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Tempest's Formula for Speed

By Jay Coyle

The newly patented T-Torque drive system handles high-powered engines with a minimum of draft.

The seed of invention is rooted in the desire to satisfy a need. The T-Torque Drive system used by Tempest Yachts is a perfect example of this postulate in practice.

In fact, so unique is the system's combination of fixed surface-piercing propellers and high-speed rudders, it was recently patented.

The system is now standard on the Tempest 42, 44 and 60 and provides the boats with high performance and low draft. But to best understand how it got this far and why a patent was obtained, a small history lesson is in order.

In the early 1980s Dick Simon, a successful businessman from Chicago, contracted a South Florida boatbuilder to produce a 40', 40-knot performance boat capable of making the trip from Simon's South Florida home to his retreat in the Bahamas.

This wasn't much of a challenge considering the technology then available. However, Simon insisted on diesel power because of its safety and reliability.

When the boatbuilder's effort failed to meet Simon's expectations, Simon was left with the task of developing the boat on his own. On the recommendation of a local engine distributor, Simon recruited designer Adam Erdberg who had moved from Israel after a stint in the Israeli navy as a marine engineer. Since his arrival in the U.S. in 1974, Erdberg had worked as a designer for Bertram and the Cigarette racing team. This work included the design of the successful Cigarette 41.

Although the Cigarette 41 was diesel powered, Erdberg was convinced that to optimize performance, a hull would have to be specially designed to accommodate the additional weight of the diesel engines.

The 44' hull (9'6" beam) that Erdberg designed had a fine entry that

The Tempest 60, above, is one of three models using the T-Torque, bottom. The T-shaped frame provides a rudder platform.

Robert Holland/Tempest

varied in deadrise to 25 degrees at the transom. This design solidified Simon's and Erdberg's partnership, and SEZ Marine was formed. It later evolved into Tempest Yachts, of which Erdberg is now president.

SURFACE PIERCING To give the diesel-powered 44 the added edge needed to meet Simon's performance requirements, surface-piercing drives were selected.

Surface-piercing systems are not new. In fact, Albert Hickman developed a successful surface-piercing system in the 1920s. These early systems were limited by the propeller technology of the day, and only in the past 20 years has propeller design and manufacturing been able to provide reliable high-speed surface-piercing wheels.

A surface-piercing propeller typically operates with only 50 percent of its disc area immersed when the hull is planing. For this reason the blades of a surface propeller are thicker and stiffer to accommodate the increased loads of this hostile environment.

The advantage of the surface-piercing wheel is quite tangible. According to John Rose of Rolla Propeller, a leading manufacturer of surface-piercing props, their propeller designs can increase top speeds by as much as 20 percent over a conventional fully immersed prop. Rose explains: "Cavitation (formation of gas bubbles caused by low pressure on the blade surface) generally occurs on conventional fully immersed propellers operating over 20 knots. This absorbs energy and this in combination with the turbulence caused by the strut renders a portion of the blade area useless."

The blades of a surface wheel are designed to operate in a mixed media of air and water, Rose says. "As the propeller blade penetrates the water's surface, it carries with it a cavity of air on its low-pressure face. This cavity expands as the propeller spins faster and pressure is reduced. This reduction of pressure increases the blades' lift and the propeller's efficiency overall."

Although the merit of a surface piercing application depends on a number of operational requirements, surface-piercing systems are primarily suited for high-speed planing applications.

Erdberg compares the operational

philosophy of a surface-piercing planing boat to that of a propeller-driven aircraft. "As in an airplane, we use between 75 to 80 percent of full throttle for takeoff," he says. "Once aloft or on plane, the throttle may be reduced for cruising speed."

DIESEL POWER vs. SURFACE DRIVE Fitted with twin 350-hp Caterpillar 3208TAs, and surface-piercing drives, the first 44 cruised easily at 50 mph and topped out at 55 mph. As far as Simon was concerned, the design was ideal.

For Erdberg the challenge had just begun. After delivering six 44s, it became apparent that the drive systems they had selected were developing excessive wear problems.

According to Erdberg, the comparatively high torque of the diesel engines proved too much for these early articulated drives, which were designed for gasoline-powered applications.

Erdberg went back to the drawing board in hopes of developing a simple solution to the problem. Erdberg felt that a fixed system, free of the complications of an articulated drive, would be the most practical.

The key advantage of the articulated system is that the propeller position can be raised or lowered to suit the varying load and trim conditions of the boat. This also allows the operator to lower the propeller into clean water at takeoff to help lift the boat up on a plane. As Erdberg's drive would be fixed, he would have to find the optimum propeller position for the particular boat.

Thus after calculation and trial and error, Erdberg determined the ideal relationship of propeller to hull. This placed the propeller slightly deeper in the water (approximately 60 percent of the disc area when planing), and resulted in the projected shaft line falling just below the vessel's vertical center of gravity. Erdberg says this relationship of shaft angle to the vertical center of gravity is critical. "By falling below the vertical center of gravity, a moment is created which increases trim and lifts the bow."

Erdberg realized that for the fixed system to work, the center of gravity of the boat would have to remain fairly constant, thus fuel was placed as close to the longitudinal center of gravity as possible. In this position, the varying weight of the fuel load would have little effect on trim.

Three-bladed, Nibral 18"x22" cupped propellers were provided by Rolla, and held in position by a stainless-steel strut that bolted directly to the transom. Fitted with cutless bearings at both ends, the strut's relatively long shaft tube provided a stable bearing just ahead of the propeller.

Forward of the strut, the propeller shaft passed through a water-cooled, Teflon-packed stuffing box fitted to the transom. The shaft was fastened to the transmission via a flexible coupling. This flexible coupling reduced the effects of shock caused by high-speed offshore operation, and isolated propeller-induced vibration.

"T" SPELLS STEERING With the drive design confirmed, the only challenge left for Erdberg was to provide a means for steering the boat. After an early design with the rudders located forward of the propellers proved unworkable, a more conventional solution with the rudders aft of the propellers was employed. The trick was in mounting and supporting the rudders, as the props extended aft of the transom.

The T-Torque Drive offers sound reliable performance for high-speed planing boats as well as shallow draft on the 60-footer.

Erdberg's solution was to create a T-shaped stainless-steel weldment that bolted to the transom. Located between the struts, it extends aft of the propellers to provide a housing for the steering system components, and a mounting surface for the rudders.

Within the box-like steering housing, all components including tiller arms, tie-rod, and the balanced hydraulic ram, are composed of stainless steel. Stainless was chosen not only because of its high strength, but for its resistance to corrosion. For even though the steering compartment is sealed, the compartment is wet when the boat is at rest.

Once underway, water is vented through drains on the underside of the housing. An inspection plate is provided atop the housing, and can be removed for access to the steering components.

THE TEST OF TIME With more than 60 Tempests in service with the T-Torque Drive, and no major problems according to Erdberg, there is little question that the system has proven reliable. Our sea trial of the T-Torque system was aboard Tempest's new 60-footer. With the exception of the system's proportions, the 60's T-Torque Drive is identical to the 44's.

Low-speed maneuvering, including backing and turning, are traditional problems for surface drives due to the propeller's location (50 percent of disc area behind the transom). However, to my surprise, the 60 backed and turned almost as easily as a conventional drive. Erdberg says maneuverability was a prime concern in the design.

For this reason Erdberg also increases the distance between the propellers over what might be common on a race boat. This additional span improves the handling characteristics of the boat by increasing the turning, and according to Erdberg affects top speed only slightly.

Advancing the throttles on the 60's twin 1050 hp Caterpillar 3412TAs brought a quick response, and once on a plane, the surface-piercing props delivered flawless performance in the four-foot seas off Miami Beach. Adjustments in trim can be made easily with Erdberg's custom-designed trim tabs. These tabs can be lowered to reduce the time needed to reach planing speed, typically 20 seconds.

In all, the T-Torque Drive offers sound reliable performance for high-speed planing boats, as well as shallow draft, approximately 36" on the 60-footer.

The December patent issued to Erdberg by the U.S. Patent and Trademark Office in Washington, D.C., confirms the originality of the system's design.

For those interested in the high-end performance possible with the surface drives combined with the reliability and simplicity of a conventional drive, the Tempest's T-Torque system is worth a close look. □

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