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NOTE

Sidewinder: Description of a New Block Winch for Deploying Instruments at Sea

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Abstract
We describe a new electric winch design and its functionality for conducting research operations off different-sized vessels. Currently, several small oceanographic winches are available for deploying research instruments and nets, but they are typically heavy, noisy, semipermanently mounted to the deck, hydraulically operated, and not readily transferable between vessels. The limitation of winch portability between vessels, in particular, has been exacerbated by the increasing use of a variety of chartered vessels to conduct state and federal agency and university research. To address these challenges, we developed a relatively lightweight (70 kg), portable block-design winch that is spooled with 400 m of plasma line, powered by two 12-V marine batteries, and operated by a remote control box on a pendant equipped with a joystick. The 2.2-kW drive produces 100 kg of line pull at speeds of 0 to 2.0 m/s. The pendant includes digital displays for line speed, scope, and angle as well as an emergency stop. Nicknamed the "Sidewinder," this winch is quiet, can be operated by one person, and is suspended outboard from a davit or crane boom, increasing available deck space and relocating all lines safely away from vessel personnel. On vessels 7 to 50 m in length the Sidewinder has been successfully tested for deploying small gear such as conductivity–temperature–depth profilers and large BONGO plankton nets that require specific deployment and retrieval speeds and line angles. To ensure safe operation, vessel support features such as the power system and davit working load capacity should be considered when the Sidewinder is custom-built.

Winch technology has undergone many developments in recent decades as marine nearshore research and commercial applications have expanded (Mulcahy 1981; Dempke and Griffin 1997; Bash 2001). Research protocols for deploying instruments and nets have also changed over the years, following comparisons of sampling methods and gear (Pepin and Shears 1997; Weinberg et al. 2002; Baumgartner 2003) and advances in the design of net sampling systems (Siler 1983; Choat et al. 1993), oceanographic sampling instruments (Rudnick and Klinke 2007), remotely operated vehicles, and hydroacoustic equipment. Development of increasingly complex sensoring systems has required integration with electronic, mechanical, and hydraulic systems (Dempke and Griffin 1997; Gordon et al. 1998; Hooker and Maritorena 2000). For commercial and deep-sea applications, new deck machinery to handle deeper and heavier loads in heavy seas has required more winch power and performance (Griffin and Nishimura 2007; Griffin 2009). This report describes a versatile new small winch application for meeting research needs to accurately deploy oceanographic instruments and small nets and that can be readily transferred among vessels, particularly smaller ones.

Existing winches available for deploying oceanographic equipment are not readily transferred between vessels used as sampling platforms to study shallow marine nearshore

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processes. Common winches still operate by hydraulics and are semipermanently mounted to the deck of a vessel (Dempke and Griffin 1997; Markey Machinery 2004). This limitation has been exacerbated by the increasing use of chartered vessels to conduct research; for example, scientific monitoring programs may conduct routine surveys from several different platforms during the season, each requiring the transfer of gear. In Alaska, the Southeast Coastal Monitoring project (SECM; conducted by the National Marine Fisheries Service, Auke Bay Laboratories) formerly used National Oceanic and Atmospheric Administration (NOAA) vessels exclusively for research, but now conducts its annual surveys using a variety of chartered vessels of different sizes. Project personnel recently collaborated with Markey Machinery (Seattle) to develop the new winch (subsequently dubbed the “Sidewinder”) design to address challenges in deploying sampling gear among various vessels.

The SECM conducts annual surveys to sample juvenile Pacific salmon *Oncorhynchus* spp., their predators, zooplankton prey fields, and physical oceanographic features in northern Southeast Alaska (Orsi et al. 2004). Sampling is conducted monthly from May to August at stations within a few kilometers of shore, typically at 50–300 m deep. During this work, a variety of small oceanographic instruments and nets are deployed from NOAA and chartered vessels from 7 to 50 m in length. Vessel configuration varies widely, and sampling operations must be adapted to vessel layout, space limitations, and permanent machinery. Fish trawling is accomplished with a Nordic surface trawl that requires large winches and reels typically located amidships. Oceanographic sampling requires smaller winches that are typically mounted on one side or on an upper deck. Some vessels do not have a winch of the appropriate size or location to conveniently deploy small instruments according to

