do you light them? We used several shark cages and put 750-watt lamps in some of them to light the whole arena. Some of the lights were outside of the cages, which allowed the sharks to bite at them. We've had some lights torn apart by sharks just biting the hell out of them, crushing them completely.

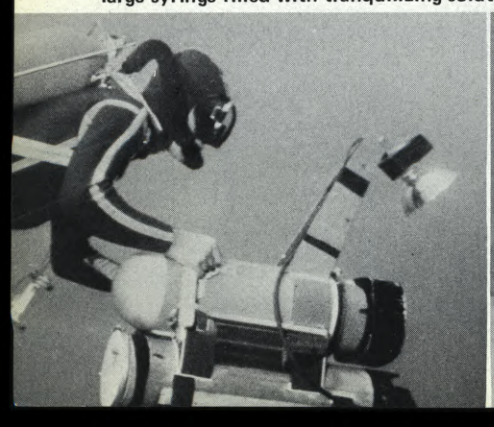
"We were using very small horizontal cages, very much like tubes with bars, that can be opened at one end. I was in one of them, but I would open the end and thrust my body halfway out, because that was the only way I could follow anything that went by and keep from getting the bars into the shot. With the end of the cage open, the small sharks could wiggle their way into the cage and I would have to manhandle them out again. A shark belongs outside a cage, not inside. The small sharks are the ones I fear most because they are the most aggressive and they can enter a cage and take a pound or so of flesh out of you like nothing.

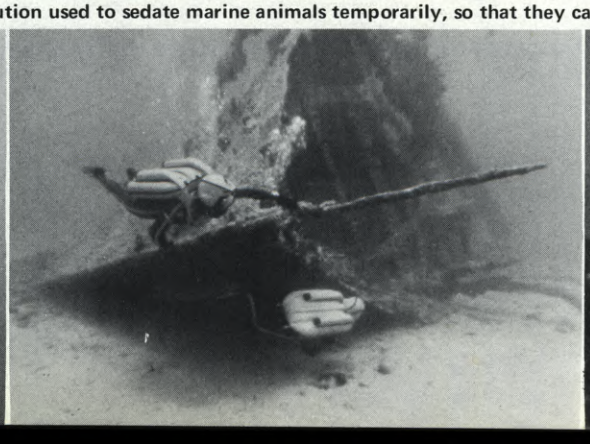
"Filming the gray whales took some doing. The main problem was more mechanical than technical. A whale swims about 25 times faster than a man. He goes by you like a train—so, how do you keep up with him long enough to take his picture? We solved it by having a fast boat on which I could ride with my aqualung on my back, holding my camera. We'd race the whale and when he'd surface to breathe, I'd jump into the water alongside him. It was rather a stupid stunt. Once I almost broke my tooth when it hit the back of the camera as I jumped into the water at high speed. It's not very safe, and it doesn't insure that you'll get the shot. You swim as fast as you can, but the whale goes right on by you as if you weren't moving at all.

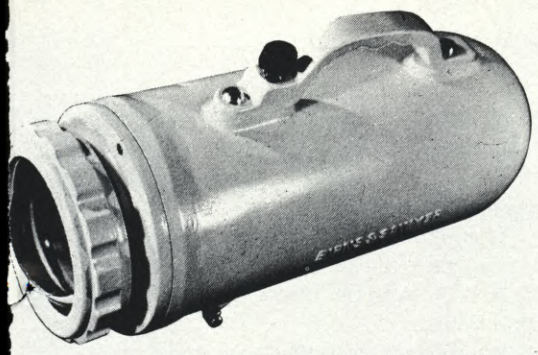
"Recently I did some interesting filming for one of our specials aboard the U.S.S. Saluda, *a United States Navy research vessel assigned to the Naval Undersea Research and Development Center at San Diego. The* Saluda *is a 95-foot jib-rigged yawl, a beautiful sailing craft with auxiliary power. The project I was shooting was an experiment being conducted by Dr. Bill Evans which involves attaching radio back-packs to the dorsal fins of porpoises, so that he can study the behavior of the school. Every time the porpoises surface to breathe, the back-packs send back signals that provide bearings as to their whereabouts. Another set of signals records the depths to which the animals have been diving. The man who actually captures the porpoises and attaches the back-packs to their fins is Bruce Parks, skipper of another research vessel, the "SEA-SEE". The whole process is really fascinating, and I think we succeeded in capturing it on film.*

"I believe that the sea is the hardest environment in which to film. You're working in the water; you have to use water-tight cameras; you have light problems; you have color problems; you have distortion problems; you have time problems and you have wild-life problems. There's nothing routine about underwater filming. It's really a challenge every time. I think you have to be very stable of mind in order to wait calmly to see the rushes, because it's always kind of touch and go as to whether you actually got it on film. You never really know if it's there until you see it. I don't, at any rate." ■

(LEFT) Cameraman swims with Cousteau underwater camera. Clamped to top of camera is 150-watt quartz light. Beneath camera is battery-pack for powering the light. (CENTER) Divers explore a very old shipwreck. (RIGHT) Cameraman shoots scenes of diver moving toward coral reef with a large syringe filled with tranquilizing solution used to sedate marine animals temporarily, so that they can be studied.







The rugged, hand-held, all-in-one B & S Polaris is a special version of the versatile Snooper. Center beam candlepower range is from 25,632 to 61,920 providing 18 to 100 minutes of light, depending upon bulb selection.

range of battery-propelled submersibles. The resistance exerted by open-reflector fixtures can be considerable, for the larger the open-lamp fixture, the greater the drag and the more open reflectors on a vehicle, the greater still will be the drag. The precise loss of horsepower and excess battery drain can be calculated by analyzing the depth of each open reflector, its surface area, and the number of lights.

Yet it is relatively simple to change to hydrodynamically clean, closed-reflector units to eliminate the drag, with its loss of forward power, motion, and usable battery life. General Dynamics Corp.'s Electric Boat Div. did. It was using a pair of 1,000-W open-reflector lights on one of the *Star* submersibles. These two units proved inefficient and costly in terms of battery life. The company substituted two closed-reflector 750-W lights and chopped power consumption from 2,000 W to 1,500 W. In the process, the submersible operators received more real light output. The saving was four-fold: greater battery life, less drag, more efficient light, and less expensive bulbs.

Among the major companies that prescribe closed reflectors for submersibles are: North American Rockwell Corp. for *Beaver 4,* General Motors Corp. for its *DOWB* work boat. Perry Submarine for its submersibles, and General Dynamics for the *Star* boats.

REDUCES BULB DAMAGE

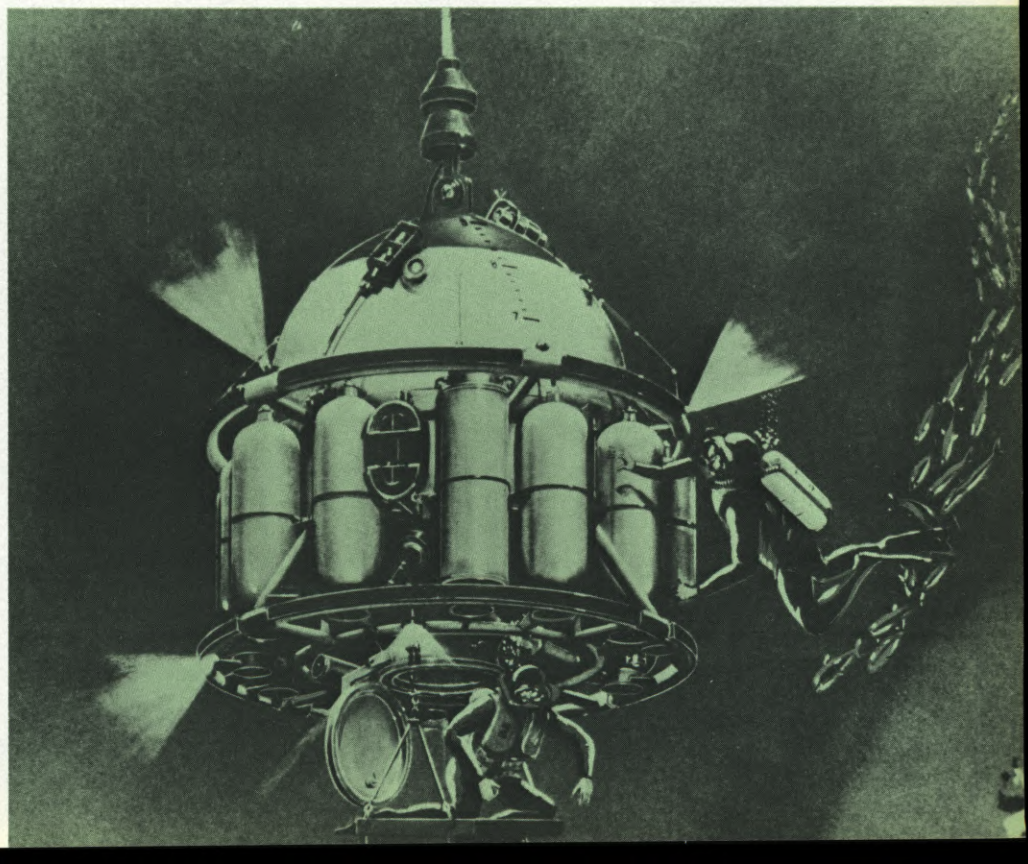
Safety is an important factor. The open reflector leaves the source lamp

Continued on Page 918

(ABOUT THE AUTHOR: Jack Birns, president of Birns & Sawyer Inc., founded that firm in 1954. His technical accomplishments include designs for underwater lights and camera housings. From 1947 to 1954, he was a Life correspondent in Asia and Europe. Mr. Birns is a graduate of Ohio Northern University.)

A diver moves through underwater canyons carrying a Polaris light. Unit can be mounted alongside camera, on mobile vehicles or stationery habitats, or can be hand-carried into selected locations by divers to provide lighting for the underwater cinematographer. The Polaris can be used at depths of 5,000 feet, far beyond the range of SCUBA divers—but a great safety factor.

Artist's conception of Personnel Transfer Capsule of the Mark II, Mod I, Saturation Deep Diving System, under construction for the U.S. Navy. Birns & Sawyer supplied 24 Snooper units for this project, to be used as work lights, as well as for documentary filming.



UNDERSEA TV SPOTS

Continued from Page 891

Company TV commercial. This one involved driving a modified Kaiser Jeep 10 feet underwater in the harbor at Nassau, The Bahamas.

The commercial's objective was to demonstrate the unfailing performance of ARCO gasoline under any and all conditions.

Running the Jeep underwater was no problem, but every time it stopped it stirred up a thick cloud of sand particles, posing not only an unforeseen, but an unprecedented, problem for the cameraman. There was no way it could be overcome—we just had to live with it.

The Jeep had to be driven a total of seven miles, every inch underwater, to complete the commercial. It took two days to finish what ordinarily would have been an easy one-day shooting job.

And, although there were no casualties among the cameramen while making the shark commercial, one almost occurred during the Jeep sequences. A cameraman was nearly run over when he misjudged the direction the vehicle was about to take.

This, I believe, emphasizes the unpredictability of shooting TV commercials under water, at least from the human standpoint.

Danger was minimal but discomfort was something else when we filmed an Indiana Power Company TV Commercial on the subject of water pollution.

This was done in a water-filled rock pit in North Miami. Props were garbage, general household rubbish, old automobile tires—you name it.

These cascaded down from the surface of the water, onto and around the cameramen, who nevertheless did a fine job of shooting while ducking potato peelings, lemon rinds, overripe tomatoes, tires, shoes, and other miscellaneous junk.

Obviously, underwater color TV commercials don't "just happen." A tremendous amount of preliminary labor and aesthetic camera work go into the making of a one-minute spot ad.

