

Science-Duty Traction Winches

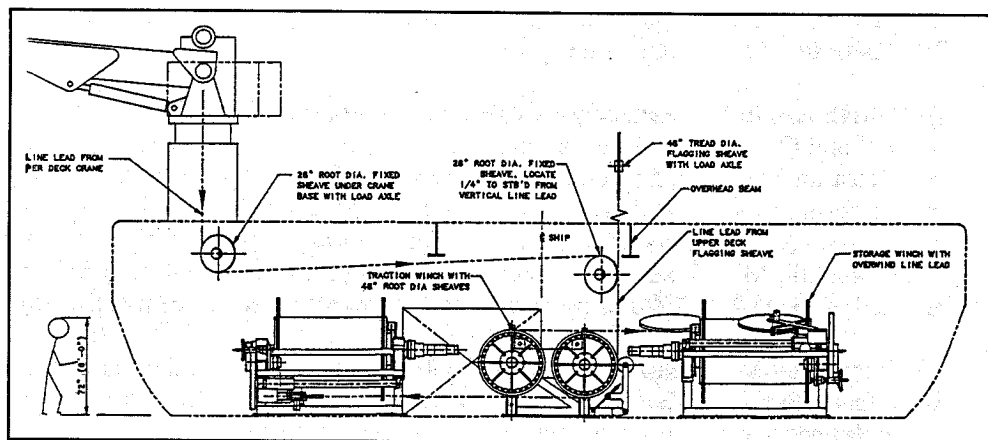
Keys to Successful Traction-Winch Performance & Predictions of Future Evolution—'What, How, What's Next'

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Traction winch systems are not new to the ocean research community. When Western Gear was in Everett, Washington, it equipped a number of post-World War II FS ship conversions with winder and reel machines. The University of Rhode Island's R/V *Endeavor* has large and smaller traction winches as well as a single-drum CTD winch. The three latest AGOR-class ships and another class of U.S. Navy data gathering ships—all under construction at Trinity Marine shipyards—have dual-reel traction winch systems.

Traction winches find frequent application ashore in the long cable stringing industry and are also found on a number of specialty deep-anchoring and geophysical ships. Several truck-mounted traction winch packages handle the large tether cables that deploy radar-carrying, unmanned blimps. With the exception of these upward leading tether machines, the basic design feature guiding most of these applications has been the uniform output pull and speed values that this type of winch can provide.

The impetus to put traction winches aboard the two vessel classes now under construction has changed and arises largely from the present and growing need to handle fiber-optic cables. These cables are rather delicate machinery elements that demand large bending radii and must be stored at very low tensions. Whereas they will



carry useful rated working loads and survive the many bends imposed by a traction winch, they will develop cracks and faults if stored long term on a full-load single-drum winch.

A traction winch is one of three historical forms of winch and is easily distinguished. The single-drum winch has a hard "dead end" and all the drive is applied to the one drum that exerts the line pull and stores its cable at whatever tension is generated by pay-load, drag, and "g" forces.

A capstan has no dead end and uses the muscle of a deck hand leaning on the inboard end of the soft line along with a number of friction wraps to provide a useful output pull. However, the term traction winch clearly is not applicable to the capstan.

True Traction Winches

A true traction winch combines a firmly dead-ended storage reel with a separate pull-creating winder. The winder unit has entirely different geometry from a capstan barrel but serves the same purpose. Its two multi-groove-powered wheels provide a "race track" adding up enough 180°

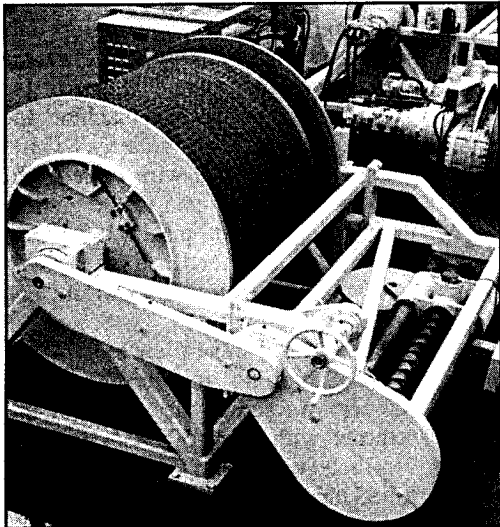
cable wraps to result in a friction-generated output at the required overboard pull. The storage reel takes the place of the man and maintains the light "tail hold." Another task of the storage reel is to smoothly and cleanly spool the cable, avoiding pull-down, gaps, back-and-overs, and other cable damaging spooling faults. Those who have kept their 1982 and 1989 copies of Alan Driscoll's green and yellow winch/wire handbooks will find a review of the basic calculations that make traction winches function.

Aboard Scripps' R/V *Revelle* (AGOR-24), Woods Hole's R/V *Atlantis II* (AGOR-25), and NOAA's R/V *Researcher*, there are two storage reels serving a single traction winder. Thus two types of wire or cable can be carried and the mission window is widened. Minimizing change-over time is one result of using overhung winder wheels as will be described later.

