Marine bearings...
A how and why

Marine bearings are on Tim Findley's agenda this month

Like lots of marine engineering stuff, bearings retain their share of staunch and ardent traditionalists. And why not?

White metal, for instance, was the bearing of choice when the first steam rawler left Grimsby, England for Newfoundland's cod fish banks.

This was in the late 1800s. Surely we've advanced since then?

Of course we have – Pearse's (or Wright's) first flight hadn't got off the ground, back then.

Today we whiz around the world without a second thought. Neither Mr Boeing nor the Airbus folk use white metal. Why is marine engineering so slow in moving to modern materials?

Bearing up

Two reasons... Firstly, Grandad's bearing line gave no trouble, nor did Dad's. If it ain't broke, don't fix it. And secondly, while vessel purpose receives all the attention it deserves, there's no driver for propulsion engineering. As a consequence, engineering doesn't advance.

Take a tanker and a trawler as example. Both are a box, with a point at one end. We haven't endeavoured to improve the base design for a couple of hundred years. Accordingly, vessel speed is limited to hull speed.

Vessel purpose – the catching of fish, the transport of oil – is right up to date. The very latest of fish detection, catching, and handling gear is fitted. The tankers' enclosures are double- and triple-lined, with safety gear and systems constantly improved.

We don't try for tankers able to commute at 60 knots, or trawlers that'll whiz out to the grounds towing water skiers. Why?

Same reason airliners travel just below the sound barrier: commercial reality. It's too expensive to fly through. And hull speed is the marine equivalent.

So there's no reason to pursue improvements to the 'box with a point' concept.

Getting to the point

All right, but what's this got to do with marine bearings?

Well, it establishes the fact that there is an opportunity for a 200-year leap forward. First, let's establish a few facts about that most vital of marine bearings – the one that supports the propeller:

1. It needs to be thin walled, in order to keep its housing no greater in diameter than the propeller boss, otherwise it influences flow to the propeller.
2. It needs to be long-lived and tolerant of the marine environment as it is really only fixable in a dry dock.

Our forefathers, once they got away from "wood is good" mentality and started building in steel, came up with the oil-filled positive pressure stern tube still in common use today. They have served, and continue to serve, extremely well.

Generally speaking, in my working experience, the majority of stern bearing failures were occasioned in wooden vessels with a water-lubricated propeller bearing and grease-lubricated inboard bearing. The cause of failure was commonly blockage of water ways or misalignment of bearing seats.

Blockages are only discovered when they evidence a stuffed bearing by prop rattle. It's too cold and wet down there to inspect as part of the daily check. Alignment however, should evidence in checks.

It's that oily slick on the water that environmentalists are on about. Doesn't seem to bother the pelican, though!

Trouble with water lube bearings, open to the sea, is that they are vulnerable to stray nylon and marine growth. Failure requires dry-docking.

If the shaft's stiff to turn by hand (in a small ship), then something's out of line.

A big ship should monitor bearing temperatures, thus knowing immediately if all is not well. It's quite astonishing how hot an admiralty gland, for instance, can get if misaligned.

Water or grease?

The old admiralty pattern gland, still fitted to traditionally-built wooden ships, comprises a white metal bearing area and a packed gland. Sea water flows right up the stern tube into the bearing area, to be contained by the gland. This arrangement is grease-lubricated, from aboard, hopefully daily.

It's important to realise that this bearing should *do no work at all*. Think about this: There's a beaut roller bearing in the back of the gear box; and there's a big prop shaft bearing just forward of the propeller. Why do we need another bearing in the middle? Obviously a bearing at each end of the shaft is doing all the shaft support necessary. Yes, but we need to keep the sea water out.

And that should be the sole reason for the admiralty pattern gland. It *should not* be used to support the shaft. That is not its function.

The gland's white metal bearing is totally inadequate to act as a main bearing. The white metal area is simply to align the soft packing to the shaft. Relatively slight misalignment will rapidly evidence in a hot-to-the-touch gland even though cooling sea water is present. Bad misalignment sees the paint blacken and bubble followed by melting white metal.

Boy, I can hear some of the Port Propeller Persons seething with rage. "We've always treated the gland as the main inboard bearing!"

I know. That's why we have so many gland problems.

Read up the old mechanical handbooks. There's one by Babbit – him that invented Babbit Metal, a grade of white metal particularly suitable for bearings.

Four times diameter is recommended for support bearing. The admiralty gland bearing lengths are between half and one diameter.

Hull material issues

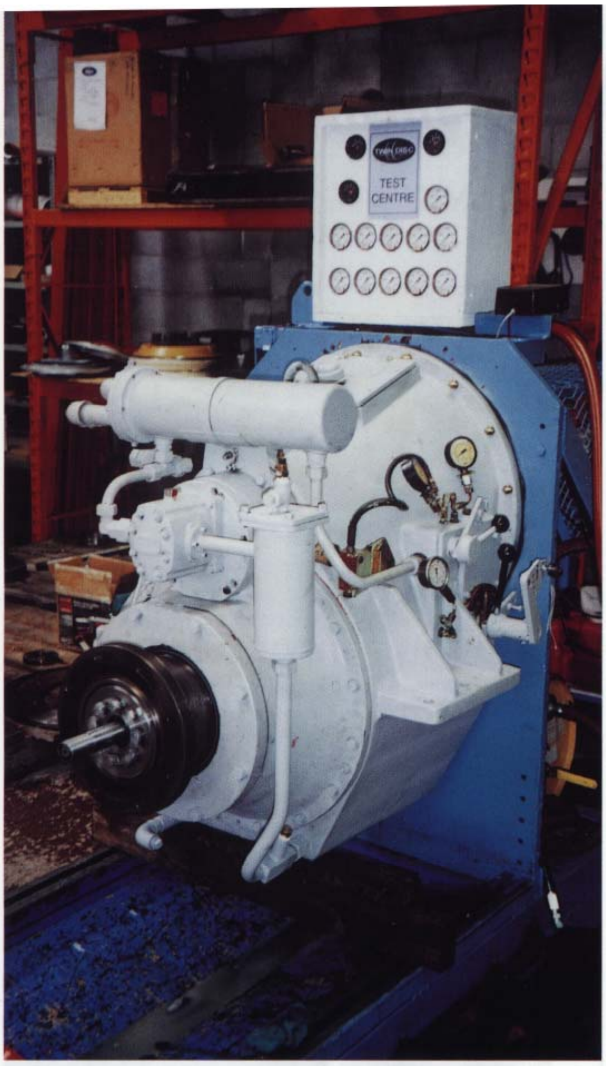
All right, but there are more small ships built of GRP and aluminium than steel these days. What do they use? A-ha. This is where a change of practice has forced engineers to rethink getting the shaft out through the hull.

GRP is easy. A heavy walled, immensely strong GRP tube containing water-lubed bearings and a modern shaft seal is glassed into, and becomes part of, the hull. It works so well as to have become the industry standard. The tube ID for its entire length is a standard off-the-shelf water lube bearing diameter. Accordingly, bearings may be placed anywhere the engineer requires.

Aluminium hulls firstly followed the steel boat practice of welding a stern tube in place, either water-lubed or sealed and oil filled.

Problem... Aluminium doesn't seem as predictable as steel, the welding process taking previously machined bearing areas out of line. Currently, aluminium builders are turning to the GRP tube methodology, locating it to the hull with special purpose resin.

From an engineer's perspective, the glass tube for both GRP and aluminium construction is superb. The engine can be installed and aligned – with shaft and tube set up - before pouring the resin. Couldn't be better. Bearing seat alignment is guaranteed.



One of our navy patrol boats' gearboxes on Twin Disc's test rig. Just forward of the coupling, inside the box, is the large thrust bearing that transfers the propeller's work into speed through the water.

Leaky stern tubes are something that's really not thought about, up here in the wheelhouse.

But still, looking back at steel ships, fitted with oil lube stern tubes that have proved themselves over and over again, why change? The environment, that's why.

To keep sea water out of oil filled stern tubes, we pressurise the oil. It's as simple as having the filler reservoir above the water line or as complex as a gauge and pressure pump system.

Propeller end problem

The problem is at the propeller end. The seal keeping the sea out, and the oil in, is vulnerable to the marine environment.

Greeblies, if the boat sits too long, nylon fishing line when steaming. Both will damage the seal, letting water in and oil out.

Good heavens, some ports around the world have the harbour masters licking their lips, and muttering about umpty thousand dollar fines, if they spy a teaspoon of oil coming from a ship alongside.