About half of the time Underwater, Inc., does only the required photography. For the other 50 percent we package the entire commercial, supplying all requirements, including specialized talent, props, logistical supplies, equipment, cameras, cameramen, shooting location and transportation to and from it.

Although we are based in North Miami Beach, most of our underwater shooting is done at various locations in

The Bahamas, where largely clear and relatively unpolluted waters prevail.

This requires maintaining a ready means of transportation from the mainland to the islands. Our amphibian airplane provides it.

Normally, we work from story boards supplied by advertising agencies, following them to the letter whenever possible. Often, in addition, we will take other shots from different angles which we believe might strengthen the sequence, and offer them on this basis to the client.

Almost all color commercial shooting done by Underwater, Inc., is on Eastman Color Negative Film 5254, which is recommended for use at a tungsten exposure index of 100. The speed of 5254 permits easy filming at greater depths, while reducing lighting requirements when working in shallower water. Last year, we used more than 100,000 feet of the film.

The most commonly used camera and housing for television commercial shooting at Underwater, Inc., is the 35mm Arriflex with a 400-foot film load. Also available, however, are Bolex, Eastman K-100, Mitchell and Todd-AO AP-65 cameras, enabling us to work in all film sizes from 8mm through 65mm.

When still-work is involved in making a commercial, we use Kodak Plus-X and Plus-X Professional for black and white requirements and the Kodak Ektachrome for color. Still-work is either 35mm or 70mm.

Tripods and/or fixed platforms are rarely used, except when shooting stop-motion studies (which normally have nothing to do with TV commercials). Hand-holding is the rule at least 95 percent of the time; it is even possible when shooting plates.

Basically, two types of lighting are used. Some of our hand-held cameras have self-contained lighting systems. When higher key illumination is required, we usually use surface-powered equipment providing up to 1 million candle power per unit and color temperatures up to 5400 Kelvin.

And all that's what it takes to make underwater color TV commercials at least in the experience of Underwater, Inc. We make many in the course of a year, and the technique varies only in minute detail from one to the next.

We feel that underwater photography is an art unto itself, having little in common with picture-taking anywhere else—except in space. The environment is unique and so are most of the techniques we employ. All of which is to say, it's great work if you know exactly what you're doing. ■

THE INCREDIBLE "SEA-SEE"

Continued from Page 839

SEE Project Manager and design engineer who was actually responsible for getting the vessel out of the dreaming stage and onto the drawing board.

BRUCE PARKS—"Skipper" of the *SEA-SEE,* he is actually much more than that. A rugged aquanaut type who spent several years as an underwater "wrangler" at Marineland, he seemingly knows no fear and will go into the water with anything from a killer whale to a sea lion in heat. He fights off the sharks and other beasties while Stitt is filming and has, in his own right, developed into a highly skilled underwater cinematographer. He is also something of an expert on buffalo behavior.

BOB HESTER—"First Mate" of the *SEA-SEE,* he is an ex-Navy "Chief" who pampers the vessel's engines with tender loving care and keeps them purring along. A soft-spoken Southern gentleman, he is totally unflappable, no matter what the crises and, in his own quiet way, runs a very tight ship.

LARRY SAMMONS—one of the still photographers from the NUC Photo

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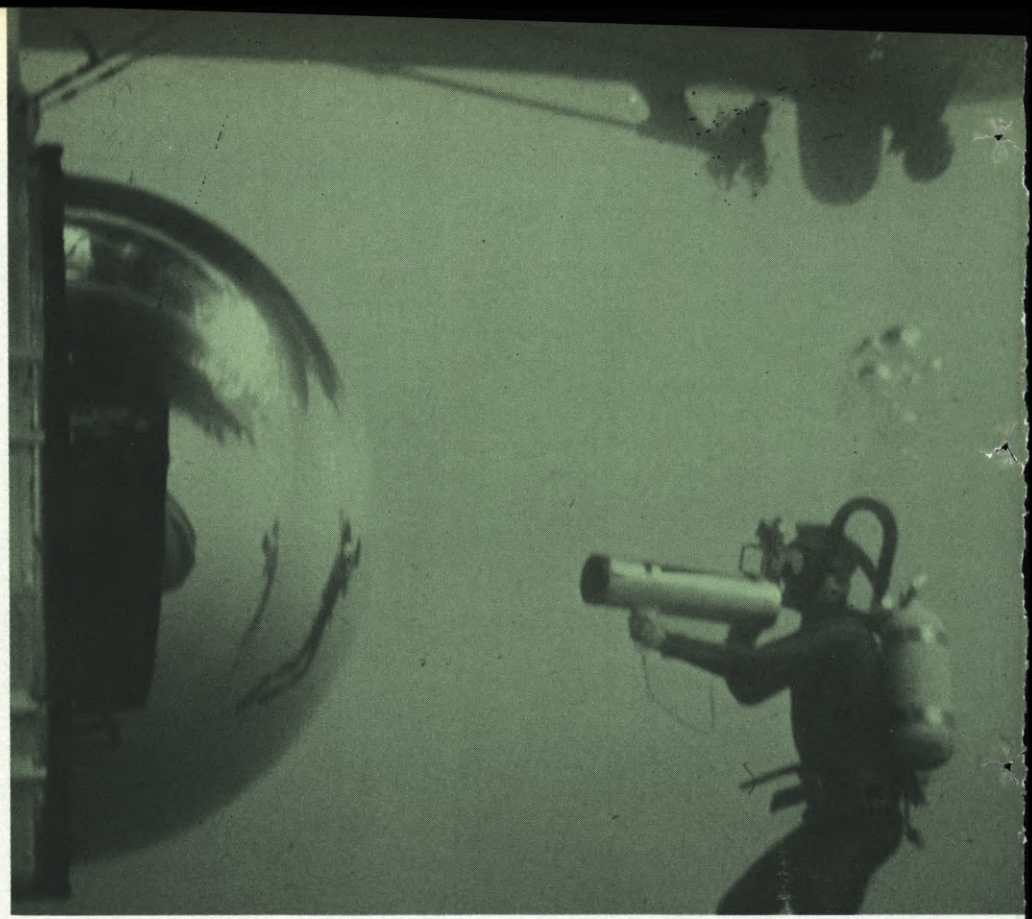

Underwater cameraman trains his Rebikoff underwater camera on scientist comfortably seated in observation bubble of the "SEA-SEE". The bubble compartment, 7.5 feet long, with clear plastic hemispherical ends, has two aircraft-type seats, but is large enough to accommodate three men, if need be. Though top of tube leading down has open access to the air, additional air is pumped in for comfort. An intercom maintains direct communication with topside personnel.

Scores of blue sharks circle about twin pontoons of the vessel, attracted by ground up fish "chum" purposely thrown overboard by scientists. Because of extreme wide-angle lens used to take this photograph from the bubble, sharks appear to be much smaller and farther away than they actually were.

"WAVES OF CHANGE"

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and skills to form MacGillivray-Freeman Films with the aim of producing documentary films of high technical excellence. Their first joint effort, "FREE & EASY", became one of the most successful films to play the 16mm lecture circuit and established them as top surfing film-makers. A short entitled, "MOODS OF SURFING", cut from "FREE & EASY", won them numerous awards including the coveted CINE GOLDEN EAGLE, the International Industrial Film Award for Creative Excellence, the CHRIS AWARD from the Columbus Film Festival, the SILVER MEDAL from Cortina, Italy, International Sports Film Festival and was selected to represent the United States at the Mexican Olympics in 1968.

Freeman films scenes from the beach for 90-minute film starring World Champion surfers David Nuuhiwa, Nat Young, Bill Hamilton and Ket Keith Paull.

Greg and Jim embarked on their film careers independently at early ages. For Greg, it all began when he was 13. Santa Claus brought what was to launch Greg on his photographic hobby: an 8mm Brownie camera. It was only natural that he'd combine his favorite sport (surfing) with his favorite hobby (photography). A year later he was showing crudely produced surfing films to crowds of almost 25. After such success, he bought a 16mm outfit with cash saved from paper routes.

Every day Greg would rise at 6 a.m. and check the surf. If it was good, he'd take pictures. If it was fair, he'd surf. If it was poor, he'd study for school. This was the standard routine through high school and his freshman year at the University of California, Santa Barbara. Three years after he began filming, Greg released his first picture, "A COOL WAVE OF COLOR". Greg, then 17, became the youngest person to ever complete a surfing film. Nevertheless, "COOL WAVE" met with enthusiastic crowds and rave reviews. As Greg explains: "I made the film for myself and my friends. We were surfers and wanted to see real surfing—hotdogging—not big waves with some kook falling off the board." Greg showed "COOL WAVE" throughout California, then took a year off from college and toured the East Coast. After returning he began his association with "Surf's Up", a nationally syndicated television show.

In a rare "on the beach" moment of rest, Greg MacGillivray explains the workings of his hand-held, housing-enclosed camera to a couple of interested surfers. Greg has been making films since he was 13 years old.

By age 19 Greg had been to Hawaii, the East Coast, old Mexico, and "every surfing spot in California," and released his second film, "THE PERFORMERS". Things couldn't have gone better. His summer schedule with "THE PERFORMERS" was a series of "sell-outs." Later, the film made three com-

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With Arriflex on Tyler Vibrationless Camera Mount, Freeman films helicopter shots of giant surf on Hawaii's North Shore of Oahu. A second, remotely-controlled camera is mounted on the nose of the craft.

THE INCREDIBLE "SEA-SEE"

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Branch, he recently won the top award in a photography competition for his mood-filled silhouette of a cameraman shooting out of the bubble of the *SEA-SEE.*

Not to be accompanying us on our sea-going safari, but very much a part of the *SEA-SEE* documentary project, is the film's producer, Robert H. White. He is, I'm told, stuck in the cutting room, busy with the editing of the considerable amount of footage which has been shot to date.

White is an all-around film-maker (producer, director, cameraman, editor), and a veteran of 20 years in the Navy. His tour included work with a combat camera group at North Island, San Diego and overseas duty in Korea and Vietnam.

Speaking of White, Tom Garcia says: "He worked very closely with the writer of this film to make sure the work of the *SEA-SEE* would be documented in the way the Center wanted it to be. It would have been impossible to make the film if we hadn't had the right type of man to see it through. He's certainly contributed significantly to the project."

These men are a breed apart—slightly larger than life—and their conversation is spiked with matter-of-fact observations about this or that assignment when they found themselves in the water surrounded by 75 ravenous sharks. It is only the rare occasional reference to crabgrass, dichondra or some other suburban trauma that reminds us, now and then, that they are mortals just like the rest of us.

So that Lee and I can get better acclimated to our surroundings, Bruce Parks very kindly takes us for a short tour of the Isthmus area in the Land Rover. The rest of the jolly crew comes along for the ride.

Along the way we spot a magnificent bull buffalo, right off of a nickel, grazing in a field. I ask if we might stop long enough for me to take his picture.

"Well, yes," drawls Bruce in doom-filled tones, "but you gotta watch out for that critter. He's *mean.* If he raises his tail, you better git your butt back in the car *fast.* That means he's mad, and he's gonna make a rug out of you."

Mentally checking whether my life insurance premium has been paid, I get out of the vehicle and approach the belligerent beast close enough to get a nice frame-filling shot. Just as I'm trying to get him to say "cheese," he does, indeed, raise his tail.

"Get back in the car!" yells Bruce. "You got him mad. He's gonna charge!"

I execute a neat non-stop flight back to the Land Rover and, with a horrendous clashing of gears, Bruce takes off at full tilt across the veldt.

As it turns out, the buffalo, far from being a fighter, is only interested in answering a call of Nature.

Bruce has a hard time living that one down.

