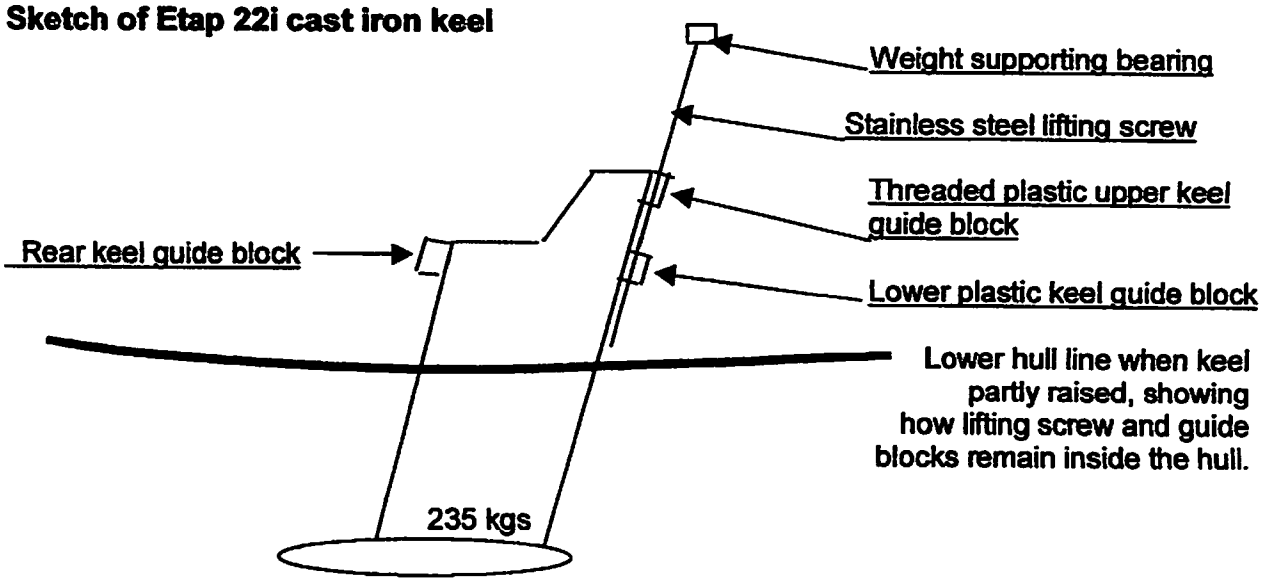
Sketch of Etap 22i cast iron keel



JEMIMA'S NEW KEEL GUIDES.

When Colin Haines found bits of plastic inside the keel lifting mechanism, he knew he had a problem.

When we bought Jemima, she was four seasons old, but looked like she was new, rather than seeking her third owner. Her retractable keel was silent when sailing - a distinct improvement on our previous boat, a Privateer, whose keel knocked continually inside it's housing.

Jemima's keel is located between a pair of semi-vertical tracks, with the 235 kgs of cast iron being supported by a long screw inside the forward track, with the upper end of the screw being suspended from a thrust bearing located inside the tabernacle. On one the side of the tabernacle is a hexagonal hole, into which a winch handle can be inserted, so that a bevel gear linkage to the screw's shaft can be operated to raise or lower the keel. The tabernacle rests on top of the keel case, which thus supports the compression load of the mast on the deck, and distributes both it, and the weight of the keel, out into the hull. There is every indication that the person who laid up the hull and keel case has shares in a glass fibre factory, as it looks like a lot of GRP has been used to build this part of the boat.

The down-side of a construction that fully encloses the keel, is that it is not possible to inspect the forward 'c' shaped keel guide channel, or check that the plastic blocks bolted onto the front of the keel have not worn it away. Nor, for that matter can one check that the plastic blocks are properly bolted onto the cast iron keel.

Another down-side of an inability to inspect this part of the robust assembly is more apparent when one is twenty miles out to sea, and becomes aware of the keel knocking. At first, it was an almost no-existent noise, but a year later it was definitely there, having slowly got worse. Bad enough for me to ask Mr Etap if there should be any noise. The reply was re-assuring, but this summer, the knocking was very obvious, and by the end of our Channel crossing summer cruise, there was definitely something wrong. Another worrying factor came to light when I extracted the lifting screw for it's end of season dose of lubricating grease. There were flakes of something stuck to it. Either sea-weed or plastic. A scorch test of one of the cleaned flakes, revealed that it smelt of nylon of some description. The only nylon near the screw is the nylon blocks bolted to the keel.

