CROWN WHEEL MAINTENANCE

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The following assumes that the keel on your 23i is constructed in the same way as the 22i. It probably is, because it is an effective design.

You do not need to drop the keel out of your boat to change the crown wheel. The whole assembly can come out through the tabernacle, once the mast is out of the way, and the boat is resting on it's trailer with the keel supported at any convenient height it happens to be at. (I do this each autumn, when I re-grease the lifting mechanism, and it is all quite straight forwards. The boat is on the trailer, and the mast is moved onto the fence round our patio, prior to taking the boat away to a caravan park for winter storage. I don't fancy finding some oaf has bent the mast because he can't manoeuvre his caravan properly. Not when Mr Etap wants the best part of a £1,000 to get a replacement onto the boat, ready to use.)

You will find four small cross headed screws at the front of the tabernacle, and two at the rear, all apparently holding a cover plate in place. In fact the inner pair at the front hold the keel counter's bracket, but as it also has to come off, all six screws need to be removed.

That will expose the plastic crown wheel.

The pinion is held onto the side of the tabernacle by three bolts holding a circular black plastic flange. Remove these, there is no need to remove the circlip, or risk the habit that circlips have, of pinging off into the wide blue yonder when being removed with a screw driver, rather than the right tool.)

You will then see two M12 nuts holding a horizontal stainless steel plate on the inner stiffening web of the tabernacle. (One port side forward of the crown wheel, one starboard side aft of the tabernacle, if I remember correctly.) Remove the two nuts. This will allow the plate to be lifted up off the stiffening web. There is a thin plastic packer underneath, probably provided to limit galvanic corrosion. Mr Etap seems to take a lot of care on this topic.

Use your fingers to turn the crown wheel anti-clockwise. Turning the crown wheel will cause the 20mm dia x 5mm pitch Acme threaded keel lifting screw to rotate in the threaded plastic block, which is bolted to the keel face. Screwing this out is as wearisome as winding the keel winch handle, and brings with it the plate you released when you took the two nuts off. When about 3ft of the screwed rod is projecting out of the tabernacle, like a mini mast, give it a waggle. This checks the state of the screw threads in the plastic block attached to the top of the keel. It also checks that the block is attached to the keel.

Be paranoid, but not so paranoid as to decide to remove the keel un-necessarily. Getting it out needs a travel hoist to lift the boat off the keel. Putting it back needs a highly skilled hoist operator, with bags of patience to align the hull exactly (+/- 1/2mm) over the top of the keel. Several hours of travel hoist time do not come cheap. (See attached draft account of the procedure.)

I do not know what arrangements were made to hold the plastic crown wheel in place on the jack screw. The one on my boat is made from stainless steel, and is threaded like an M12 nut. This engages with a matching M12 thread on the upper end of the lifting screw. A M6 (poss M5) screw passes down between the crown wheel and the screw jack, so that half it's thread is in the crown wheel, and the other half in the screw jack shaft. This acts as a key, to prevent the crown wheel being undone, instead of the screw jack turning and raising the keel.

Located inside the crown wheel is a 16mm thrust bearing - made from carbon steel - that transfers the weight of the keel onto the tabernacle's stiffening flange. I strongly recommend you replace this, as if you have not done so before, the ball tracks will be corroded, and on their way out. Indeed, corrosion may lead to stress cracking, and knacker the thrust race, which is working near it's upper rated load capacity. Stainless steel thrust races cost about five times carbon steel.

(Thrust bearings are available from bearing stockists - use Yellow Pages. Bearing Services - BSL - will able to sell you one. As will smaller bearing stockists at a lower price. Bearings are sold to OEMs at list less 70% or 80%. Joe Public might get charged full list price. Memory tells me it is a 16mm bearing, so don't take my word for it. I will be dismantling the keel lifting screw this week-end or the next, and can confirm it then, if necessary.)

Located under the stainless steel plate that the thrust race sits on, is a bronze top hat bearing.
This serves to locate the screw jack shaft in the plate, and, as it sits on the shoulder where the 16mm dia of the upper end of the screw jack shaft increases to 20mm, it supports the weight of the boat when it rests on it's keel. It is not rated to support the weight of the boat, and rotate as well.

The thrust bearing cracked on my boat - corrosion fatigue - and I had to fit a new one. To protect it from salt water, I made a gaiter out of rubber sheet, which fits round the hub of the crown wheel. Talking to another Etap 22i owner - a retired CDT teacher, he came up with a better idea, and cut a gaiter out of an old bike tyre inner tube. We both had the same design objective, which is to allow the bearing to be packed with grease, and sealed against the ingress of salt water. Use Duckhams Keenol grease, as it has a high film strength and reasonable anti-corrosion properties.

I commend you to think of making a gaiter yourself, which will be trapped between the bearing support plate and the underside of the crown wheel. Make it about 1mm longer than the space available, so that the end is forced to retain contact with the stainless steel plate. This also allows for the fact that you can not cut it precisely to size. When finished, it will spin in a puddle of grease - see assembly comments below.

It is possible that Mr Etap will supply the new crown wheel threaded M16, so that it screws onto the end of the jack screw. However, he can not drillit for the M6 locking screw, as he can not know where your locking screw hole lies in relation to the place where the crown wheel 'bottoms out', when screwed up tight onto the jack shaft. Nor can he know where the threads of the M6 screw actually start.