On the first morning of our sortie into the deep, we eat breakfast at the best (and *only*) restaurant at The Isthmus. Frolicking in the mud outside the door, with grunts of porcine ecstasy, is a tiny piglet who, I am informed, is actually a baby boar. The *SEA-SEE* crew regard this creature as a kind of mascot but, not being too swift with the biology on dry land, they haven't been able to figure out what sex it is—so they simply call it "Myra Breckinpig" and let it go at that.

We pile into the Land Rover and jounce down to a secluded bay hard by USC's Marine Sciences Center and there, tethered in the water, is the *SEA-SEE* in all its catamaranic glory. It is just about the most unusual craft I've ever seen, but the really strange part (the bubble) is concealed under water.

The engines are revved up. Bob Hester listens keenly to their tone and then nods approvingly. "Skipper" Parks does things with the controls and the spunky little craft, proudly flying the stars and stripes, moves out into the deep. We head for a spot several miles off-shore, in search, hopefully, of clear water. The mission for today is to film documentary scenes of Stitt and Parks suiting up, donning SCUBA gear and plunging over the side with their Rebikoff underwater cameras at the ready. While they're getting prepared for this, Tom Garcia checks and rechecks all of the meters, connections, etc. on his 16mm Arriflex.

With its bubble in the retracted position between the twin pontoons, the *SEA-SEE* appears to have a fat smokestack sticking up through its center. When we finally anchor and the bubble is lowered (by means of winches) to its fully extended position beneath the craft, the top of the stack is flush with the deck.

Lee and I, who have been excitedly waiting for this moment, are elated when our hosts invite us to go below for a look. We clamber down the ladder like a couple of kids at Disneyland (tired ones!) and settle into the two surprisingly comfortable aircraft-type seats. Each of us is seated next to a crystal-clear hemisphere which presents a 180° view

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UNDERWATER EQUIPMENT

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speed, viewfinder focus, internal lighting, on-off switch, are all within reach of the operator's hands. The housing has a built-in light meter which indicates the proper T/stop on a lighted scale just above the viewfinder screen. Alongside the T/stop scale are internally-lighted calibrations which indicate the focus setting and T/stop setting of the lens.

A specially designed viewfinder is built into the housing and shows the operator exactly what he is shooting on a ground glass. A signal light on top of the housing indicates when the camera is running. Nickel cadmium batteries supply the power.

The linkages between the camera and the external controls are so designed that synchronization of the calibrations is automatic when the camera is inserted in the housing.

The camera features a 500-foot, single-chamber magazine with direct gear-drive to slip-clutch. Speeds are variable from 16 to 32 fps. Basic lens equipment is a 40mm, T/2.8 Super Panatar lens which focuses from three feet to infinity. Other lenses available upon request. Bright aerial-image viewfinder yields correct image. ■

DEEP CINEMATOGRAPHY

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the normal everyday type of filming location the cinematographer is too concerned with the state of his art to be annoyed with trivia. But under the surface of the sea nothing is trivial. Everything is of the utmost importance —the position of the boat above, how much air is left, the set of the current, the time you've already been down, the decompression tables, whether the big shark circling is hungry or just curious, a possible malfunction in your diving gear, and a dozen other things.

When I am filming under the sea, I must concentrate completely on my photography and not have any other worries. I let my safety diver worry for me. Many times a deep water subject is such that it can be filmed once and once only; thus, it must be done right the first time. So my safety diver is second only to my equipment in importance, and there have been a couple of times when he became even more important than anything else. He became my only chance for life. Your life while filming under the sea is actually in the hands of your safety diver. It goes back to the old saying: "It is better to have him and not need him than to need him and not have him."

Good safety divers are few and far between. Such a man must be more than a weekend diver who brings home a car trunk full of fish every Sunday night. He must be a *professional* diver. He must be reliable and not swim off sightseeing the minute your back is turned. He should, without any doubt, be of proven diving ability. He should understand what the cameraman is trying to accomplish and have a basic knowledge of any photographic problems that might arise. Your safety diver should be as much at home in 30 fathoms as your assistant cameraman is in a magazine darkroom. By working with the same safety diver all of the time, you become a team, and I can't emphasize enough the need for teamwork between the underwater cameraman and his safety diver.

Regarding equipment, I prefer the self-contained camera to the camera with a separate housing. It is more compact, faster loading, easier to take on or off the boat, can be used out of the water in an emergency, and, in general, is more practical all around. If possible, own your own. Nearly every camera that I have ever rented for submarine cinematography had something or other go wrong. With my own camera (a Rebikoff) I know its capabili-

ties and can depend upon it. Even so, however, when filming in remote areas, I usually take a spare underwater camera along just in case something might go wrong with my own camera.

If time permits, and this can be planned in advance, I usually take several rolls of black and white negative film with me along with an amateur's home-developing kit, so that a camera check and "slop" test can be run on location. You can never tell whether your camera may have become damaged in shipment, the batteries will not retain a full charge, the F-stop control gears are out of mesh, the aperture could have foreign matter in the frame that can't be seen by merely taking off the pressure plate, etc. This checkout is especially important when using rental equipment.

Another item not to be overlooked is a good diving boat. If the film crew is to live aboard, it should be large, comfortable, and well-equiped. A good cook is imperative. If you are to live ashore, then a fast boat is preferable. But it must be large enough to have a dry semi-dark area for camera loading and unloading and have a padded or soft area for storing the camera gear when under way to avoid damage from the constant pounding of a planing boat. Accommodations for entering and leaving the water are of more than a little importance. A ladder over the side alone is not sufficient. A good camera boat must have a diving platform that is easily climbed upon from the water when you are loaded down with camera gear. It should be fixed rigidly so that it will not pound up and down with the waves. Then, too, there is the boat's captain. He should have the qualifications and ability to get you to where you want to go and back. And the vessel itself must be sound and seaworthy. Many a good shooting day has been wasted because of a boat's mechanical breakdown, with no spare parts available. On your charter contract make sure that you have a clause eliminating any charter fee for time spent in port due to mechanical failure of the boat. Not only will this possibly save you money, but it will also serve to have the boat's owner make sure that the vessel is sound and that there are adequate spare parts aboard.

Undersea cinematography is time-consuming, can be rather expensive, could be hazardous, and requires some degree of luck concerning weather and sea conditions. However, submarine cinematography, when well planned and done right, can produce some highly spectacular results that will be well worth the time and effort involved. ■

THE INCREDIBLE "SEA-SEE"

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of the surrounding sea. It is an incredible sensation—that of being suspended in Inner Space while a myriad of sea creatures glide and swoop about outside, peering at us through the capsule within touching distance. We are seeing everything a SCUBA-geared cameraman would see, but we are comfortably seated on a stable "platform" in a "shirt-sleeve" environment, with fresh air pumped down the tube from above. There is no need to fight the surrounding elements or struggle to maintain equilibrium for filming—or simply to breathe, for that matter.

Just to get the feel of what it is like to actually film from inside the capsule, I whip out my trusty Beaulieu Super-8 and grind off some footage of what is happening out there. Lee Collins is doing the same thing—except with an Arriflex. (What else?)

Suddenly there are the sounds of a commotion topside. The voices are excited and there is a good bit of scurrying about. Then someone pokes his head down the tube and announces that a school of killer whales has been sighted off the starboard bow. The *SEA-SEE* decides to give chase.

Now there's a sensation—sitting in this glass cocoon while the vessel that supports it goes plowing through the water in pursuit of a whole herd of deepsea leviathans.

It suddenly occurs to me that it might get a bit sticky if one of those four-ton beasts decided to turn about and ram the bubble—*while we were down there inside of it.* A chilling thought! But then my overactive sense of the dramatic shifts into high gear and I realize that one could hardly ask for a more spectacular way to go. Think of the headlines!

As I am conjuring images of world-wide mourning, a voice comes over the intercom informing us that we've lost them—the killer whales, that is. The news is not really surprising. Despite its sterling qualities, *SEA-SEE's forte* (especially with its capsule dragging) is not high speed on the high seas.

Still, it has been an exhilarating experience and, in the days to come, further undersea adventures and a great deal of picture-taking combine to make a solid *SEA-SEE* convert out of me. I can think of no better, more comfortable or more precise way of filming at shallow depths—and subsequent viewings of footage shot from the capsule only serve to solidify my considered opinion.

However, it is not *my* opinions that are critical here, but rather those of the men who actually work with the vessel and the scientists who "contract" for the use of *SEA-SEE* to aid them in specific research projects.

Following are verbatim quotes from several of these directly-concerned parties:

TOM GARCIA—Producer/Director/ Cinematographer and Associate Head of the Motion Picture Branch at NUC

I'm the one who took the first movies and still pictures, shooting through the bubble. I was also down in the bubble on the first cruise that was made with the *SEA-SEE*. I've done all types of photography in my life—just about every kind you can imagine—but never have I experienced the thrills that I have had while working from this boat. Seeing all those whales, sharks, porpoises and other sea creatures and being able to film them close up the way you can on the *SEA-SEE* is a great thrill.

FRANK STITT—Producer/Director/ Underwater Cameraman

The *SEA-SEE* offers several important advantages in underwater filming. You don't have to suit up. You don't have to have your camera in a watertight housing, nor use any special equipment. You take whatever equipment you feel you need to do the job right down into the bubble with you. You sit there in comfort and take your pictures as the action develops outside the bubble. Sometimes when I'm out there diving I have to struggle like the devil to get the shots I want. Tom Garcia is sitting inside the bubble grinning and getting good pictures of me, while I'm working my head off to get good pictures of him. When you're shooting in the water, you're in the fish's element. When you're shooting out of the bubble, you're in your own element. You can sit in there with your camera on a tripod where it's nice and quiet and shoot the action. But if you go out there in SCUBA gear to take pictures in the water, you've got the waves up top that are kicking you back and forth, and whatever you're trying to shoot is ducking in and out of rocks. All this plus the fact that you've just plain got to work to breathe. The *SEA-SEE* eliminates all of that hassle. We've had a lot of good fortune with the boat. It's always performed very well, and so have the people who run it. Bruce Parks, the skipper, is a very special kind of fellow. I would be extremely hard pressed to describe what kind of guy it would take to replace him. We have quite a bit of

respect for each other and we work well together. The same is true of Bob Hester. He's just like a doctor when it comes to diesel engines. If one doesn't perform just right he knows just what to check next. He can take the pulse of an engine. He's invaluable to us in the same way that Bruce is—although they're entirely different. But they're both very much a part of the *SEA-SEE*.

L. E. McKINLEY—*SEA-SEE* Project Manager/Design Engineer

Some of the parts of the *SEA-SEE*, such as the pontoons, center deck and portions of the forward house, were constructed about ten years ago as elements of a garaging vehicle for the Moray submersible, but when that project closed, the parts were simply stored at China Lake. We began to wonder how we could use these parts to build another kind of vehicle. Bill Evans and a couple of other fellows were called into it and we incorporated some of their requirements into the design. However, it was an open boat. It had no berthing facilities of any kind, no head, no mess and no real shelter. Bill and I made several transits with that configuration and nearly froze. We decided that it needed something more. About that time, I got pulled off the project and Bill had a cabin built, which was then installed in the back of the boat. Later we added width and length to the boat, put in diesel engines, closed in the forward cabin, installed radar in it and ended up with a much bigger boat. The *SEA-SEE* was launched in June, 1968, in the configuration which it presently has. It's been in constant service since then, with Bruce Parks as skipper. But its existence is due mainly to Bill Evans. After it was launched, it was he who committed his entire funding for the following year to the boat, with the conviction that he would be able to get back more data with the boat than he could by using the same amount of money in any other way. He was so very committed—probably even more thoroughly committed than I was in building it and launching it. So, Bill Evans is part and parcel of our team, even though he is no longer directly associated with the management and operation of the boat.