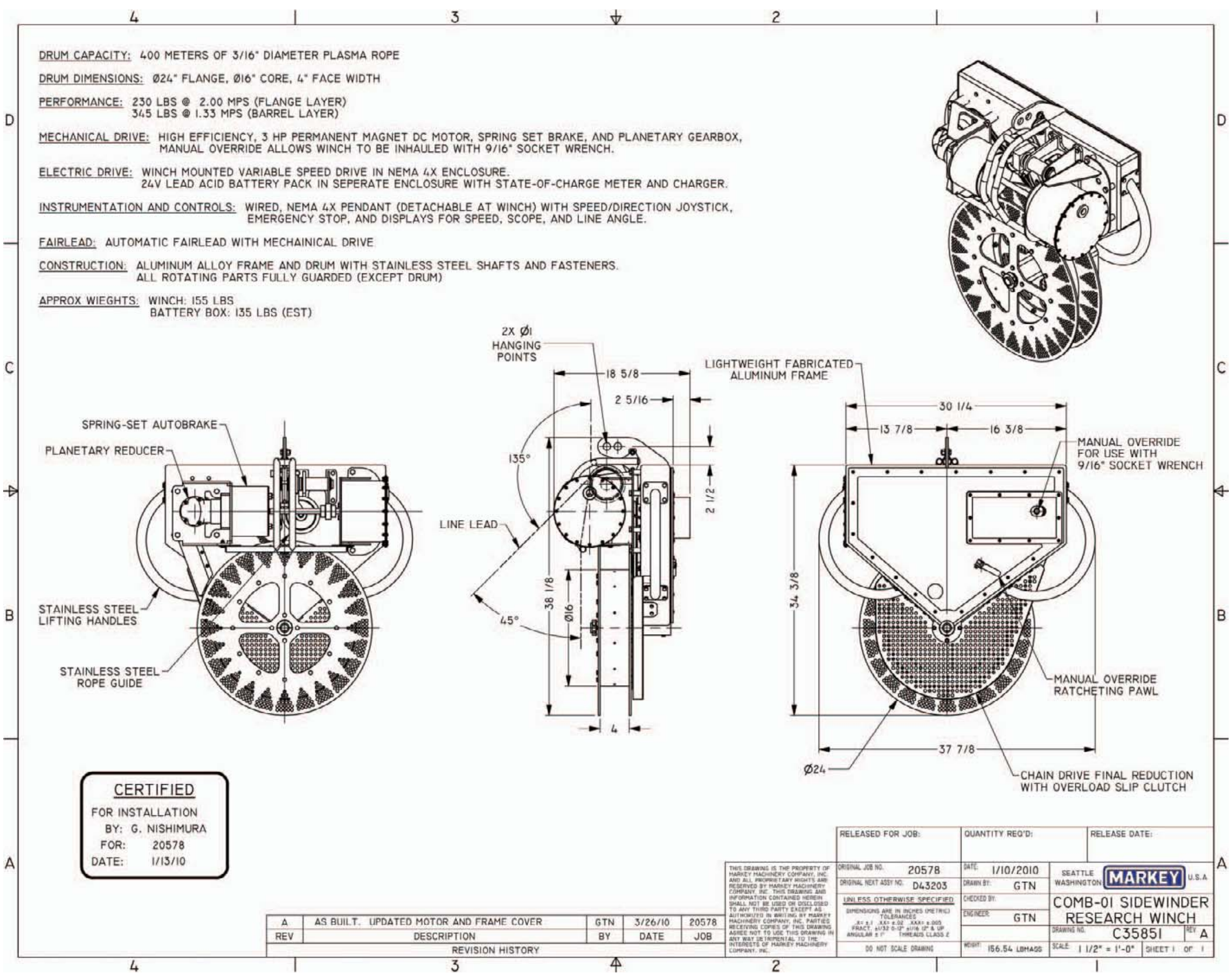

FIGURE 1. Schematic diagram of the COMB-01 Sidewinder Research Winch (Markey Machinery 2010) showing construction details and mechanical, electrical, and instrumentation features (American National Standards Institute specifications).

standard specifications. In these instances, the SECM project has provided a small hydraulic winch with a separate electronic display showing meters of line out. However, this winch is relatively heavy and nonportable, and requires a semipermanent mounting location near hydraulic lines. Like many winch systems, the rigging is directed through a remote block on a davit or boom that pivots to one side, where the sampling gear is attached. In addition, this winch is inconvenient because several staff are needed to monitor its operation and coordinate with vessel power to meet specific sampling gear requirements (e.g., BONGO net deployment and retrieval at defined speeds and line angles; Orsi et al. 2004). The operator uses winch-mounted controls, a second person reads line speed from an electronic display located away from the winch, and a third person monitors the line angle (40–50°) manually with an inclinometer.

In contrast to the summer surveys, which include fish trawling, the SECM survey in May is restricted to oceanographic sampling for which the laboratory's 7-m RV *Quest* is of adequate size. The standard conductivity-temperature-depth (CTD) and vertical plankton net tows are readily accomplished using a hand line through a block, but the BONGO zooplankton net (about 45 kg) requires towing in a double-oblique trajectory to 200-m standard depths at a payout (deployment) speed of 1.0 m/s out and inhaul (retrieval) speed of 0.5 m/s (Orsi et al. 2004).

FIGURE 2. Photograph of the Sidewinder block winch showing the aluminum housing of the drum below the (left to right) planetary reducer, brake, line guide, and motor and the lifting handles above.

Thus, a simple hand winch could not achieve these specifications. Developing a winch that could be used on this vessel for intermediate oceanographic gear such as BONGO nets and Tucker trawls (Posgay and Marak 1980; Siler 1983; Pepin and Shears 1997) would eliminate the need and cost of chartering a larger vessel to conduct the work.

METHODS AND RESULTS

The COMB-01 Sidewinder research winch (Sidewinder; Markey Machinery 2010) was designed to address the portability limitations of deck-mounted hydraulic and electric winches and to increase the potential for using small vessels as sampling platforms for oceanographic research. We desired a winch small enough for two people to transport that would not require using the limited deck space of the RV *Quest*. We considered an electric recreational pot-puller but determined that line spooling capacity was too limited and that typical power (0.8–1.6-kW, 12-V DC) was insufficient for our application. These considerations lead to the suspended block winch concept. Initial measurements of the line tension (coefficient of drag) were based on a 60-cm diameter BONGO net at a 30-m depth, towed from a block off the davit of the RV *Quest*. The tension was measured using a DynaLink load cell and a hand winch, providing information to determine the required winch power for standard tows of the BONGO and similar nets used to sample zooplankton and ichthyoplankton.

Several power sources were considered for the winch, including the existing 12-V system charged by twin outboard engines. Although these engines are rated to produce 25 A each, output is reduced at lower engine speeds and is also used for engine ignition and other onboard systems. Thus, the winch requirement of nearly 200 A for a 12-V motor drive that produces 2 kW of mechanical power far exceeds the charging capability and would quickly deplete typical batteries. Therefore, a dedicated 24-V battery pack was chosen that would provide operational flexibility and increased performance. The Sidewinder can also be customized for different vessel power options, including a 12-V system charged by the engines or a power conversion unit for use with a portable generator or an existing AC power system.

The low-voltage system led to several other design challenges because of the limited availability of low-voltage, lightweight, marine-grade components. The majority of existing components are mass-produced for specific customers, to be sold as part of a finished product. If components are available separately, technical information is often proprietary and is difficult or impossible to obtain. As a result, many components were used from other applications, including food processing machinery and battery-powered commercial vehicles such as fork-lifts and other indoor vehicles. The design was developed and built by Markey Machinery, and performance was verified through comprehensive shop-testing. Field tests were performed successfully on the RV *Quest*, and the final winch was later used throughout a survey on the 50-m charter vessel FV *Northwest Explorer*.

FIGURE 3. The Sidewinder block winch suspended from the davit of the 7-m RV *Quest*.

The Sidewinder's block design is relatively lightweight and portable; overall dimensions are approximately 0.86 × 0.94 × 0.47 m and weight is 70 kg. A schematic diagram indicating size, construction details, and mechanical, electric, and instrumentation features of the Sidewinder is presented in Figure 1. A 2.2-kW variable-speed drive produces a full-drum line pull of 100 kg at 2.0 m/s. As line is deployed off the drum, the maximum speed decreases to 1.3 m/s at the first layer, satisfying the speed requirement throughout the drum capacity. The drum and internal level-wind are protected by an aluminum frame that also provides a watertight compartment for the electric motor controller and contains stainless-steel drive components for the level-wind. The electric motor in its watertight enclosure, the stainless-steel reduction gear box (Mulcahy 1981; Dempke and Griffin 1997), and the sealed electromagnetic motor brake (Figure 2) are located above the drum. The drum is driven by a self-lubricated chain and has capacity for 400 m of 4.8-mm-diameter lightweight, high-strength (2,500 kg) plasma soft-line

FIGURE 4. Bongo net being retrieved by the Sidewinder block winch suspended from the amidships boom on the 50-m charter FV *Northwest Explorer*. The remote control operator is partially visible at right, and the net is being retrieved through a "barn door" by the scientist in the yellow hardhat.

Spectra. The entire water resistant unit can be suspended over the side of the vessel from a sturdy davit or J-frame on a small vessel (Figure 2) or from a boom on a larger vessel (Figure 3). Such supporting structures must be rated with a safe working load at least equal to the combined weight of the winch and maximum possible line tension for a given operation. The unique, two-sheave, level-wind allows the working end of the line to be deployed at a 90° angle to the turning drum (Figure 4). With line departure from a single stationary point, the line path is located very close to the winch center of gravity and reduces any "swinging" of the winch caused by fluctuations in line tension (Nishimura and Sturdevant 2011). A stainless-steel line guide ensures proper alignment with the level-wind, regardless of departure angle. An added 15-m of black chaffing at the terminal end of the line minimizes abrasion and provides an off-color visual alert to the winch operator that the instrument is close at hand. Electric power for the Sidewinder is supplied by cables from two, 12-V deep-cycle marine batteries monitored by a programmable battery gauge. Another cable connects the winch to a remote control box, which features a joystick; emergency stop; and displays for line speed, scope, and angle. An optional manual override allows line retrieval using a standard socket wrench in case of drive or battery failure. The override uses a ratcheting pawl to prevent the winch from free-wheeling during such retrieval. Operational safety is ensured by the completely contained mechanics, having the working line and load off-board, and accommodating various operator locations within the range of the wired, remote control box. An additional safety feature is the built-in overload slip clutch that allows rapid deployment of the line in the event of a gear snag. The clutch automatically resets when the load returns to normal levels, immediately restoring all winch functions.

DISCUSSION AND CONCLUSIONS

The Sidewinder block winch has solved a variety of problems experienced while deploying oceanographic instruments and nets during nearshore research activities, particularly from small vessels. Its advantages include

1. portability among vessels owing to size and power requirements
2. functionality on vessels as small as 7 m long
3. elimination of hydraulics
4. enhanced safety of operation owing to self-contained mechanics and lines and offboard location
5. convenient remote control with displays for line speed, line out, and line angle
6. fewer operators needed owing to use and features of remote control
7. sufficient power and spooling capacity to deploy and retrieve standard BONGO and Tucker trawl nets in moderate nearshore conditions
8. freed-up deck space
9. quiet operation

The Sidewinder's innovative design offers researchers new flexibility and portability in deploying small oceanographic instruments and nets from small vessels. Sidewinder is an attractive, cost-effective option to deck-mounted winches that nonetheless requires consideration of any unique features that may affect vessel stability during operation (e.g., counterbalancing the weight of the winch by placing heavy batteries on the opposite side of the deck). The Sidewinder has been especially useful in extending SECM capability to deploy standard BONGO plankton nets to 200-m depths from small vessels when a larger, winch-equipped, vessel is not available.

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