The last thing I wanted was to find was that the stainless steel lifting screw had stripped away the threads in the nylon block bolted to the keel. It meant that the keel would remain down permanently, which is not a good idea for a trail-sail boat.

There are other travel-hoists nearer, both to the East and West of our home, but when it came to dismantling the boat to find out what was failing, the lack of the resources of a factory,counted for less than the confidence we have in the Dinas Boat-yard. Anybody can lift a boat off her keel - The real test is positioning the hull perfectly to get the bits back together again. Perfectly means not only +/- o.5mm over the keel, but also precisely tilted to the same off vertical angle as the keel guides pass up through the boat.

The drawing shows that there are two blocks of plastic bolted to the front of the keel, and one at the back, with the bottom of the latter's guide being blanked off, so that the keel can never fall out of the bottom of the hull. This block can only be removed when the keel is fully raised, as the two holes in the keel case are provided for a socket wrench to line up with the block's retaining bolts. Or put more accurately, they did all line up when we first bought Jemima, but were nowhere near lining up when I un-zipped the neat padded plastic 'leather cloth' covering of the keel case. It required the services of a jack and baulks of timber under the keel to 'persuade' the bolt heads to come back into view properly. It confirmed that something was going amiss inside the keel case, and that for the first time, we would have to spend real money on the boat to investigate the cause.

At Dinas, I dismantled the gearing inside the tabernacle, and got the boat into a condition where lifting the hull would leave the keel behind on the trailer. Then the lift began, with the trailer being slowly moved to accommodate the diagonal movement of the keel moving backwards whilst the boat moved vertically upwards. The moment the lower plastic block appeared, one reason for the knocking became obvious. Instead of being attached to the keel by two bolts, there was nothing other than a notch in the cast iron keel holding it in place. Time, and the passage over many waves, had seen the swinging keel slowly tear it's way through the loose plastic with each roll of the boat.

The upper plastic block is threaded for the lifting screw, and when it came into view, the reason why I had to use a jack under the keel became obvious. One of the bolts had become loose, and undone itself to the point of leaving a 6mm plus gap between it and the keel. The lower one had also lost interest in being tight, and with nothing to position the block properly ,it was easy to see why the lifting screw was stripping away the threads inside the plastic.

It is impossible to explain with 100% confidence why Jemima suffered this potentially catastrophic failure. There are some clues though, hopefully enough to help ensure that it does not repeat itself.

Once out of the boat, it looked as if the entire surface of the keel was rusted, yet most of the brown was easy to clean off, and revealed a surprisingly small amount of rust generated by nine years experience of salt water. Before I was ready to re-spray everything with zinc paint, I had my first clue as to why the mechanism had failed. There are four bolt holes in the front of the keel. Two for the top plastic block, and two for the lower block. Three of them were in line, and the fourth one at the top was off-set by about 2mm or 3mm. The lower pair of holes were cut straight into the cast iron. The upper holes were threaded steel inserts. The lower holes had first looked as if the bolts had snapped off inside them, which left me with the unpleasant prospect of extracting the hard stainless steel remains without damaging the soft metal of the expensive iron keel. The good news was that the bolts had fallen out so long ago that the holes were actually filled to the brim with a mixture of rust and mud. The bad news was that a lot of the rust had once been the screw threads.

The second clue came when I discovered from the Etap Agent - North West Yacht Sales - that new plastic blocks supplied by Mr Etap do not come with slotted holes in them. In other words, somebody had, at some time in the past, offered up a standard part to the keel, then decided to modify it to accommodate the off-set hole. It is anybody's guess as to why the hole is off-set, as it is obvious enough to fail Mr Etap's otherwise apparently entirely paranoid quality control systems. (Prior to finding this, I would have said the boat's entire 'Constructional Faults List' comprises one badly applied pop-rivet inside a cabin locker.)