WILLIAM E. EVANS—Biologist

As far back as 1960 we were searching for a way to study the behavior of pelagic marine animals off-shore. Jumping into the water with underwater cameras just wouldn't work. The animals don't stay around. They're moving, and you've got to be able to move with

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FILMING WITH 5254

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plete with decompression chamber. Underwater props consist of such things as the Aluminaut, a real-life $5 million submarine; mini-subs, and an undersea counterpart of the lunar LEM.

Topside photography included a great deal of shooting inside mockups of the lab, various underseas vehicles, and a variety of on-location sequences made, among other places, at Miami's Vizcaya Gardens and the Opa-Locka airport.

Each of the topside situations provided Poland and his camera operator, Oscar Barber, with unique opportunities for utilizing the smaller aperture openings that the faster exposure index of 5254 film made possible.

For example, closeup interiors of a mini-sub mockup were exposed with only 100 foot-candles of light. When long shots were demanded by the script, lighting only had to be increased to 200 foot-candles, obtained from floods located at the open end of the mockup. The aperture on the Mitchell camera being used was set at F/4.5 for the closeups and F/5.6 for the long shots. The film was pushed in development one stop.

"Depth of field was excellent," says Poland. "To achieve the same results with the former color negative film, we would have required twice as much light.

"It wasn't only a question of less equipment, but less power as well as less make-ready time and planning. The faster film allowed us to set up the sequence much more quickly.

"This makes sense," Poland comments, "especially if you are using rented equipment, as we were, and you have a 12-day shooting schedule, as we did."

The Eastman Color Negative film is rated for an exposure index of 64 in daylight and 100 in tungsten light.

The extra speed and versatility of 5254 film also paid dividends on some outdoor sequences, as it was decided not to use arcs outside and go with reflectors only. Once, Poland recalls, he was shooting at Vizcaya Gardens, using guest stars Jose Ferrer and Chris Robinson, and, unfortunately, the weather was uncooperative. By and large, the days were bright and sunny, but with patches of clouds that intermittently floated overhead.

"Devastating results would have occurred only a few years ago," Poland says. "The sun played hide-and-seek behind the broken clouds, as the lighting varied from bright overcast to direct

sunlight. Our decision was to read our lighting for direct sunlight and let the film's wide latitude take care of the variations. It did. There were only negligible variations detectable when we viewed the overnight rushes a day later." The picture's 12-day shooting schedule made it imperative to finish their sequences right on time.

In another outdoor sequence, location photography was locked into the timing for launching the $5 million sub, which had been in drydock. Launch time could not be changed to accommodate photography.

It was sundown on location when the scenes were ready to be filmed, although the script called for the launching to be done earlier in the day.

Poland opened the Arriflex camera zoom lens aperture to F/3.9, permitting almost maximum light input, yet maintaining acceptable depth-of-field.

"In spite of the warm color of the late-afternoon sunlight a suitable color balance was obtained with a minimum of correction by the processing lab. After the sun went down, we pulled the 85 filter and pushed exposure one-stop in the lab, using only skylight for our light source.

"It was literally impossible to tell that we shot that scene in waning daylight," he adds. "Color saturation was normal and color balance wholly acceptable."

Underwater cinematography for "THE AQUARIANS" was handled by Jordan Klein and underwater direction by Ricou Browning, president of Ivan Tors Studios. The speed of the color negative was combined here with the first use of a high-powered, portable lighting system engineered by Klein.

His lights each develop 1 million candlepower from a 12-volt, 4-ampere battery pack small enough to be carried on a diver's back. A ballast arrangement boosts the 12 volts to 380 volts input to the lights.

The system is unique in that it completely eliminates back-scatter, long the bane of underwater cinematography, penetrating water for great distances while illuminating foregrounds more brilliantly than was ever before possible.

Two hand-held 35mm Arriflex cameras were used—one with a Kinoptic 18mm lens and the other a Kinoptic 9:8mm with special dome port at apertures from F/5.6 to F/11—protected for underwater operation by Mako housings, invented and now produced by one of Jordan Klein's companies.

Underwater crews varied in size, but for the most part only two cameramen

and two divers were required to manipulate the lights, also hand-held.

"Net effect of this new cinematographic technique," explains Klein, "is that the camera lens probed farther, providing more significant depth-of-field underwater, and screen colors were more brilliant.

"Partially, this is a characteristic of the film, in that it produces brighter greens and blues, colors you expect to see under water," says Klein. "However, the fact that we had so much more light to use down there contributed to the overall brilliance of the colors. After all, color photography is really just a recording of the reflectance of light." ■

U.S. FILMS WIN TOP PRIZES IN RIO FILM FESTIVAL

In the latest edition of the International Scientific Film Festival held in Rio de Janeiro, Brazil, the American motion pictures selected by CINE (Council on International Nontheatrical Events) were honoured with First, Second and Third Prizes in each of three categories. A total of 104 films from 19 countries were entered in competition in the Festival's five categories.

The First Prize in the Research Category was awarded to Loma Linda University's "HEART MOTION BY COMPUTER GRAPHICS" which was sponsored by the University and the Aerospace Corporation.

Second prize in the Carioca Festival's Popular Science Films group went to A. T. & T.'s "LASERS UNLIMITED" produced by Jerry Fairbanks Productions of California and distributed by the Bell System.

"POLLUTION," a University of Southern California production, won Third Prize for Information Films in the Brazilian Festival.

The remaining four films selected by CINE to represent the United States in the Festival were awarded Certificates of Participation. The titles of the films are, "DUNES", "HIMALAYA: LIFE ON THE ROOF OF THE WORLD", "IF YOU HEAR THE EXPLOSION THE DANGER HAS PASSED", and "PLANTING AND TRANSPLANTING".

The Scientific Film Festival, held May 25 to 30 in the cultural capital of Latin America's largest country, drew more than 7,000 spectators over a six day period.

CINE's Board of Directors recently selected 181 American short films to represent the United States of America at international film festivals during the coming months.

GHOLSON 2000

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both a soft even fill light and a powerful but evenly spread key light was evident. The use of variable focus lamps did not seem to be the answer, primarily because of spottiness. This characteristic always makes the film viewer aware of artificial lighting. It became clear that at least two types of light reflectors would be needed and that, on occasion, both fill lights or both key lights would have to be employed. A large pain in the buttocks would be experienced every time you had to surface to change reflectors and globes. The solution was to place a lamp at each end of each light head. Currently I'm using a 450-watt incandescent lamp with medium-wide lens on one end, and a 350-watt quartz lamp in a very efficient flood reflector on the other. Each light is covered with a pyrex hemisphere that attenuates the light into a very even spread. You simply spin the head to the lamp you want and roll.

In actual use I found I was able to dolly alongside an actor at his full swimming speed, keying his face from an extreme cross position and providing a little kicker on his tanks with the fill light. The skin tones were perfect and the separation fantastic. The same went for a tracking shot along a reef, gently cross-filling the foreground of coral or kelp, while key-lighting, from a high down-angle, a swimmer moving on the other side of the reef and parallel to camera. The depth that the planes of color give you is fantastic. This is during daylight hours. At night you can lose your mind.

Everyone who has shot underwater footage knows that, except in the shallowest and clearest water, flesh tones and bright colors are dulled down tremendously. Everything tends to go monotone blue. The way in which the aforementioned lighting system can bring back all the true colors—with a subtle and natural look—to your underwater subject is formidable.

My ultimate satisfaction came when I was asked to show my underwater sample reel to both agency people and the client in the pre-production stages of a recent TV commercial assignment. The agency producers were afraid that the subjects might not appear natural if filmed with the aid of artificial lighting under daylight conditions. Then I showed them the sample reel, which included underwater scenes filmed at the same time, but alternately with and without the use of the artificial lighting

system. When it was over, the client leaped to his feet and exclaimed (referring to the *lighted* scenes): "That kind of color is what people *expect* to see underwater. Just give me *that* look, and the hell with everything else."

The 16mm model is set up at present for three lens—the 5.9mm Angenieux, the 10mm Angenieux and the 12mm Elgeet Aspherical Navitar. The choice of focal-length depends upon how close you want to work to the subject and the turbidity of the water. All the lenses are water-corrected. The 5.9mm Angenieux is incredible in dirty water and absolutely spectacular in water with more than 15 feet of visibility. The camera can, of course, be opened with safety under pressure, and automatically vents through a non-return valve if suddenly returned to the surface after being exposed to ambient pressure internally. The externally-mounted light meter is in its own housing and, of course, goes to the same depth as the camera. The entire rig can be field stripped underwater, without tools, in minutes—so that the camera alone may be used in small spaces. The electrical plugs for the lights may be plugged or unplugged underwater with complete safety.

Besides the F-stop control, there is an electrical footage counter visible from the rear which lights up intermittently every foot so that, even when remotely operated, you can tell the camera is running. Unless you put your ear to the housing, you cannot hear the camera run.

Oceanic Films, Inc., Pacific Palisades, Calif. is now manufacturing the camera, as well as a separate battery lighting unit, with the same extendable arms attached, that fits onto any underwater film or video camera.

Finally, I've quit complaining about underwater photography and, most important of all, my wife loves me again. ■

CINE ANNUAL AWARDS CEREMONIES TO BE HELD IN WASHINGTON D. C. IN NOVEMBER

CINE, The Council on International Nontheatrical Events, plans to hold its Annual Awards Ceremonies on Thursday and Friday, November 12 and 13.

During the two day event CINE will award the Golden Eagle Certificates and the many prizes won by CINE films in International Festivals. The winning films will be shown along with a selection of outstanding international films of the season.

So far this year there have been 44 prizes and 64 diplomas or certificates issued to CINE films. ■

THE INCREDIBLE "SEA-SEE"

Continued from Page 904

them. In 1965 a fellow named Ken Norris at UCLA put together an airplane gas tank with a drum underneath that had some windows in it. I went over to Hawaii and rode in that, taking movies with a Bolex camera. The results left a lot to be desired, but it was the first time we had gotten underwater and we could see the potentials of being able to observe herd interactions and the behavior of groups of animals. I came back with that information and went over to China Lake to show the movies that I'd taken underwater from this very primitive kind of rig that we had. I got together with Larry McKinley and gave him some criteria for what would be required to meet the needs of biologists, and he then translated these things into engineering terms. So, I'd say that I've been familiar with *SEA-SEE* since the time when it was nothing but an initial sketch on a piece of paper. From the very beginning, its possibilities as an observation and photographic platform were quite obvious. We were especially interested in it from the standpoint of cinematography because we are interested in behavior and the only way we have of storing our data is on film. I look at the motion picture camera as a piece of data-collecting equipment, so that the quality of the pictures I take is sometimes not the prettiest—but at least we can resolve what is happening. This facility for making an accurate photographic record, coupled with the possibility of being able to move and stay with the animals, has opened up a whole new vista of research. Before that most of our behavioral studies were limited to working with animals in captivity, which is not at all the same as observing them out in the open ocean.

DR. C. SCOTT JOHNSON—Head of the Marine Bio-Science Division, Ocean Sciences Department

While there is a variety of studies going on in the Division, concerned mainly with marine mammals, my own interest is largely in sharks, and countermeasures to dangerous sharks. The *SEA-SEE* is the only vehicle of its kind and it is an essential element in my research. Heretofore, we've had to do most of our observation diving in a shark cage, or something of the sort, which is very limiting. The *SEA-SEE* is such a great observation platform. With it we've been able to get out into the open sea and observe sharks underwater that cannot be kept in captivity very well. By now we've photographed probably a

thousand different individual blue sharks—something which would be impossible to do in any other way. Motion picture cameras are the essential element in our research, as far as taking data is concerned. It would be impossible to describe in written form the observations which we have to make. Sometimes this is required—but even in such cases, it is valuable to be able to view a film and then describe in detail what we have seen. I'm not an expert photographer and so the movies I take are not of the quality achieved by professionals like Frank Stitt, Tom Garcia, Bob White and the others. But I am able, with the Canon Scoopic camera, to record the things that I see. The Scoopic is relatively simple to operate and is reliable. The results, while not of the highest quality, are good enough so that I can record the observations that I need. It's a way to get the kind of data that just could not be taken in any other way. ■

"SEA-SEE" UNDERWATER OBSERVATION VEHICLE SPECIFICATIONS:

Hull: Catamaran type
Length: 50 ft
Beam: 20 ft
Power: Two GMC 353-N diesel engines
Draft: 3.5 feet with observation capsule up, 10 ft with observation capsule down
Speed: 7.5 knots with observation capsule up, 3 knots with observation capsule down
Range: 300 miles
Electronic equipment:
- Sonar Corp. Model 115 marine radiotelephone
- Raytheon ADF
- Raytheon Model D-120m depth indicator, 250-ft maximum
- Raytheon Model 1900 radar
- Motorola 35-watt UHF FM transmitter-receiver
- Motorola 15-watt UHF FM transmitter-receiver, portable
- Binaural hydrophone array and system frequency range, flat ±3 dB, 20 Hz to 120 kHz
- Lockheed Model 417 instrumentation tape recorder-reproducer, seven-channel direct record-reproduce, frequency response ±3 dB, 200 Hz to 100 kHz at 30 in/sec

Electrical power:
- 12-volt and 24-volt DC, 130 amps
- Kohler 110- 115-volt AC, 60-cycle, 2.5-kW motor generator

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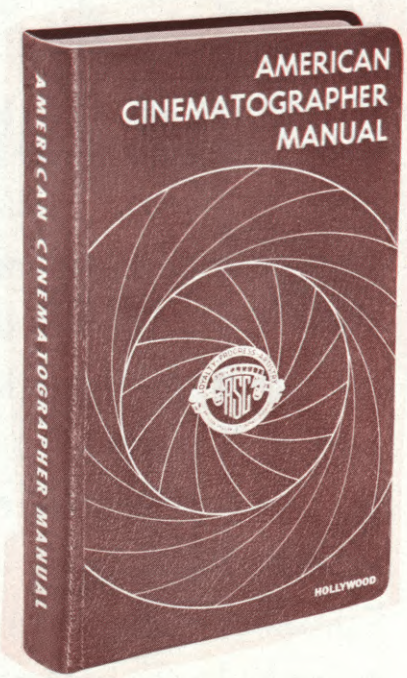
AMERICAN CINEMATOGRAPHER MANUAL

COMPILED AND
EDITED BY
Two Veteran Cinematographers
ARTHUR C. MILLER, A.S.C.
AND
WALTER STRENGE, A.S.C.

THIRD EDITION



The third edition of the A.S.C. *Manual* has all the answers about underwater cinematography: UNIQUE PROBLEMS; CHOICE OF U/W EQUIPMENT; LENSES; LIGHTING PROBLEMS EQUIPMENT; HOUSING FOR ENCOUNTERED U/W; EXPOSURE; COLOR CAST; WATER TURBILITY; SELECTION OF FILM; COLOR CORRECTION; ARTIFICIAL LIGHTING U/W; SUBJECT AND EQUIPMENT COLORS; UNDERWATER DAY-FOR-NIGHT EFFECTS; SUBMERGED CAMERA MOUNTS; 65MM-35MM-16MM UNDERWATER CAMERAS AND HOUSINGS.

OFFICIAL PUBLICATION

AMERICAN SOCIETY OF CINEMATOGRAPHERS

Jordan Klein,
Underwater Cinematographer says:

I find the Manual *invaluable since it makes available, instantly, facts that would be impossible to remember.*

THE AMERICAN CINEMATOGRAPHER MANUAL
P.O. BOX 2230 THIRD EDITION
HOLLYWOOD, CALIFORNIA 90028

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"WAVES OF CHANGE"

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plete runs throughout California, each one year apart, and each to "sellout" crowds. This fantastic response made "THE PERFORMERS" the most successful film of 1965 and 1966. Turning from success, Greg returned to the University. It was during this year that Greg and Jim Freeman began thinking about making films together.

At an early age, Jim became fascinated by the possibilities of preserving something on film. His father had regularly filmed family events such as birthdays and Christmases but was tiring of the job and was anxious to relinquish this duty to Jim. Thus, somewhat reluctantly, Jim became fairly competent with the basic technical operation of the camera at age 12. Utilizing this knowledge, he got a job in a camera store two years later in order to earn money for a 16mm camera; for the next four years all his earnings were invested in equipment and supplies. At 16 he made a candid camera-style film about his high school and the activities of his friends. When this film was presented to the student body at the end of the year, the response was so great that Jim began to realize that he might be capable of more than "home movies." Influenced by a lecture travelogue film he had seen about a bicycle trip through California, Jim began to ponder the possibilities of equally adventurous activities. Encouraged by his friends, who especially liked to see themselves in his films, Jim decided to make a surfing film. While going to school and working four hours a day in the camera shop, Jim produced his first feature-length film, "LET THERE BE SURF". It was a big success and provided him with excellent capital for subsequent films. Inspired by this success, he set out to make a "different" film—a film in 3-D, a very difficult and expensive process. He built the necessary equipment and flew to Hawaii to film the best surf. With two synchronized cameras running simultaneously, motorized, and supported by a precision cradle and tripod, Jim filmed "OUTSIDE THE THIRD DIMENSION". The three-dimensional process worked, but because of projection difficulties, "OUTSIDE" could not be shown as extensively as other films. He soon produced another film, "THE GLASS WALL" which proved more successful than any of his previous films.

Both Jim and Greg realized that, as partners, they could combine Jim's camera work on the beach with Greg's

photography from the surfboard to obtain unparalleled coverage of the sport. The formation of MacGillivray-Freeman Films is in itself a unique endeavor. Not only have they chosen to locate in Laguna Beach, far from the studios and labs of Hollywood (and also from the congestion), but they have also set up their own distribution office. This arrangement has developed partly by choice and partly out of necessity. Jim and Greg are interested in producing quality "G" rated films, but major distributors are reluctant to invest in such films. Hopefully, the public will show, as they have in the past, that they still want good films suitable for the entire family.

Jim at 26 and Greg at 25 have followed their tremendously successful film, "FREE & EASY" with a short, "CATCH THE JOY", a film about dune buggies. "CATCH THE JOY" will be distributed by United Artists and is scheduled to open at the Radio City Music Hall in the near future. It has already started to win awards, capturing a HEMISFILM '70 Special Jury Award at the San Antonio Film Festival and a Gold Medal in the recent Atlanta Film Festival.

FILMING IN THE CHANGING SURF

By GREG MACGILLIVRAY and JIM FREEMAN

Those wonderful changing moods of the ocean, though beautiful to look at through a glass picture window, present ever-changing difficulties from behind the lenses of our cameras. The most obvious problem is the ocean's unpredictable creation of waves; though this contributes to the wonder and beauty of the sea, it is the cameraman's curse. Truly photogenic waves do not come often. An acceptable average might be estimated at about 30 days of good waves out of a year. Due to this poor showing on the part of the wavemaking elements, the photographer is condemned to long boring periods of watching and waiting. Even when the waves come with that perfect shape and break, they can only be photographed and used if accompanied by equally perfect color and lighting.

Once the waves, color and proper lighting arrive, the problems are far from being completely solved. In place of the rather boring chore of waiting, there are the more stimulating challenges of humidity and salt water spray. These are the problems which really should have been taken care of while the photographer was passing those bor-

ing hours waiting. In Hawaii, South America and Mexico, where such problems principally occur, we pack the film and cameras in air-tight aluminum cases with packages of silica gel which will absorb any moisture. Extra precaution is still necessary, so while we are in South America filming, Jim flies back to Hollywood at our half-way point of travel in order to process the film and thus be assured that the latent images were not being altered by the tremendously high humidity.

While filming anywhere on a coastline, the cameras and lenses must be covered with a cloth or plastic bag, as the salt spray from the waves can do terrible things to the metal gears of the camera and to the coatings on the lenses. Normally we simply employ a changing bag and lens cap. An additional advantage of a big changing bag is that you can huddle under it with the camera during tropical rains in places like Hawaii.

The most limiting condition while filming surfing is the distance between the shore and the action in the water. The surfer looks like a brown dot on a canvas of blue when riding a wave a quarter of a mile away from the beach and camera. However, the distance can

be overcome by several means: the telephoto lens, the waterproofed or boat-mounted camera, and the helicopter. Most often we use an Arriflex or Bolex from shore with a strong telephoto lens—ranging from 150mm to 650mm in focal-length. To efficiently use these lenses, a sturdy, fluid-head tripod, a heavy-duty lens cradle and a very steady hand are necessary.

Probably the most unique shots in "WAVES OF CHANGE" were taken from shore while using a Mitchell high-speed camera. This model of Mitchell is a variable-speed camera offering slow-motion rates of up to 600 fps, and is used mostly for high-speed equipment testing and by the Space Administration. Since the Mitchell we used was not reflexed, it was necessary to convert the lens for telephoto viewing. Century Precision Optical Company, which we prefer over all other telephoto lens makers, built a 230mm lens and a 385mm lens with reflex viewing systems and adapted these lenses to the Mitchell. Because the shutter speed of a high-speed camera is usually faster than one one-thousandth of a second, depending upon the frame-rate selected, the use of a film more sensitive than Ektachrome Commercial 7255 is necessary. Under normal daylight circumstances we filmed at 400 fps, at F/8.

In order to capture the immediate, involved feeling of surfing, it is essential to have a camera in the water. We have tried several times to use a boat, such as the Boston Whaler Outboard, for this purpose. However, the one great advantage of maneuverability is considerably outweighed by the disadvantages. Even while using a vibration-reducing mount, the bounce from the boat is still very disruptive. Also, the distance that still must be maintained from the wave for safety purposes makes shooting from a boat much less feasible in comparison with shooting from a surfboard or while swimming.

The most important point about these latter alternatives is the necessary waterproofed camera housing. In the past seven years we have built 12 plexiglass and fiberglass waterproofed housings for cameras. Today, three of those models go with us whenever we travel. The largest and heaviest case houses a 200-frame-per-second Bell and Howell Eyemo camera and 24-volts of rechargeable nickel-cadmium batteries. The camera weighs about 40 pounds and captures, in extremely slow motion, the poetry and beauty of the surfer and his wave. Because of its size and weight, this camera is used only in surf smaller than six feet.

Unfortunately, there is one extreme disadvantage in working with this camera. It has only 100 feet of film capacity which means that after one-half hour of swimming in order to position oneself for a shot, only 20 seconds are needed (at 200 fps) to run out of film.

The camera we use most often from the water is one of our three plexiglass-cased K-100 Kodaks. Although this latter camera is not reflexed, and has only a 100-foot capacity, its greatest advantage over other cameras is its 40-foot camera run on one winding. The 40-foot wind is enough to insure that every wave of a set will be covered. Though a battery-operated camera would be ideal, its excessive weight would render it impractical for use on a surfboard or while freely swimming. The third type of camera we use from the water is the small Bell and Howell magazine-load model which is a perfect size for filming while surfing. Of course, the magazine capacity is limited to 50 feet.

Although filming from the water creates the involved fluid feeling that we desire in our films, this is probably the most hazardous of techniques. Our most memorable awards for these spectacular shots are our scars and stitches. Several times we have crawled from the water, saving our lives but not our equipment. Despite our frantic searches afterwards, our lost cameras remain securely in Davy Jones' Locker.

