The Development and Use of an Equipment Retrieval Reel

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1 July 1977

Harbor Branch Foundation, Inc. Technical Report No. 20

Presented to SNAME - Gulf Section
New Orleans, La.
31 March 1978

INTRODUCTION

The Harbor Branch Foundation, Inc. makes extensive use of two manned submersibles in its science programs. The area being studied is East of Ft. Pierce, Florida, in a region of the continental shelf strongly influenced by the Gulf Stream. Retrieval of scientific instruments and experiments in strong ocean currents, as well as the ever present possiblity of rescuing one of the submarines, is a continuing problem faced by operations personnel.

Attaching the end of a surface cable to a submerged object is time consuming and often hazardous if surface conditions are less than ideal. One of the solutions developed is a means of delivering the complete reel of cable to the equipment to be lifted, attaching the free end of the cable, and returning the reel to the surface. The reel can be returned by the submarine or it can be released to rise by itself with the aid of controlled flotation.

The complete system is initially neutrally buoyant, making minimum demands on submarine trim, and requires a single controllable external air line to activate the flotation and release mechanism.

DESIGN & CONSTRUCTION

The device consists of a reel mounted on a three-part framework; (1) the main frame with reel brackets, (2) hinged triangular float frame holding the inflatable flotation

device and controlling the break-away feature, and (3) a short attachment frame which secures to the tool holders on the JOHNSON-SEA-LINK submersibles. The attachment frame is connected to the main frame by a pair of pneumatic cylinder operated pivot pin joints.

Small submersibles are quite sensitive to weight and buoyancy changes, so all attached devices must be designed within the payload limitations of the submarine for which they are intended. At Harbor Branch we attempt to make all optional equipment approximately neutrally buoyant since submarine payload requirements for our missions are quite variable. Following is a general description of the weight/ buoyancy considerations arrived at during the design of the equipment retrieval reel.

	Wt. in Air lbs.	Displacement (Seawater) lbs.	Net Buoyancy lbs.(+)or (-)
Main Frame (2" Pipe)	23.97	30.62	+ 6.65
Triangular Float Frame (1" Pipe)	4.03	4.2	+ .17
Attachment Frame (2" Pipe)	8.54	11.95	+ 3.41
Cable Reel (10" Pipe)	26.87	75.83	+48.96
Total W/O Cable	63.41	122.6	+59.19
2000' Kevlar Cable	292.69	225.15	-67.54
Total W/Cable	356.1	347.75	- 8.35

A further consideration was the 1,000 foot operational capability required of the device. According to the A.S.M.E.

code for external crush pressure, the one and two inch pipe are safe to at least 1400 feet, including a four to one safety factor. The ten inch tubing used for the barrel of the reel will operate to over 600 feet safely, and a valve is provided in the hub to pressurize the interior to 300 p.s.i., which extends the depth capability to nearly 1400 feet. The reel holds 2,000 feet of 5/8" jacketed Kevlar cable which has a 36,000 pound breaking strength.

Flotation is provided by a commercially available inflatable plastic float approximating neutral buoyancy when deflated, and providing a little over 300 pounds positive buoyancy when fully inflated. Relief valves set at five p.s.i. were added to prevent over pressurization during ascent.

The reel itself has a sealed 10 inch diameter barrel and flanges of paddle shaped spokes surrounded by a bent aluminum pipe rim. The paddle spokes provide water resistance while the reel is paying out cable during ascent, thus preventing backlash. Stub axles attached to the hub ride in Delrin bearing blocks attached to the main framework.

The main frame is welded aluminum tubing and is attached by the pivot pin release system to the submarine attachment frame. The release system is designed to hold the total surface weight of the device, but release smoothly and reliably underwater when triggered from the pilot's console.

The forward end of the main frame contains the float, folded on its hinged triangular frame. A stub extension of the main frame provides the location for the cable attach-

ment device, which may be a hook, grapnel or other coupling method. This location depends on the design of the submersible, since operational visibility must not be impaired.

OPERATIONAL DESCRIPTION

In operation, the submarine pilot maneuvers the submarine until the hook or grapnel is attached to the equipment to be lifted. After a coupling has been accomplished, the submarine backs clear, trailing cable. It can now ascend to the surface, paying out the cable from the reel or blow the reel free to ascend alone. The submarine can now stand by on the bottom to observe and direct lifting, or proceed to some other mission.

To release the reel, the pilot turns on the compressed air supply line. The compressed air goes first through a needle connector (much like that used to inflate a football), then through a three way valve. The valve directs the air to the float on the apex of the triangular frame. As the float inflates, it breaks its bonds and unfolds. When continued inflation produces a buoyancy of about 100 pounds, the nylon ties securing the apex of the hinged triangular frame break, allowing the frame to be pulled upright on its hinge.

The change of position of the triangular frame actuates the three way valve, diverting the air flow to a pneumatic cylinder which unlocks the pivot pin release system. The excess buoyancy at the forward end of the main frame causes

it to pivot, releasing it from the submarine. The change of position of the main frame also pulls the needle connector free, releasing the air line.

Ascending with the lift buoy uppermost, the reel pays out cable under light tension produced by the drag of the paddle shaped flange spokes. As the cable pays out, the reel becomes more buoyant. The float also gains buoyancy due to expansion of compressed air in the continually decreasing ambient pressure. As the differential between the air in the float and ambient pressure exceeds five p.s.i., the relief valves open allowing excess air to escape.

Once on the surface, the device floats in a horizontal position. By this time, loss of cable weight has made the entire reel and frame positively buoyant. Enough cable remains on the reel to pay out slowly while surface currents move the reel away from the underwater site. During the interval, a surface vessel either retrieves the reel, or attaches an additonal length of line from a larger, less nimble ship.

Dimensions and weight/buoyancy calculations depend on the type of submersible used, the length and strength of the cable needed, and the expected operating conditions. Harbor Branch's system is considered operational to 1000 feet. A second system is being built for 2000 foot capability. Although this device may be built to various dimensions for a wide range of tasks, it remains in concept, a simple inexpensive tool with which to expand the capabilities of a working submersible.

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