Not being satisfied with modifying the standard part by slotting a few millimeters out of the side of one hole, to accommodate the mis-positioned hole in the casting, that somebody decided to widen both sides of the holes in

both the upper and lower plastic blocks. I hate slots. When a bolt head is tightened down onto a slot, the washer under the head only rests on less than a quarter of the material that has been slotted. When that material is a plastic, like Nylatron GSM, which is what it appears Mr Etap used to make the guide blocks from, it is easy to deform the plastic. And with it, the washer clamped onto it by the bolt head, Just as happened with the lower blocks on Jemima's keel, which still had chips of broken washer imbedded in the deformed material. Then, as the bolts no longer gripped the plastic, each roll of the boat let the sides of the slots simply unscrew the bolts. Witness marks show the history of this. As I said, I hate bolts in slots being used to hold dynamically loaded objects together.

Returning to Dinas with some unmodified Etap parts, I assumed that apart from dealing with the one mis-positioned hole, everything would fit together again, and we would be on our way home in a few hours. Nothing went together properly In fact, I suspect that the same gentleman who routed large lumps out of innocent bits of plastic, also discovered that when bolted to the keel, the blocks would still not line up properly with the guides inside the keel casing. Just as I did. Which brings me back to Mr Etap's paranoid quality control. I suspect that, despite having tried to rectify the error of the mis~drilled hole by using inserts, further work on the casting was abandoned in favour of returning it to the foundry.. I hold this opinion because the cast faces that the blocks clamp onto do not position the blocks correctly. A straight-edge, duplicating the guide track, and clamped to one block should touch the matching face of another block. Only it did not. In fact there was no relationship between any of the faces, which were also twisted relative to each other as well. Assuming the original moulding pattern was good, the deformed faces could be created in a badly prepared mould.

It is not the first time I have met such a situation. Forty years ago, I served an Apprenticeship in a factory building printing machines. It had a foundry, and castings would be roughly machined prior to being delivered to the fitting shop. There wasn't such thing as precision CNC milling in those days, that came ten years later. Fitters were expected to file components flat and true to a thousandth's of an inch accuracy, so-they operated perfectly. Standing in the side of the boat- yard shed, I had a file, and could remember well enough the shoulder aching job of filing cast iron, needed when the machine shop had left more than a few thous' to remove. In fact, when I had cleared the rust and the remains of the original rough cast surface of the keel face, it was clear that anything up to a couple of millimetres had to be removed in some places.

A passing sail maker asked what I was doing, and suggested I bought an angle grinder from a nearby B & Q shop. The car's boot was filled with all sorts of kit, but because angle grinders had cost about £80.00 the last time I looked, I had never been interested in buying one. The sail maker was the hero of the day, because he said B & Q's own brand cost £17.00. Cheaper than renting one! Five minutes later I followed him out of the boat-yard, because he was going to pass B & Q, and I was a stranger in the area.

The angle grinder eased the task of my office worker's muscles brilliantly. Kissing the spinning disc against the iron could never produce a flat face, regardless of how carefully I did it. The effect I sought was a shallow 'trench'. It was then much easier to 'make good' the surface between each grinding, as it took a lot less use of the file than cutting away all the metal by hand. All I had to do was remove one side of the 'trench' to re-orientate the new flat surface towards where it should be. The real time consuming task was the lack of a datum to work to. The only option I had was to alter one face a little, attach it's plastic block, then measure the positional error relative to the other block two blocks bolted to the keel. Each small change on one face, allowed the other one to be altered to bring the straight edge closer to the correct line. By the time the job was almost finished, it was dark. Spending the night on board the boat was not part of the plan, but it did mean I was beside the job when it got light again.

The angle grinder also had another use. I had brought with me some penny washers, intending to file one of them down to size, when I knew where the edge of the slotted hole would end up, so that the bolt's grip on the plastic would be better spread.

Locking the angle grinder in a vice, and with a penny washer clamped onto a bolt held in the chuck of a pistol drill, the washer could be spun against the angle grinder. Quicker than filing, it also produced a perfectly true circle. Conscious of time passing, I pressed the spinning edge of the washer harder than normal against the 10,000 rpm cutting disc, and discovered a new metal forming process. Some of the stainless steel was ground away, but more was folded over, so that the penny washer gained a raised rim. The result was a piece of metal that could be made to be a perfect fit inside the circular hole in the plastic block Mr Etap had provided for a socket head spanner to

reach the bolt head. Any tendency for the plastic to deform under the compression loading, and let the bolt's grip be reduced would be eliminated. Even the block did want to slide, the bolt's perfect location inside the larger hole would prevent that happening. Even repeated applications of the loading would not see the edge of the penny washer cut into the plastic, because my new metal forming technique had made the edges so much thicker.