The third photographic technique that we use quite frequently is filming from the helicopter. The helicopter, once equipped with the Tyler vibrationless camera mount, enables us to hover above the surfer, recording his white slash across the wave with a motorized 12mm-120mm zoom lens. This unique angle permits the audience to participate in the surfer's ride and momentarily experience his feeling of control and mastery of the wave. Shooting from high in the air can be equally as dangerous as shooting from the water. The big waves suck air into them as they break, creating a vacuum immediately above the white water. Several times while filming, the helicopter lost its air support and dropped within inches of the giant surf. Once, the helicopter even hit the water, but fortunately it had pontoons and enough power to climb out of the way of an onrushing wave.

We have tried in our photography to capture the many moods of the graceful, artistic sport of surfing. Through the techniques used in filming "WAVES OF CHANGE", we hope to bring the viewer closer to the exhilarating feeling that a surfer experiences while he slices across a wave. ■

UNDERWATER LIGHTING

Continued from Page 893

unprotected. Bulb damage is frequent, and the potential danger to divers of electrical shock from naked wires exposed in sea water is ever-present. The thin glass envelope of a quartz iodine bulb—or any bulb for that matter—can be shattered easily, exposing the hot electrical filaments. A 115- or 220-volt AC open line exposed by a shattered glass envelope can be deadly.

A manufacturer of open-reflector lamps in Italy recognizes this danger and protects his bulbs with a metal grid. His stainless steel wire grid duplicates what the U.S. Navy had used in protecting its underwater lights for many years but discarded after only a few days during *Sealab II.* One aquanaut returned to the habitat with his Navy light and entered the diving chamber. (The diving chamber is essentially an airlock between the habitat itself and the water below.) The diver did not realize that some sardines had slid through the protective grid into the reflector portion of the light. They died there serenely, quietly—malodorously. The odor of dead sardines permeated *Sealab II;* the stench clung for days. The atmosphere ruined many an aquanaut's appetite for sardines. The Navy no longer uses open-grid underwater lights. It is impossible for a sardine to wiggle into a closed-reflector light for its final resting place.

During the two-year interim between *Sealab II* and the attempted *Sealab III,* the Navy standardized all its underwater incandescent lighting, choosing closed-reflector units. More than 60 closed-reflector lights of various types were in *Sealab III* when the habitat went into the water. This included eight on the personnel transfer chamber that shuttled between the support ship *Elk River* and the habitat. The Navy also specifies closed-reflector lights on the *Mark* 1 and 2 diving systems.

IMPROVES REFLECTOR EFFICIENCY

Anyone dealing with lighting or reflectors is aware that an oxidized or dirty reflector has a dramatically lower efficiency than a clean reflector. Open-reflector fixtures use a U-shaped or V-shaped metal backing as the medium of reflectance. For protection against sea water, the surface is painted white or aluminized. As users of these lights know, corrosion begins the moment the light is first immersed and continues unabated as long as the light is submerged. Regardless of constancy of out-

put by the source lamp—incandescent, strobe, or thallium—the effectiveness of the open-reflector light is degraded continuously until the lumen energy output of the lamp is reduced to the level where the fixture might as well have no reflector at all.

The closed reflector, in contrast, is as efficient its last day of operation as its first. Not only does its reflectivity remain constant, but it also saves money since its surface is not destroyed.

Proponents of open reflectors basically ignore the existence of dirty water. The light emanating from the bulb element passes through water prior to reaching its reflective surface; any degree of turbidity reduces luminosity reaching the reflector. This loss in luminosity prior to reflectance, proportional to the amount of suspended matter in the water, is multiplied by the absorption of an unclean reflector—one corroded by salt water and covered by tiny marine organisms.

Any appreciable degree of turbidity reduces luminosity by up to 25% prior to reflectance. And reflectance is 25% less for painted or oxidized reflectors than for polished, clean reflectors. It is possible for open-reflector lamps to deliver only an estimated 50% of rated lumens, which approaches the same amount of light available with a naked bulb. When fouling occurs on the bulb itself, the unit is doomed.

The relative costs of replacement for bulbs in open-reflector and closed-reflector units warrant mention. The average incandescent quartz iodine lamp costs about $8 to $14. These are stock items, available anywhere, whereas bulbs used in open reflectors sometimes are modified by the manufacturer to fit a particular fixture. Such replacement bulbs cost five to ten times as much as the stock items. They are available only from the manufacturer who made the fixture.

WITHSTANDS FOULING BETTER

Fouling has been a problem since man put his first crude fishing raft into the water. Underwater lighting intensifies the problem because the warmth of a light attracts and incubates organic growth.

A prime example of fouling of underwater lighting and what to do about it arose at the Navy's test gantries for the *Poseidon* missile. These are on station for six months at a time at the Navy testing complex off southern California near San Clemente Island. The gantries are festooned with high-speed 16mm cameras that photograph areas illumi-

nated by more than 32 closed-reflector lights. After a rocket engine test firing, divers remove the cameras to retrieve the film, but the lights stay in position.

In time, fouling covers first the lens and then the entire lamp. When luminosity is reduced, divers go below to hack away the growth with knives and scrape the lamps clean with steel wool. The heavy glass lens of the closed reflector unit is impervious to damage from a diver's knife and cleaning compound. In addition, in this installation, it protects the lamp from the thermal and explosive shock of the missile's thunderous engines. Open-reflector units have collapsed under the diver's knife. Scraping ruins open reflectors, shatters bulbs, and bends the thin housings. Marine growth begins to bridge between bulbs and reflectors and clings so tenaciously that attempts at cleaning may break the bulbs.

LENS PROTECTS UNIT

Basically, lenses of two different thicknesses are used in closed-reflector lights. A 5-in. diameter domed glass 5/16-in. thick is used for battery-operated 30-V units. Although relatively thin at only 0.132 in., it is guaranteed against failure to a depth of 5,000 ft, or a pressure of 2,200 psi—far beyond the endurance or range of any diver. Fracture actually occurs between 7,000 and 9,000 ft, depending on fatigue and individual specimens' compositions.

A glass dome similar in diameter but 0.625-in. thick is the standard glass cover for 115- or 220-V units operating directly from power mains. This lens is guaranteed to a depth of 11,000 feet or a pressure strength of 5,000 psi. Fracture occurs at about 17,000 feet from deformation of the lens seat and not due to weakness of the glass.

When this same glass on a steel fixture was tested in a test tank, the tank seals ruptured at 10,000 psi, or a depth of 23,100 ft, with no damage to the glass. Other than the bathyscaphs, no underwater vehicles approach this depth.

Lenses offer another advantage in addition to pressure strength, shock protection. Currently in Da Nang, South Vietnam, there are 24 closed-reflector lights attached to pilings, bridges, and wharves at an ammunition dock. The lighting is a deterrent against Viet Cong frogmen who have blown up or damaged other such facilities in night raids. These lights, although connected to power mains, use glass domes 5/16 in. thick because they are in less than 35 ft of water—murky water in a river that washes silt from the uplands out to sea.

The lights illuminate the area around the pilings. Marine guards patrolling these structures drop halfpound antipersonnel depth charges at random every 5 minutes during the hours of darkness, approximately 100 a night.

At the time this article was prepared, the 24 lights had been energized for a minimum period of three months, meaning that approximately 9,000 charges had been dropped in and around the support grids for the lights. This is the equivalent of bombarding one light an awe-inspiring 216,000 times. During this period, only two lenses fragmented from the repeated assault. Their durability is a testimonial to closed reflectors and the shock-resistance of glass. If the heavier glass lenses were used, it is a safe prediction that the fracture rate would be nil.

If open-reflector lights had been used, the bulb damage would have been great, and the anti-frogman program might have been useless. What is the real meaning of such statistics? Every underwater light can and should be fitted with a protective glass cover.

Let us translate the lesson of Da Nang to civilian use. Much underwater development will be in offshore mining with the use of underwater blasting, underwater jack hammers, and other shock-making equipment. The protected or closed-reflector unit will be of inestimable value for the staggering amount of work yet to be done.

INCREASES PENETRATION

Open-reflector lamps use special tubular envelopes over their existing filaments, necessitating overly large reflectors. In addition to increasing the adverse effects of drag, these oversize reflectors in turn increase the beam angle light output. It is axiomatic that the greater the beam angle, the greater the backscatter. The greater the backscatter, the less the penetration. Add to the weakened penetration the compounding factor of turbidity and the open-reflector units place a poor second.

Reviewing the open reflector's disadvantages of drag, susceptibility to corrosion, inefficiency from turbidity interference, comparative lack of electrical safety, vulnerability to fouling, design weakness in beam angle, and maintenance and replacement expense, the open reflector invites a tempting comparison. Open-reflector underwater lamps represent a stage of development analogous to the early automobile's and horsedrawn coach's open-reflector headlamps or brass coach lamps. It took 40

years to conceive and perfect the sealed-beam automobile headlamp, a closed-reflector light.

In the dark underwater world, man needs the same range of lighting as he does on land. He needs the broad-beam general illumination of the street lamp; the penetrating beam of the automobile headlight for his submersibles; the warmth and tone of a household incandescent in his underwater habitat; a fluorescent type of floodlight to illuminate his watery tasks; a flashlight to pinpoint a small area; and a photographic light to match his color film.

Closed-reflector underwater lights provide assistance in that part of the world, where, if there is no vision, people can perish. ■

"THE PRIVILEGED WORLD"

Continued from Page 845

was up except by feeling for the air bubbles. And that's not easy in the dark. We just grabbed one another and somehow got to the surface."

Returning to Grand Cayman in June of 1969, both men were anxious to continue with the filming. This time LeRoy had another lighting system. He had the lights attached to the cameras. They were 100-watts each, compared to the 1,000-watt aircraft landing lights, but these units were especially made for cinematography, so the light was more evenly distributed. The systems were 12-volt, rechargeable, self-contained units. They were far superior to the previous system because they afforded the divers complete mobility and there were no cables to worry about, no generator at the surface. Also, this unit could conceivably go as deep as 300 feet. There was a slight weight problem with this system, but this was corrected by simply attaching pieces of styrofoam to the camera housings to make them more buoyant.

During the entire filming process French and Hall used a Kodak K-100 and a Bell & Howell 70-DRS for the underwater filming. The housings were developed by the Bamboo Reef. There were always two cameras for the underwater shooting; one was always kept as a backup. They shot with Kodachrome II Daylight film. This was chosen because after experimenting with other film, it proved to reproduce most accurately the brilliant colors that the divers saw underwater. For the surface photography, they used a Beaulieu and also a Canon Scoopic with ECO film.

It was on the second trip that the divers gave special attention to night diving and photographing. These night-

time expeditions were difficult to arrange.

"It took about four hours to prepare to dive at night," French stated.

"Because the boat was in darkness, we had to be very careful about arranging the supplies before we left the shore," Tom added. "We would work all afternoon, taking advantage of the daylight hours—although we would actually dive only half an hour to an hour. You have to remember that, while night diving, it's hard to see the aperture openings. Most of the time we shot with the lens wide open."

LeRoy tells this story about the perils of filming at night: "Once I was anxious to photograph sharks at night. To do this it's necessary to have a cage for the divers to shoot from. Obviously you need to be protected from the sharks. We didn't have the usual metal cage, so we had an islander make us one—only, he made it out of wood and chicken wire. The top was an actual wooden door. It was a rather ridiculous arrangement, but we decided to use it.

"We went out one night, dropped the cage and threw out the fish and blood needed to attract the sharks. Our emergency signal to those on the boat waiting to haul us up was two pulls on the rope that connected us to the boat. And that emergency signal really meant haul us up fast!

"Well, we sat at the bottom for about half an hour and nothing happened. Not even a minnow swam by. We finally gave the signal to be pulled up. By accident, we pulled twice. On the boat they, of course, thought we were in trouble—and they pulled like crazy, dragging the cage and us in it, over the coral reefs since the boat was about 60 feet away from where the cage had settled on the bottom. We didn't even have time to get the coral rocks that held the cage down out.