Were I to be faced with the task of making the new part fit, I would acquire a stainless steel bolt with a matching M16 thread to that on the screw jack - there are two M16 thread pitches - and then use the bolt as a machining tool. Firstly, I would put the new crown wheel on the jack screw, and twiddle it round until it would go on no further - finger tight, no more. This will tell me where the locking screw has to go, and let me mark off it's position on the crown wheel.

Then I would put the crown wheel onto the new bolt, and with the whole lot locked up in a vice, drill down between them, so the hole was half into the bolt, and half into the crown wheel. (If it is an M6 screw, the suitable size drill is 5mm dia, or if M5, it is 4.2mm dia. Don't bugger about hoping that a 4mm drill will suit, it won't, and you risk breaking the brittle tap - buy the correct one, which any Engineers stockist will sell you. At the same time as buying a new drill, also buy some drilling compound, as stainless steel is good at blunting drills If this happens, the metal will surface harden under the drill bit before you realise that it has stopped cutting. The first you will know is that the end has gone blue. If it does harden, you have problems, but I have a cheap solution that has always worked so far.

The last item on your shopping list is a pair of taps. One is a taper tap, and the other a plug tap, which match the threads in the flank of the jack screw for the little locking screw. If you are not sure what thread form it is, take the locking screw with you to the Engineers Stockist, and ask for a pair of taps to match. I assume you will have a small spanner to grip the square ends of the taps to turn them in the hole. Quarter inch socket sets usually come with three sockets with octagonal holes, rather than hexagonal holes, and with luck one will fit onto the square end of the tap.)

With adequate tools to hand, you can drill the right size hole through the crown wheel and scrap bolt, remembering to use the cutting paste. (Smear a glob onto the end of the drill.) Remember also to use a good deep centre punch mark to stop the drill from wandering away from the right position. If you have any doubts about your ability to drill at precisely 90 degrees to the top of the crown wheel, ask somebody to watch. Ie, you can see that the drill is square-on from one direction, and your assistant watches at 90 degrees to you to make sure you are square on from the other direction. If you want to practice before hand, buy a stainless steel M16 nut, and try drilling half-and-half down the flank of the bolt. You have a long way to go without straying.

If practice does not make perfect, then take the crown wheel and jack shaft to somewhere with suitable kit to do the job for you. This has the advantage that, if the contract machine shop wrecks your bits, they will have to pay for new ones from Mr Etap. (Actually, making good would be cheaper and easier.)

With the hole cut though both bits of metal, half and half, you can remove the crown wheel from the bolt, and transfer it to the jack screw. You will now have two half holes that line up when the crown wheel is screwed onto the jack screw. One half is already threaded, the other is plain. Using the taper tap, carefully get it to engage with the threads that already exist in the flank of the jack screw, and give it a full turn. Then remove it, and check all is well, as this is the moment when you can set yourself up for buying a new jack screw. The last thing you want is for the tap to re-thread the sides of the jack screw.

If all is well, apply cutting paste to the taper tap, and try two more complete cutting turns. Then check again. If all is still OK, clean the paste and tiny bits of swarf off the tap, apply more paste, and try three more turns before checking. After that, if all is OK, you can run the tap down to the bottom of the hole. Then finish off with the plug tap, because the taper tap will not have made a long enough thread.

If you have never used a tap before, remember that the tap is very brittle and will snap if you try to bend it at the same time as twisting it. The other rule is 'two steps forward, one step backwards'. After a couple of thread cutting turns, reverse the direction. This prevents a long spiral of swarf building up inside the hole, which will jam the tap when you try to extract it. If in doubt about swarf build up, remove the tap, clean it, and carry on for a few more turns. Doing the job takes less time that writing about it. Extracting a broken tap can be the very devil of a job, especially when the hole is half bunged up with bits of swarf. Adding an extra five minutes to the task, because of keeping the tap cleaner than necessary, is much better than finding the tap has become jammed in the hole, and won't go backwards.

Once you have finished the job, and wiped everything clean, you are in a position to re-assemble the bits. In effect, you are now doing what you should do once a year as part of the autumn maintenance - I am assuming you use the keel lifting facility as much as we do, which is perhaps twenty times a year, if not a lot more.

Having bought a tub of Keenol grease for the thrust race, the same stuff can be used liberally on all other parts of the assembly. Acquiring disposable gloves - garage forecourt - helps keep the hands clean during re-assembly.

1) Wipe the jack screw clean - a boring tedious job, because there is about four foot of threaded shaft to clean, and get bright and shiny in the roots of the square threads. (Look at what you are removing, lest you find flakes of plastic = bad news.)

2) Apply a liberal coating of grease down the full length of the squeaky clean jack screw. Most of this is not going to pass through the threaded plastic block bolted onto the keel. Some will fall off, and become a lubricant between the keel blocks and their aluminium guides. More will end up as a reservoir to slowly slide down the jack screw, and refresh that which gets washed away by water swirling around inside the keel case.

3) Prod around inside the keel case with the lower end of the jack screw, and find the entry to the plastic block, and screw the jack screw down through it. Another wrist aching job.

4) At a convenient height, stop screwing the jack screw back into the tabernacle.

5) Place the bronze top hat bearing on the jack screw.

6) Drop the plastic packer down over the jack screw, and over the two bolts projecting out of the tabernacle stiffening plate. Swear mildly, because it's the wrong way round, remove, turn it over, and try again.

Clean the rectangular stainless steel plate, and hold a straight edge against it, to make sure it is flat. (On my boat it was not, which probably contributed to the breaking of the thrust race.) Drop the cleaned plate over the jack screw, copying the way round the plastic packer is, and get the top hat bearing to engage with the hole.

7) