

Steering Refit

Replacing worn-out mechanical steering with a new hydraulic system is well within the scope of the experienced DIYer but it does require a combination of diligence and a willingness to endure some snakelike physical maneuvers in the small, dark places in your boat.

By Peter Caplan

A boat's steering system winds up in the out-of-sight-out-of-mind category when it comes to maintenance until responding to stiffness and play in the system, the symptoms of wear, forces an inspection of the installation. A dual steering station set-up aggravates the situation, as the wheel in use must not only turn the rudders, it must also turn the wheel at the other steering position via another cable, compounding the stiffening effect. This was the case with UK boat owner Alan Hanson's 30-plus year old 42' (12.8m) Sealion. Steering was a matter of first overcoming 50° or so of free-play in the wheel before the wheel would turn the rudders and the wheel at the other station. Although the system still did the job, steering the boat on long passages was a tiring exercise. Eventually, with a system replacement imminent, the obvious choice of new equipment was a hydraulic system. The light action and reliability of modern hydraulic steering systems make them the norm on nearly all larger power yachts. [Ed: If you are sticking with a mechanical steering system, refer to DIY 2004-#1 issue for step-by-step details on installing a new mechanical (cable) steering system.]

There are several manufacturers of reliable marine steering systems and the boat owner settled on Teleflex SeaStar, a system that's installed as original equipment on many production boats, such as Boston Whaler, Carver, Cruisers, Grady White, Hatteras, SeaRay and Viking. No matter which system you select, the installation of hydraulic steering is pretty well identical whatever the make.

Preplanning

During extreme system demands in rough seas, rudders generate high forces that feed back through the system to the rudder actuator, in this case, the steering cylinder or ram. This is why it's vital that all the system components be bolted to a support structure that is strong enough to take the strain. On many boats, the original mount will be adequate but, if additional sections are needed to support the new system, these must be equally as strong as the original structure.

On the Sealion, there is a substantial aluminum mounting frame extending across the lazarette. It needed only a couple of solid aluminum spacers fitted to bring the new hydraulic cylinder up to the same height as the old mechanical steering connections.

The installation of the hydraulic steering is very simple but the routing of the cables throughout the boat complicates it. This is a simple process when a boat is being built and the equipment can be fitted before the deck is set down onto the hull.

For a retrofit, the cables have to be passed through, around and behind all the furnishings and fittings. Tying messenger lines to the old steering cables before they are withdrawn can help draw the new cables back through the boat to the various connection points.

Piping Choices

Hydraulic steering suppliers offer a choice of materials for the piping (hydraulic lines), which includes plastic, copper or made-up hydraulic piping (hose). The Teleflex SeaStar system specifies either 3/8" (9mm) copper, which can be purchased in rolls from natural gas suppliers, or hydraulic piping with

swaged end fittings for quick assembly. They don't recommend plastic piping for this system, as the burst limit for plastic is not sufficiently above the maximum pressure relief valve settings on the helm pumps.

The choice of whether to use copper or hydraulic piping is then a matter of either cost or convenience. Copper piping is a fraction of the price of swaged hydraulic hoses but is more difficult to route through the boat as every curve and bend must be formed as it passes through. It's possible and, with care, offers a significant cost saving. The flexibility of 3/8" (9mm) copper makes it relatively easy to install. It's essential that copper be securely supported throughout through the boat to prevent vibration, which causes work hardening and fractures. This need for support can sometimes cause problems where access to various compartments is severely restricted.

On a boat with unrestricted access, properly installed and adequately supported copper piping that is not subject to corrosion from saltwater exposure lasts just as long as hose.

For this installation, hydraulic hose was chosen for ease of installation and a long life with no worries of the effects of vibration on the piping. Many hydraulic steering system suppliers can supply hydraulic piping but a look in the local Yellow Pages will produce a list of hydraulic equipment specialists who can make up the necessary lines. Prices vary between suppliers so it's a good idea to shop for the best price.

When using copper tubing, you can buy coils of sufficient length to complete the job. When using hydraulic hose, each hose must be ordered to the correct length so that the end fittings can be swaged on. This is the only critical part of the installation but is easy to achieve by running

DIY BILL

All the parts necessary to install a dual station hydraulic steering system can be purchased for less than US\$1,400. Completing the job took two days of actual work but was spread over several weekends, which included planning and allowed time for ordering and receiving the piping. While no two boats are the same, the work involved and the problems encountered are typical of most boats as well as different makes of hydraulic steering systems. While hydraulic piping makes the routing job very much simpler, using copper tube reduces the overall cost.