"Before too long, the cage literally started to disintegrate around us. The ocean does strange things to wood and chicken wire. By the time we got to the boat there was pretty nearly nothing left of our protection. Fortunately, the bait we'd thrown out hadn't worked; there were no sharks. If it had worked . . . well, you know."

Night diving, in fact *all* diving, is filled with these stories of adventures and misadventures. But you need only see the finished product—"THE PRIVILEGED WORLD"—to appreciate the fantastic beauty, the thrilling colors, and the incredible solitude of the deep and, to know why men like Tom Hall and LeRoy French undertake just such a project. ■

THE INCREDIBLE "SEA-SEE"

Continued from Page 911

CML Model MRS 500 24-volt DC to 110-115 AC inverter (500 watts)

Accessories:

Electrical anchor winch

Four-transducer underwater pass-through in observation capsule

13 ft 6 in. Boston Whaler, 20-hp Johnson outboard motor

Two 250-watt thallium iodide underwater lights (by prior arrangement)

Personnel:

Four scientists, two crew, observation capsule seats two

The vehicle also has sleeping accommodations for two crew and two scientists; galley, head, and instrumentation console.

CALVIN COMMUNICATIONS TO HOLD 25TH ANNUAL MOTION PICTURE WORKSHOP FEBRUARY 1, 2 AND 3, 1971

Calvin Communications, Inc., will host its 25th annual motion picture workshop February 1, 2 and 3, 1971. The Workshop will be held on the Calvin sound stages and throughout the company's facilities at 1105 Truman Road, Kansas City, Missouri.

The Workshop program will review basic procedures in all phases of motion picture production and examine many of the newer aspects and developments occurring within the industry including electronic video recording, (EVR).

Staff and guest speakers, special presentations related to film making, film examples, group discussions and audio-visual equipment displays will comprise the 1971 Workshop.

The only cost for the three-day event will be the $20.00 per person advance registration fee. Reservation confirmation cards will be sent in advance by Calvin after registration begins, October 15. The card must be presented at the Workshop registration desk for admittance.

Attendance will be limited to 600 on a first-come-first-served basis. Because of space limitations, the Workshop Committee requests attendance of no more than four persons from any one organization, school or company. In 1970, advance Workshop registrations filled all available space two months prior to the event.

For additional information, contact Ron Miller, Workshop Chairman, Calvin Communications, Inc., 215 West Pershing Road, Kansas City, Missouri, 64108.

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lence—a kind of post-orgasmic calm. Then a burst of wild applause. The teenage surfers, barefoot and beautiful, stroll out into the night—still on Wave Nine.

In the following interview with the *American Cinematographer* Editor, George Greenough discusses his techniques, his ideas, and his hopes for the cinematic future:

QUESTION: What was it that led you to become interested in film-making to the point of developing your own camera housings, mounts and accessory equipment?

GREENOUGH: Being a surfer, I used to go to see surfing movies all the time. I'd see stuff that other people had shot from their surfboards in small, gutless surf. They just didn't shoot in the big, hard-breaking waves. I used to go out in the biggest, most powerful surf I could find and I felt that I could go far beyond what I'd seen on the screen. I wanted to film it the way it really was. They were doing that in some of the skiing films. I mean, guys were getting on the slopes going 60 miles an hour while carrying the camera. I wanted to carry it inside *the wave. There's really no other way to show it like it really is.*

QUESTION: Had you ever done any photography before?

GREENOUGH: I'd done some still photography of surfing, but it was after seeing pictures like "GRAND PRIX" and "2001: A SPACE ODYSSEY" and seeing what the heaviest parts of those films were like that I became interested in movies. I wanted to do something similar, but didn't have the technical knowledge to capture anything like what "SPACE ODYSSEY" had in it. I did feel, though, that I might be able to use photographic techniques similar to some of those used in "GRAND PRIX".

QUESTION: What was the first camera rig that you developed to shoot surfing footage?

GREENOUGH: It was a little, tiny Keystone home-movie camera that I bought for 15 or 20 dollars. It was a 50-foot, magazine-load camera with a 15mm lens. I built a waterproof housing around it, using fiberglass, which could be used as deep as 30 feet underwater. It was not designed to go real deep. The

wall thickness was about 1/8th of an inch and was built more for impact protection than to resist depth pressure. The Keystone camera was so small and light that I just carried it in my hands. I did a lot of experimenting with that camera.

QUESTION: Where did you go from there?

GREENOUGH: I decided that a 100-foot-load camera would be much easier to use because the film would last twice as long. It would simply be a matter of learning to surf with a heavier camera. My choice was an Eastman K-100, which is spring-wound, but will run for about 40 feet on a single wind. I still use that camera a lot in the water for filming anywhere from 24 to 64 frames. I also have a Bolex which I use for filming closeups from the water. The problem with wind-up cameras is that when you run out of wind you have to stop and unstrap the whole rig out there in the water, wind the camera and strap it all on again—which is a big disadvantage.

QUESTION: Do you use any electrically-driven cameras in the water, and—if so—what kind?

GREENOUGH: The only camera I use in the water that is electrically-driven was built for me by Century Precision Optics. It was adapted from a war surplus Traid Model 200 camera, which was built by Bell & Howell. It uses standard C-mount lenses and runs at about 200 frames per second. This is much faster than it was originally designed to run, which means that I've got to oil it every time I use it. Otherwise, the motor will burn out. 200 frames slows things down pretty well, but the big problem is that this gear is very heavy. The camera, the batteries to run it and the housing add up to quite a lot of weight to carry.

QUESTION: Just how much does the full rig weigh?

GREENOUGH: It varies—depending upon which camera I'm using, the type of housing, the number of batteries needed to drive the camera and whether I'm using floodlights for filming at night. The K-100, with its housing and mount, weighs about 18 pounds. Adding the lights and their batteries to this rig brings the weight up to about 30 pounds. The high-speed camera, with its housing and batteries for the electric drive, weighs in at almost 35 pounds.

It's a problem to surf well with so much weight on your shoulders, because it throws your balance off. You've got to get the center-of-balance of the camera mounted properly in relationship to your own center-of-balance. Some shots are very difficult because they require surfing with the camera's center-of-balance just a little bit off from your own. Then, when you turn, you're pulling two G's—which means that the camera is twice as heavy, too. This throws the turning point of the board off and, if you're riding one of the smaller boards like mine, the centrifugal force can take you right off the side or back of the board.

QUESTION: Since the K-100 is a wind-up camera, what happens when you "wipe out"—does it just keep on running?

GREENOUGH: You've got cables that control the K-100 and these are gapped so that you can turn it on or off from outside. The high-speed camera, of course, is electrically controlled and you can start and stop it by means of a push-button in front. When you wipe out, you may want to continue filming underwater so that you can intercut the footage with shots of someone else wiping out. If you wipe out in a really large wave, most of the light will be cut off and the screen will go black. There's so much white water rushing over your head and so many bubbles to cut off the light that it sometimes gets very dark. But if the wave is not too big and you don't go too deep, there is usually enough light to see what's going on.

QUESTION: Have you ever wiped out hard enough to severely damage your equipment?

GREENOUGH: Not really, but I've come very close. One time I rode too high on the wave and got thrown from the top to the bottom. The board went over the falls and I got sucked over after it. The board was going up and I was coming down—and we collided. The camera hit the board and almost broke it in half, but the housing held up and there was no damage to the camera. Another time, a big wave threw me across the rocks and I got jammed between two rocks and fell on top of the camera. It didn't do too much to the housing, except scratch it.

QUESTION: What are the requirements that you take into consideration when building your own housings?

GREENOUGH: Aside from the obvious requirement of being watertight, the housing must have high-impact strength and also be capable of floating with the camera inside of it. It's made out of fiberglass, built like a crash helmet and designed to protect the camera in every way. Unless the housing actually gets punctured—which is very unlikely—it will hold up under a very hard impact. The ability to float is very important, because otherwise, if the camera gets away from you, it will sink like a stone and you may never find it. That happened to a Nikonis still camera that I used to have. A friend of mine dropped it in the water and we dived for it for hours, but were never able to locate it. You've got to assume that if you lose the housing, you've lost the whole rig—so, each time that you're in the water with equipment becomes a sort of Kamikaze

QUESTION: In other words, then, you've almost got to regard your camera equipment as being expendable.

GREENOUGH: Right. For example, I have a 16mm Beaulieu camera that I use for filming from the shore. It has several characteristics that would make it an ideal surfing camera: automatic exposure control, a compact shape, electric drive, a tough but light-weight pressed metal case, reflex viewing and easily-accessible controls. The camera weighs only 4 pounds and I could easily build a housing for it—but it's the most expensive and most valuable camera I've got. Having it get wiped out would be a real loss. I haven't wiped a camera out yet—but it could happen. So, I keep the Beaulieu out of the water, for shooting on the beach.

QUESTION: In addition to the watertight, buoyancy and high-impact characteristics which you have already mentioned, what other qualities do you feel are important in an underwater camera housing?

GREENOUGH: It should be easily opened and easily closed. You shouldn't have to hassle with that kind of thing. Also, ideally, you should be able to change focus, F-stop and frame rate while you're in the water. I can do all of that with the Bolex, but not with the others. I just pre-set them, because I'm using such wide-angle lenses.

QUESTION: What focal-length lens do you use on the Bolex, and how does your usage of it differ from those of the other cameras?

GREENOUGH: It carries either a 50mm or 75mm lens, because I use it for closeups from the water. In order to get in super tight you need a longer lens and you usually have to follow focus. It's on a rifle-stock mount and I usually just paddle out into the water with it and shoot it while sitting on a surfboard or air mattress. I use a bit longer lens than is normally used in the water, because I do follow focus.

QUESTION: How do you go about creating a camera housing from the ground up? Do you use some sort of a mold?

GREENOUGH: Yes. I build a mold—a different design for each camera. I've built a few of these cases for other people—usually for Arriflexes. I need the camera for a month or so, because it takes a while to build a mold and then I've got to fit the housing to the individual camera. It's a one-piece housing made of fiberglass, with cloth and other reinforcement to give it maximum strength. Then you put your controls and eyepiece into it. There are stock controls commercially available and you just drill a hole and fit them through. But I design all of the focus parts myself and they're made of machined aluminum.

QUESTION: I notice that you've also built your own fluid-head tripod. Can you tell me a bit about that?

GREENOUGH: Well, when I'm shooting from the beach with the Beaulieu, I've almost always got the lens racked out to maximum telephoto. This means that the movement in following, panning and tilting has to be super smooth, because even the slightest jiggle is greatly exaggerated. What I really needed was the very best fluid-head—something like a Miller, but that piece of gear costs several hundred dollars, which I didn't have. So, I took an old wooden tripod I had and re-worked the head. I used STP (the stuff they put in car engines) as the fluid and sealed it over with fiberglass. It works as smooth as can be—and the whole thing cost only a couple of dollars to make. I'll admit it doesn't look as pretty as the Miller, though.

QUESTION: You mentioned earlier the use of "floodlights" for night filming. Can you tell me more about these lights—including how and when you use them?

GREENOUGH: The lights are 24-volt, 150-watt quartz slide-projector lamps. I

use four of them enclosed in two fiberglass housings which I built, with tinfoil behind them to act as reflectors. They aren't ventilated in any way, so you can only burn them for about 20 seconds at a time. Otherwise you run the risk of a burnout. The lights were very helpful in photographing the opening scenes of the "Coming of the Dawn" sequence for my "INNERMOST LIMITS" film. You may remember that it begins in almost total darkness, with shots made inside the hollow wave. I was running the camera at 64 frames and, even though I was using High-speed Ektachrome EF pushed two stops, it still required powerful lighting to get the contours of the wave to show up at all.