Pleased with finding a means of locating the plastic against the smooth cast iron face that did not just rely on clamping friction, I rapidly created a set of four. (Plus one scrapper produced when I over enthusiastically reduced the diameter a bit too much.) A rat tail file let me make the bore' of the washer have an exact fit on the shank of the bolts. The washer for the mis-located hole simply had it's circular bolt hole moved off-centre.

I had brought some longer bolts with me, expecting to find enough thread in the lower two holes to grip them. It was not to be. Partly torqued up, the remaining parts of the threads failed. The only answer was to deepen the holes, and extend the threads, so a pair of even longer bolts could be used. Which was when I discovered another possible reason for Mr Etap abandoning work on the casting. I only had one drill bit, and once again I had cause to be glad I had purchased the angle grinder. There was a hard spot in the iron, where some sort of inclusion rapidly blunted the drill. A quick whiz of the angle grinder re-sharpened the drill, and it cut through a little bit further before blunting again. I was not going to let the inclusion steer the drill.

It took me back to the days of my Apprenticeship, as hard inclusions in cast iron were not unknown, along with their ability to steer a drill miles off course, creating elliptical holes. As were drills that wandered off course when first starting to cut. My solution was to finish off the hole, thread it, and then look over my shoulder to check the foreman was not looking. If he was at the other end of the shop, in would go a soft mild steel bolt, as far as possible, until further turning sheared off it's head. A hack-saw and file then removed all sign of the protruding bolt, and provided a good flat surface to re-start the job properly. Quite why somebody chose to use threaded inserts where the hole in the keel was wrong is not obvious. However, it did have the effect of stopping me moving the hole, as did a lack of mild steel bolts - these days they are all made from high-tensile steel. Drilling down the side of a strong steel bolt inside soft cast iron would, at best, see the drill move off course, and possibly even break off the tip of the drill in the hole. I had nothing in the back of my car to deal with extracting a broken drill bit.

I do not know what standards are common in the boat building industry, but when the two plastic blocks were finally assembled onto the keel, they were sitting on perfectly flat iron faces that are as identically orientated as any CNC milling machine could make them. The difference is that a CNC miller would take a few minutes to achieve the same result as I achieved in four hours with the aid of an angle grinder, smooth faced files, hard-steel ruler, long straight-edge and a handy bit of triangular metal with a perfectly square corner. Had the foundry taken a little more care when preparing the original mould, none of the work would have been needed. Victorian iron-casting techniques were capable of producing enough accuracy for the plastic blocks to have gone straight onto the keel without any machining being needed.

I have never attempted to stop a cast iron keel from rusting. In fact, because the application of zinc paint was mainly cosmetic, and I assumed the parts would fit, I did not initially expect to damage the remains of the effective anti-rust treatment Mr Etap had applied to the iron. Thus, there was only the can of zinc paint in the car. As well as a tube of silicone, and some 'Thread Lock', which works by hardening when it comes in contact with the element iron.

My attempt at anti-rust treatment had to be done with the materials at hand. The bright iron face is now protected by a layer of zinc paint, dried quickly by the cooling air blasted out of the angle grinder's motor. The paint is protected in turn by a generous application of silicone sealant, applied once the bolts had been screwed in far enough to reach the thread-lock compound. I doubt if the Nylatron will relax under the compression load of the bolt heads, because it is spread over a wider area by the penny washers. If there is any attempt to move, the fact that the washers are a tight fit in the holes provided for the socket wrench, will eliminate all possible movement. So I hope the silicone will remain undisturbed, and protect the zinc paint. More importantly, the silicone will hopefully keep water away from the screw threads in the iron.

Re-assembly of the boat back onto her keel required a lot of precision handling of the travel hoist. This is because the plastic blocks are now a good sliding fit in their guides, and the boat had to descend perfectly in line with the keel. It would be very easy at this stage to have the

track at the wrong angle, and as the boat descended, tear the plastic blocks off the keel. I suspect that who-ever put the keel into Jemima the last time would have encountered big problems at this stage. The fact that the cast iron faces the blocks were clamped onto were twisted relative to each other, would mean that the guide blocks would decline to enter the guide tracks. Or more accurately, the upper block might have gone in, but the lower block would have refused to enter the hole. The temptation would be very strong to slacken off the bolts, so that the block would be free to find the right position to enter the track. Having done so, the bolts could be re-tightened.