POWERBOAT - RIGGING

stiff cable through the boat to each connection position and then carefully measuring each length. It was at this stage that we ran our messenger strings to allow easy threading of the new piping through the boat as each length of measuring cable was withdrawn. The big advantage of hydraulic hose is the ease of connection once everything is fitted and the piping is run. Hydraulic fittings, unlike compression joints, use a cone and seat connection that only needs connecting and tightening to make a perfect joint. It's virtually impossible to overtighten or spoil a hydraulic connection, whereas compression joints are all too easily over tightened and damaged by inexperienced installers.

Removing The Old Steering



Remove the wheel hub cover by undoing the securing screws.

The lower helm position, with fascia panels removed, reveals both ends of the original steering rack.



This exposes the wheel securing nut, which is undone with a large wrench.



Remove the wheel by gently rocking it back and forth to free it from the taper on the shaft.



The steering shaft is held in place by a wire circlip. Pry this off using the tip of a screwdriver blade (or split ring pliers).

The nylon bearing block is now free to pull out, leaving the steering assembly loose behind the fascia panel.



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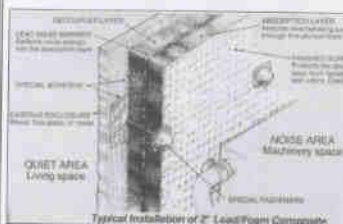
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The steering mounting assembly is held on with four nuts and studs behind the fascia. Once these are removed, the whole assembly slides out. This leaves the steering rack loose on the end of the cable inside the fascia panel where it remains until disconnecting the other end of the cable from the rudder arm. Follow the same procedure at the upper steering position before proceeding to disconnect from the rudders.



The original steering system still in place in the lazarette shows the size of the push-pull cables and the sturdy alloy mounting frame that connects both rudder tubes and provides a solid mount for the cable ends.



The first step of the dismantling process at the rudders is to disconnect the ends of the cables from

the fork connection on one of the rudder arms. These are clamped into position with a nut and bolt through a slot in the side of the cable end fitting. Once the nut is undone and the bolt removed the cable end slides out of the fitting. Note the heavy-duty construction of all fittings in this system, one reason it lasted so long.



Next, dismantle the mounting bracket holding the outer cable. This consists of a double cup arrangement that allows the outer cable to pivot slightly as the rudders are turned. A spring keeps the whole assembly under tension to prevent vibration. Undoing the four machine screws and lifting off the top section accomplish removal.



Once the uppermost cable has been removed, the lower cable is dealt with in the same manner. The original push-pull mechanical steering used on this boat is probably common to boats of this era and quality. Remove and discard the mounting bracket that held the outer cables along with the cable end fittings attached to the rudder arm. The eye to which the fittings are attached is left in place, as it may be suitable for the later attachment of the new hydraulic steering cylinder.

This provided the length required for the balance piping between the two pumps. The same procedure was followed from the helm pumps to tee connectors where the two systems meet. More electrical cable was drawn from the tee connectors to the lazarette. Each of these cables was formed into sweeping radiused bends to emulate the run of the piping and then marked with masking tape and cut, leaving extra length to allow for error; slightly longer piping can be hidden out of sight; piping that is too short is absolutely useless.



With all cable ends disconnected the old cables are withdrawn from the boat. At this step, the draw-strings (messenger lines) to the ends of the old cables to assist with threading the new piping. As we were installing hydraulic hose, rather than copper tubing, it's now necessary to determine pipe lengths. Using the messenger lines, we pulled spare electrical cable through the boat between the upper and lower helm pumps.



Installing the Hydraulic Steering
Calculate the position for the cylinder by measuring the total length of movement of the shaft within the ram and then moving it to its mid point and measuring from the eye on the end of the shaft to the center of the mounting base on the cylinder.



The installation begins with marking the hole for the lower helm pump in the front fascia panel and then carefully cutting it out with a jigsaw.

Use the template supplied with the kit to mark the holes for the helm pump mounting studs.



Carefully drill the holes, taking care to keep the drill square as the bit passes through the fascia. This was critical due to the close proximity of the original mounting holes.

Apply a coat of varnish to seal the cut edge to prevent moisture intrusion that can rot the wood. Allow to dry prior to fitting the pump.



Follow the same procedure at the upper command bridge steering position where the helm mounts on a fiberglass panel.



Before mounting the helm pumps, install the necessary fittings after first removing the protective plugs.



Apply liquid thread sealant to both lock and seal the threads. Don't use tape as stray ends can get into the system and block the valves.



There are two main connections, port and starboard, and one balance pipe fitting in each helm. The upper helm pump (left) has the balance fitting in the bottom and the lower pump (right) in the upper fitting. Note also the different oil filler caps. The upper helm pump has a vented knurled cap for easy removal for system top up. The lower helm has a semi-permanent cap that needs a screwdriver to open. Once the system is filled, this cap should not be opened otherwise oil pours out.



Moving back into the lazarette, mark the position for mounting the steering cylinder onto the original frame.