"Well, use soluble oil, or a synthetic that won't harm the environment." Fair enough – problem is that bearings are compromised. Oils emulsify, leading to bearing failure.

"Keep the positive pressure up, and water won't get in – it'll just mean the oil will require topping up regularly." Quite right. But that's the point. The oil gets out into the environment.

It's taken so seriously that many shipbuilders are turning to water-lubed bearings as the preferred methodology. There's a stack of papers on oil pollution for leaking stern tubes.

Some are shocking. Try Colin Sowman's "Stern Warning of Leaking Oil" in *The Motor Ship*, page 15. December 1999, where he suggests 50 percent of the world commercial fleet will suffer stern tube seal problems (leaking into the environment) over the next 11 years.

The US Coastguard, under the Oil Pollution Act, can hold ship owners criminally liable for *any* oil discharge. The UK has just hoisted their fine on summary conviction for oil discharge from £50,000 to £250,000.

Terrified? You bet. Some third world ports will view this as a legitimate way of increasing their revenue!

"So what's the answer?" Water-lubricated shaft bearings.

"Yeah, right. How long do they last?" That's the million dollar question. It's being answered for us, though.

Coming up 25 years on, Rolls Royce have been using water lube bearings in their giant water jets. Fitted to everything from the Swedish Navy's 73-metre stealth corvettes, to Techno-Seaway's Japanese passenger and cargo ferries, Rolls Royce jets have proved their worth.

So much so that oil company BP specified a water lube stern tube and bearing system for its four Alaska Class tankers built by NASSCO in San Diego USA. These ships carry oil on America's west coast, a particularly sensitive environmental area.

BP (and every other oil company) is right in the spotlight when it comes to environmental concerns. Stan Taylor, BP's technical manager comments: "The prop shaft is an area where, traditionally, some lubricating oil may leak into the sea. Even a small amount will leave a visible sheen when in port."

Easy answer. Go to a water-lubricated stern bearing system. But is there such a system that will give the faithful service an oil-filled tube practically guarantees?

Pollution control

Yes there is. It's been around awhile, but with slow acceptance without a driver. Well, the driver's arrived in the shape of pollution control.

Every major port has an expanding environmental office. And while I make smart remarks about "revenue grabbing", I do remember some of the Pacific ports we visited when sailing aboard our own boat. Some places where we were required to tie up, waiting for clearance, were so polluted as to leave a brown line right around our boot topping.

Anyway, there's the driver and here's the answer. But just before we explore water lube bearings, let's ask what's required of a stern bearing.

Not a lot, really, in the way we think of loading. Take a truck, hurtling along the highway with six or eight tonnes of payload. If it's a six-wheeler, there's a tonne or more per wheel, when stationary, on flat ground.

At 100kph the load doubles or triples as it sways. Shock from a bump may take the load up to 50 or 100tn momentarily. The point is, the bearings have to deal with the weight of the truck and its payload.

A boat is different. The water it floats on bears the boat's weight, laden or empty. The boat's main bearing carries *only* propeller and shaft weight.

Sure, that weight will double and quadruple momentarily, as the boat pitches, but this most important of bearings really has very little work to do in comparison with the truck's wheel bearings.

"But there's umpty thousand horsepower being delivered to the propeller, so the stern bearing must be stressed accordingly!" No.

All of that huge horsepower is being turned, from rotation to fore-and-aft thrust, by the propeller. This thrust, translated to boat speed or tow power, is dealt with by and on-board thrust bearing, which is nothing to do with the propeller shaft stern bearing.

So, in terms of work, the stern bearing has little to do at all – just support the prop, as it spins. Accordingly, water-lubricated stern bearings can be made out of almost anything that will handle living beneath the waterline.

There are melamine laminates that have been around for years, with common trade names such as Tufnol and Novasteen. Then there's a plethora of rubber bearings, the most famous of which is Cutlass. Add a few polyurethane ones such as Countrose and you've got bewildering choice.

They all work well – as they should since they don't have much to do. But with all these tried and true, off-the-shelf, stern bearings there's commonality.

But none of these types of bearings approach the oil-filled tube for reliability. All are subject to failure from marine growth, fishing line wrap-ups, and contaminated water.

So what's the answer? What's fitted to those Alaska Class tankers, fishing survey vessels, and now to every class of new builds around the world?

That's what we are going to get into next month, now we understand the what, why, and how, of stern bearings.