With most of the plastic cut away by slotting the holes, the result of tightening bolts would be that the small bit of plastic remaining under the bolt heads would be easily deformed. This would get worse as the block was forced further into the right orientation by the rigidly located guide. Given time, and by that I mean months, deformed plastics 'creep' or 'relax' under load. The result is that what was once a tightly gripping bolt, enforcing the deformity, slowly becomes a lesser grip with the passing of time. And, as it is the grip of the bolt that stops it's head sliding sideways along the slotted hole, the result is inevitable.

It took the best part of an hour to slowly lower Jemima onto her keel, repeatedly using a straight-edge held against the rear keel guide track to ensure she was precisely orientated all the time. Towards the end of the operation, I was knelt on the deck, peering intently down through the tabernacle, to where the top of the lifting screw should appear. If all my filing and measuring was correct, the end of the screwed shaft would appear in the centre of it's support bearing. If it did not, then the error would have to be measured, the keel removed again, and yet more grinding and filing true take place. Or making slim packers to make up for my removing too much metal. You may imagine my feeling when the shaft came up out through the hole, precisely where it should be.

After re-assembling the gear mechanism, so that the lifting screw could once again take the weight of the keel, I had a pleasant surprise. The handle went round much easier than I recall it ever did before. So much so, that I did not think the keel was going up as fast as my wife, who was watching from the ground, claimed it was rising.

It is reasonable to wonder how it is that Mr Etap sold a boat with such a defect. The quality of the rest of the workmanship on the boat is so good, that I doubt if it was originally intended to use the casting. Possibly, somebody placed the reject in the wrong place, and it got passed into the assembly shop. Then faced with the task of making it fit, perhaps the worker it was issued to was old enough to remember his pre-CNC skills with shims and packers. After that, one can only speculate why the original parts were replaced with new standard parts, ones that were incompetently modified with the aid of a hand-held router. Guessing from what caused some of the other witness marks, it seems that an angle grinder was also used in an attempt to get one of the blocks to fit better against the keel. I doubt if the keel was removed to apply the anti- fouling that remains on the plastic. Perhaps a previous owner had complained about the keel being difficult to raise and lower. Who knows?

It is a thought that comes with now having correctly orientated parts, and the single experience of moving them in their guides, giving me the impression it is much easier to move the keel than before. Taking the boat to a lake, the following week, I was able to check this impression. We use a 12 volt portable drill, with a bit of stainless steel hex bar in it's jaw, as a substitute for the winch handle. Previously, the drill got so hot that it began to smell of burning before the keel was half-way up. This time it managed the whole job, and did not smell particularly hot afterwards.

It would be nice to know who did such a shabby bit of work on Jemima, if only to point them out to other readers as a place to avoid. However, it is not possible to do so, as we have had Jemima for five years now, and with luck, they may well be out of business. It is probable that I made a greater effort than needed to obtain a much higher degree of precision than is necessary. But, I knew I would have to pay for the boat to be lifted off, and then tried back on
again if the parts did not fit. My time cost nothing - it was better to be overly precise. A temporary up-side of the high precision was that there was a maximum possible clearance to slide Jemima back onto her keel. No matter how skilled it's operator, a travel hoist remains a machine whose designers did not intend it to be used to position a boat within a fractions of a millimeter of accuracy.

The previous worker, who presumably claimed to be a professional with an adequate selection of tools and an understanding of boats, could have achieved 90 % of my accuracy in a fraction of the time that I spent. Prior to starting the task, I would have made no claim to have a detailed understanding of keel lifting mechanisms. Nor did I

have the right tools. Now it is all together again in the boat, I suspect that a 90% result could have been good enough, provided he had not stupidly slotted all the location holes in the plastic.

I have no idea what to advise readers who have to trust somebody to undertake work that can not be inspected. Whoever did the work on Jemima's keel breached that trust badly. I am fortunate to have the skills, knowledge of how materials behave, and had enough substitutes for the tools needed with me at the time. If the work now turns out to be wrong, I know exactly who to blame. One positive point, as far as I am concerned, is that having got to study the bits of the boat's construction that are normally impossible to see, my opinions of Mr Etap's boat building techniques have gone up another notch or so. I have long since got over parting with a lot of money for an expensive boat, now I just have the quality to enjoy.