A complete traction winch system includes the traction winder, one or more storage reels, the hydraulic power unit (HPU), one or more operating stations, cable instrumentation

and display systems, and the often-forgotten large sheaves required to lead the wire through the ship and overboard. This modular format allows great flexibility in adapting the machinery system to a particular ship. Traction packages for large cables are heavy and best located below in winch rooms. Smaller traction winch sets can go topside with the HPU below.

The AGOR traction system provides two reels: one for 9/16-inch 3 x 19 coring and trawl-duty wire rope and the other for either 0.680-inch EM cable or 0.681-inch fiber-optic cable. Since the two reels are of equal size, there is room for 30,000 feet of the larger cable and 45,000 feet of that



nasty and hard-to-spool triangular non-rotating wire. The reels have high and low line leads so that they feed onto opposite sides of the traction winder.

Keys to Traction Winch Success

The three keys to a successful traction winch system are storage reel drive, fairlead, and details; line tension control between the traction winder and the storage reel; and winder features and specific geometry of the two traction winder shafts.

Storage reel drive, fairlead, & details. The first key to a successful traction winch system centers on the storage reels, which must be under sufficient control to always be trying to run a little faster than the traction winder is hoisting line and trying to run a little slower than the traction winder during payout. This requires proper design and coordination between the variable pumps, variable motors, and through the PLC program from the cable-instrumentation sensors. These particular AGOR storage reels have barrel diameters of 48 inches beneath their Lebus-grooved shells (approximately 70 times the 0.681-inch diameter). The cable reel has a 48-inch-diameter nylatron level wind sheave, whereas the wire

reel has a 30-inch-diameter sheave. The entire level-wind and shell sub-packages can be exchanged between reels for cable selection flexibility in

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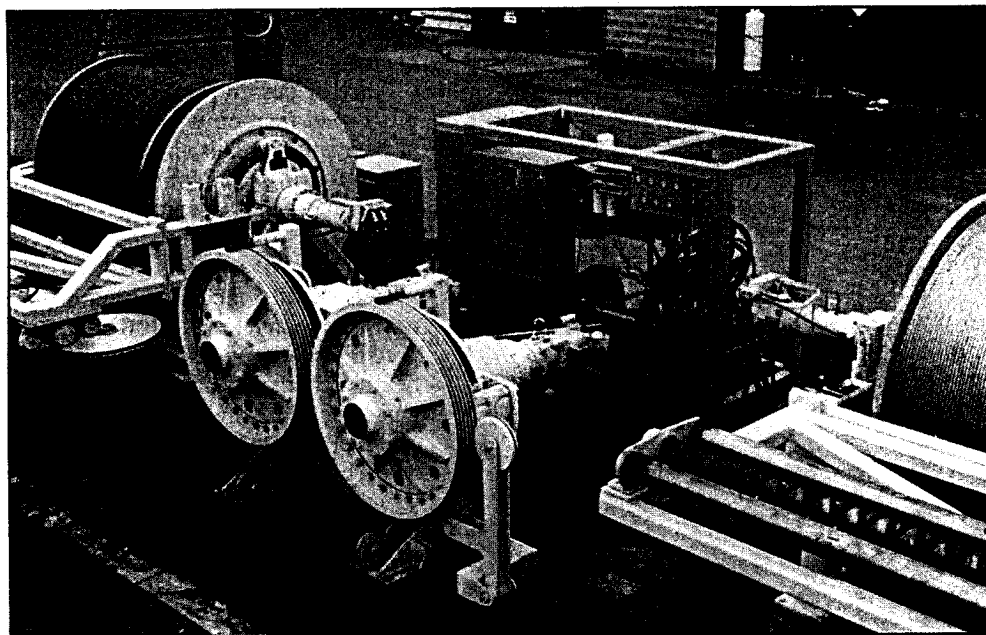
years to come.

The lines make 90° bends around the fairlead sheaves, which are the ideal location for the storage reel load cells and counting encoders. Simple counterweighting to finger-tip level allows the large sheaves to track the layer changes.

Since the storage reel tension is adjustable and layer compensated to fixed values from 800 to 3,500 pounds, fairlead head adjustment could be difficult trying to make the occasional head adjustment into the line's bight. A dual-stage differential system is introduced into the chain drive between the drum and the diamond screws to allow light wheel effort for such adjustments. The 800-pound reel tension is sufficient to provide the 30,000-pound-rated system output-pull rating, given the usual steel-on-steel friction coefficient. Higher tensions are provided to suit the spooling requirements for different wires.

Line tension control. The second key to proper system performance is to never allow the line tension between the traction winder and storage reel to vary from the selected value, whether stopped or moving in either direction.