QUESTION: How did you calculate the exposure for these scenes?

GREENOUGH: It was pure guesswork. I just set the lens wide open, had the film pushed two stops in development, and prayed. I didn't know whether it would come out or not. I've gotten to the point where I can usually estimate exposure pretty well by referring to previous shots I've made under similar conditions—but I had no precedent to go by here. There's a lot of trial and error involved in exposing this kind of footage. When I'm riding inside a hollow wave on a brightly sunlit day, shooting at 200 frames with 7255 or 7252 film, I can usually get a pretty accurate exposure by setting the lens at F/4. But there are so many variables involved: how bright the sun is, how cloudy the sky is, how thick the waves are and how dirty the water is. Dirt in the water cuts down the light a lot. I can get a fair idea of the exposure by taking a reading from the beach with the Pentax spot meter. This meter concentrates on such a narrow angle that it can reach right into the wave and read just the shady area. This usually gives you a pretty accurate idea of the exposure to use when riding inside the wave. However, in some situations you can't do this, so you just guess at it, judging by what you've shot before.

QUESTION: Your use of over-cranking, or, shall we say, "slow motion", especially in the "COMING OF THE DAWN" sequence in your film, is extremely effective. Do you have any special criteria for deciding what frame-rate to use in shooting a particular scene.

GREENOUGH: It depends mainly on how close you're riding to the wave.

When you're riding a wave and really concentrating on what you're doing, this intense level of concentration seems to slow things down. You may be going very fast, but your mind extends time so that it feels like you're doing the whole thing in slow motion. That's the effect I'm trying to get across to the audience when I shoot at 200 frames. I try to get them to experience what it actually feels like—to make it as realistic as possible. Many of the surfers who watch these scenes in slow motion say that they can actually feel the turns, because the action is being projected at the same speed which they experience when they're surfing. If it's projected too fast, they can't understand what's happening. I think slow motion is beautiful.

QUESTION: I notice that in some of the scenes shot from your board with the camera on the shoulder mount, we see only the wave—while in other scenes we see the board and sometimes the back of your head and part of your shoulder. Is this because you changed to a wider angle lens?

GREENOUGH: No—it's because I have an adjustable mount. I can vary the position of the camera so that only the wave shows, or so that part of my board shows. Or I can put my head and shoulder in the picture, so that someone watching it feels like he's riding along with me—kind of like he's riding on my back. I do that when I intend to inter-cut with scenes of myself surfing. When I plan on inter-cutting with scenes of someone else surfing, I usually show only the wave.

QUESTION: How far behind you does the camera have to be mounted in order for you to include your head and shoulder in the frame?

GREENOUGH: Only about a foot. That's because I'm using such an extreme wide-angle lens.

QUESTION: Speaking of wide-angle lenses, can you tell me something about that latest ultra-wide-angle job you had built—the one you used in filming those spectacular shots for the "COMING OF THE DAWN" sequence in your film.

GREENOUGH: Basically, I wanted a lens that would "see" an angle similar to that of human vision. I talked to the people at Century Precision Optics about it and they built a lens for me that covers an angle of 165 degrees. It has a 3.5mm focal-length and is ex-

tremely fast: F/1.5. Fitting it onto the Kodak K-100 camera created a problem because the rear objective of the lens curves 3/8ths of an inch into the body of the camera. It was necessary to modify the camera internally, so that the rear objective of the lens would clear the shutter. I can also use it on my high-speed camera without any modification.

QUESTION: Have you had any problem with it getting out of calibration because of vibration and the punishment it takes when you're surfing especially hard?

GREENOUGH: This did cause some problems. The lens stayed in calibration very well during most of the time I was surfing with it. But, toward the end, I had several very severe wipeouts when I got bounced off the board or went over the falls. This banging around did throw the lens out of calibration a bit. Mounting it on the front of a car shook it around some, too. The variation wasn't noticeable when I shot with the lens stopped down, but the scenes shot with the lens wide open were a bit soft. I noticed this and took the lens back to Century. They checked it out and got it back into calibration with a simple adjustment.

QUESTION: When you first proposed the building of such a lens to the people at Century, what was their reaction?

GREENOUGH: They weren't really sure that it would be possible to make it, because no one had done anything like that before. Some of the parts came originally from an instrumentation lens that covered a circle in the center of a 16mm frame. I wanted them to extend the circle of coverage outward so that it would touch the sides of the frame instead of the top and bottom. This necessitated regrinding some of the elements and making several new ones—but they did it, and managed to keep the resolution extremely sharp at the same time.

QUESTION: In view of the fact that such an extreme wide angle lens exaggerates perspective enormously, is it necessary to alter your surfing style in order to get the kind of shots you want?

GREENOUGH: You have to surf extremely close to the wave—and it has to be a pretty hollow wave so that the curvature will show up. In filming surfing we use a telephoto lens to exag-

gerate the steepness of the wave. An ultra-wide-angle lens has just the opposite effect—it seems to flatten the wave out. So, it's very important to have a very hollow wave to shoot. To get the full effect you should ride inside the actual tunnel. You have to ride very far back inside of it—and that's where the design of the housing must be very strong, so that it can stand the wipeouts which happen a lot when you're riding inside this kind of wave. Sometimes I'm able to punch right into the wave, ride straight through the tunnel and come out the other side. It depends a great deal on the shape of the wave and whether it's big enough. If you're riding far back inside of a hollow wave and you run into the top of it, you generally don't get out again because there's just too much pressure. It slows you down too much. A hollow wave that's six to ten feet in diameter is just about right for filming with this lens.

ABOUT THE LENSES MADE FOR GEORGE GREENOUGH

By CHRIS CONDON
Century Precision Optics, Inc.

We actually supplied George Greenough with three different types of lenses, but one of these was a replacement having a little bit wider angle—so we're really discussing just two lenses.

The first is a 6.5mm, F/1.8, which has since become a regular stock item with us. It covers the full 16mm format without vignetting. There's no dark corners or anything like that.

The second and most recent lens that we made up for George is a 3.5mm, F/1.5 model, but our current stock version of this lens is F/1.8. We've had to cut down on the speed slightly because the first one we made cost $750. In order to get that down to a figure of about $500, it was necessary to compromise and sacrifice a little bit of speed. However, we feel that there isn't enough difference in the speed to offset the advantage of a $250. reduction in the price.

Both lenses—the 6.5mm and the 3.5mm—might be described as ultra-retro-focus lenses. They both come in fixed-focus mounts. There is no focusing required, because the depth of field is so fantastic. Anything that's in front of the lens will be in focus. You can literally touch the front element of either lens with your finger and it will be in focus.

Both lenses are fully color-corrected and a certain amount of barrel distor-

tion has been left in them in order to maintain the sharpness out toward the corners. However, the distortion is nowhere nearly as extreme as that of a bug-eye or fish-eye type of lens. It's not the same at all.

The 3.5mm lens does record a circular image, 10mm in diameter, in the center of the 16mm frame. It's not possible to make a lens of this short a focal-length that would cover the full format. They haven't gone that far in optics yet. Nobody's ever done it, but even if they could, the lens would have the poorest resolution you could imagine out toward the edges.

The biggest headache in making a 3.5mm lens is that of alignment. The alignment problems in the concentricity of optical manufacture for a lens of this focal-length are just fantastic. Such a lens really should be collimated directly to the particular camera on which it is to be used, because the error allowable in the seating of such a short focal-length lens is less than ½ of a thousandth. The tolerance in the manufacture of the very best cameras is about that—but if the error in the camera happens to be on the plus side and that of the lens is on the minus side, then the lens will be out of focus. You have an enormous depth of field in such a lens, but the focus error in the camera is less tolerable—much less than it would be with longer focal-length lenses. So, the 3.5mm lens we designed for Greenough was made specifically to fit his camera and mounted directly onto it.

His camera is quite rugged. It is a solid-front camera, not a turret-mount. But I would say that the lens is perhaps a bit more fragile than other lenses. Any misalignment that is caused by a bump, or something like that, is going to show up in the picture—whereas, with a normal lens, it might not show up at all. However, if that should happen, the lens could be realigned with no great difficulty. We wouldn't have to shim it up. There is an adjustment on the mount that enables us to bring it back into focus right on the customer's camera.

We make the 6.5mm lens for both the C-mount and the Bolex Reflex mount. Some people think these mounts are the same, but they really aren't. There's a slight difference. For the Bolex camera we collimate the lens to be used with a behind-the-lens filter, because all the later model Bolex cameras have gel filter slides in them. So, we collimate the lens with a gel filter—even if it's a clear filter—because placing a 1/5000th-thick gel filter behind such a short focal-length lens will set the focus back slightly. ■

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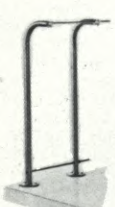

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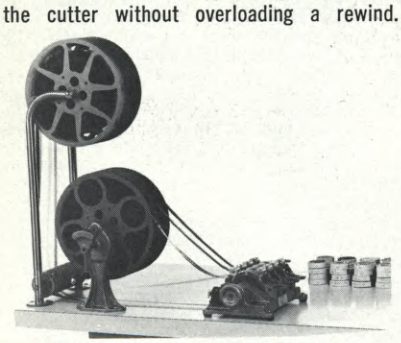

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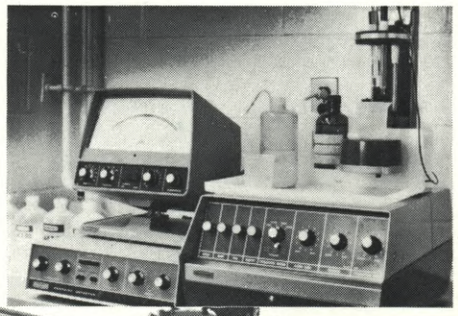

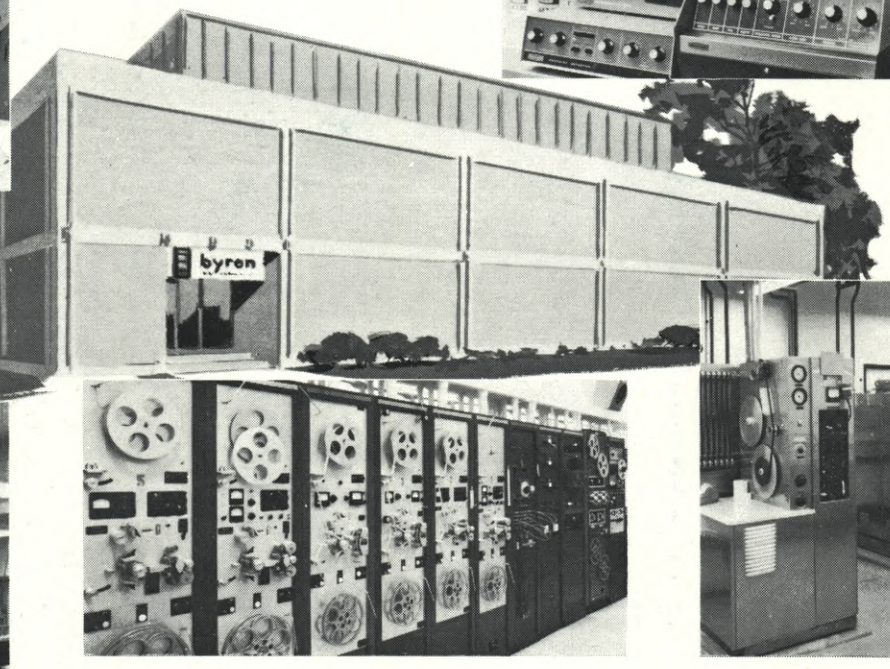

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