Transfer this figure to the mounting frame in the lazarette and measure from the rudder pivot point along the mounting frame to give the position for mounting the cylinder.



Calculate the position for the cylinder by measuring the total length of movement of the shaft within the ram and then moving it to its mid point



The only modification required to the mounting frame was to fabricate two 1/2" (12mm-) thick aluminum spacers to raise the cylinder up by 1" (25mm) and back far enough to align it with the eye on the rudder arm. A piece of alloy from a local scrap yard was used.

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Once the athwartship position of the cylinder had been finalized, the next point to check is the distance (shown as A-B in the illustration above) from the rudder pivot point along the rudder arm for attachment of the cylinder shaft end. This is important as it decides the number of turns on the wheel and the correct loading on the cylinder. If the turning radius is too small, there will be fewer turns on the wheel but the amount of force required to turn the rudders may exceed the designed limits. If it's too large, the rudders may not turn to the required 35° in each direction. In this case, the heavy-duty eye on the rudder arm was within 1/4" (6mm) of the required position, which was considered close enough. The kit comes with detailed instructions and clear diagrams to assist with correct installation and, in this case, most of the measurements were so close to those of the original steering that little modification was necessary.

and measuring from the eye on the end of the shaft to the center of the mounting base on the cylinder. Transfer this figure to the mounting frame in the lazarette and measure



After cutting the plates to size, they were drilled, etch primed and epoxy coated to protect from corrosion.

The spacing plates and cylinder are placed in position and the fastening holes in the mounting frame are marked.



The fastening holes are then drilled into the mounting frame. Only two of the cylinder bolts pass right through the mounting frame. The other two pass through the spacers that overhang the mounting frame.

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For additional security, holes are drilled and bolts attached to either end of the spacers.



Once all holes are drilled, the cylinder is bolted firmly into position. We used Allen Head machine screws because they were onboard.



Finally, the eye connection between the rudder arm and cylinder rod is firmly tightened. A Nyloc locking nut prevents loosening under vibration.



Now route the piping using the messenger lines that were prepared earlier and make this a very quick and simple operation. The two pipes from the cylinder in the lazarette are the first to be run.



Piping soon appears through the access hatch in the head cabinet, ready for connecting to the tees.



Piping was originally routed across the transom but, for safety, we reversed the bleed valves on top of the cylinder so that the piping would clear the steering cross bar and avoid the possibility of chafe.



Fit and tighten the tee connectors behind the head cabinet.



Once connected the piping is routed across the lazarette forward bulkhead and held temporarily with plastic cable clips.



Connect the piping to the upper helm pump from inside the wheelhouse. The lower pump connects in the same way.

Once the equipment and piping installation is complete, replace all plastic cable clips with proper stainless steel P-clips fitted with anti-chafe grommets.



from the rudder pivot point along the mounting frame to give the position for mounting the cylinder.

Filling And Bleeding The System

Bleeding a dual station system is accomplished in two phases, beginning at the lower helm position. It's most important to ensure that the section of the system to be bled is completely filled with oil before starting the bleeding process. The system comes complete with a tube and fitting those



Reinstall steering wheels before beginning the bleeding process. Once air bubbles have stopped coming out of the helm pump (this may take some time), turn the wheel clockwise until the steering rod on the cylinder is fully extended one way.

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pump constantly topped up with oil from the container throughout the process to prevent air entering the helm.

Connect the bleed tube (supplied) onto the bleed valve at the end where the rod is extended and the bleed valve opened. Turn the wheel in the opposite direction to force air out of the system. It's vital to keep the helm



Once the oil is free of air bubbles, close the bleed valve and tighten. Bleed the other side of the system in the same way.

screws into the filler hole. The tube is connected to the oil container so that oil can run into system while air vents up the tube and into the container.

Fit and tighten the filler cap on the lower helm pump and follow exactly the same process with the upper helm. It was found, in practice, that small amounts of air remained trapped within the system after the bleeding was complete but when left for a couple of days the air found its way into the helm pumps. To purge the lower pump, slacken the filler cap and allow the air to escape under pressure from the oil in the upper helm. Simply topping up the system purged the upper helm.

Performance Comparison

It was interesting to note the difference in steering power between the hydraulic system and the old manual steering. While testing the system with the wheel hard over, we managed to bend the rudder stops that, for 30 years, had been more than adequate for use with the manual system. This meant beefing up the stops with additional angle sections.

The difference in steering performance is marked. There is now no play at all in the steering compared with 50° of free play on the old system. More noticeably, the steering is no longer a muscle straining exercise. In fact, the action is so light now that it's easy to steer with one finger. The owner's only comment on the subject was "wish I'd done it years ago!"

About the author: Peter Caplen is a mechanical engineer and British technical writer with nearly 30 years experience in building, maintaining and renovating mainly powerboats.



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