This is particularly critical during starting and stopping transients when any slack would bounce the payload unacceptably. In addition to timing the



Markey Machinery traction winch system, ready for shipment to Trinity for AGOR-24. Traction winder and 150 horsepower HPU is in center with dual storage reels on both sides. Top photo shows underslung storage reel with 9/16-inch 3x19 wire in place.

pumps, motors, and autobrakes, this goal is aided by a spring-loaded-out-put-pressure roller, which holds the line exiting the traction winder firmly into its final groove.

This brings us to the traction winder: the true heart of the traction winch system. On the new AGOR ships, two six-grooved, 48-inch-diameter wheels are separately powered by their own co-axial stacks of manual, pump-set maintenance disc brake, planetary reducer, spring-set clutch, spring-set auto-brake, and variable-displacement piston motor. Since only the multiple line wraps connect the two wheels and the separate drives take oil from a common header, the slight compliance needed between the two wheels is provided. Other manufacturers have built traction winders with the two wheels geared together. Since by theory the cable tension increases with each 180° wrap, its length must also increase slightly. The older geared wheels failed to allow the two to slightly change their angular relationship as needed to average out the cable growth. Worn gears, grooves, and wires resulted.

On the AGOR winches, the traction

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wheels are overhung rather than straddle-mounted. This provides a major reduction in the time needed to reeve a new line. To illustrate this point we can relate a somewhat embarrassing story from the final Seattle factory witness testing day of the AGOR 24’s complete system as assembled to duplicate the ship’s winch room arrangement. After a week or two of lifting 6,000-pound test blocks as the system was being calibrated, the changeover was made to the 15-ton, full-ABS-test weight. (These machines carry ABS certification). Special traction wheel rims were made up for the 7/8-inch test wire of ample

strength reserve by the book. The visitors from the yard, the government, and the community were in the control tent well off to one side and the man-high weight was going up and down, creeping, stopping, and doing fine. With the weight roughly 75 feet off the ground, we suggested that one of the guests get a feel for the machine and that he bring it down “smartly.” Thirty feet up the 7/8-inch wire parted. The 15-ton weight dropped to the ground, digging an 8-inch pit in the yard’s gravel, and the freed end of the wire flopped back over the anti-rain tent, damaging nothing.

There was a short silence.

Less than 45 minutes from the moment of fracture, the shop truck had returned with a new 500-foot length of 7/8-inch wire, and three men had tidied the grounds, re-spoiled the reel, re-reeved the two traction wheels and the crane, and gotten the test underway again. Overhung traction wheels were a major factor in this cable exchange.

Another design feature is the use of alloy steel traction wheel rings bolted to their spiders. This allows future provision for ring pairs (plus reel-grooved shells and fairlead sprockets) to suit wires from 1/4- to 3/4-inch or even larger. The overhung access to the wheels greatly facilitates this change when compared to wheels that are supported on both sides by pillow-block bearings with the cable requiring over-and-under threading.

Winder features & specific geometry. The third key to traction-winch success is the geometry between the two traction winder shafts. In plain view, the shafts are parallel but the wheels are offset one-half groove. In face-on elevation one shaft is about an inch higher than the other so that the two incoming wires from the reels can reach the far winder wheels cleanly. In end elevation, there is a small “out of parallel” that is introduced to prevent

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the cable from touching high on the groove wall and being forced to "roll" into the groove root. When the winder is laid out right, the wire goes through the entire system with no induced twist.

Once the 150 horsepower HPU is on and warmed up, a single joystick controls the speed and direction of the selected reel drive and the two traction winder drives. The operator sees tension, speed, and length displays and this data is readily available to the ship's computer. Reel tension is dialable and a large red "E-Stop" button will bring the entire system to an orderly halt and retain the reel's tension as the system shuts down. The output line can be completely slack and the "dead" winch package will maintain that same reel tension value for as long as necessary.

As of now, when low tension storage is the cable survival requirement, the traction winch appears to be the necessary choice. (It should be noted here that if constant output speed and pull are the selection basis free of the single-drum winch's "radius effect," modern encoders, PLCs, and drives will layer-compensate a single-drum winch to hold such constant values across the full depth of the drum. A small power penalty results but the single-drum package should always be cost-effective and simple.)

What's Next

At present most marine research traction winch systems are for the large size cables and wires. Smaller, single-reel systems are equally feasible for 1/4- or 0.322-inch EM, cable, and the variety of smaller fiber-optic

cables that may be forthcoming.

One evolution may be the replacement of elderly, large, single-drum winches with traction systems. Retrofitting to existing ships will be more demanding than clean-screen designs,

as always.

Another possibility should not be overlooked. It is not beyond imagination that just as the research fleet is finally converted from single-drum to traction winches, the folks who make the fiber-optic cables will invent a new form of glass lines that will tolerate storage at rated pulls on single full-power drums. Until that time, continuing to make both types of research winch available to the community appears to be the proper and necessary way to proceed. /st/

Michael Markey is part owner and executive vice president of Markey Machinery Co. He has worked for the family-owned firm for more than 38



years and recently turned over his position as CEO to Blaine W. Dempke, former engineering manager with 18 years at the company. Markey is now concentrating on product definition, proposition engineering, and sales travel.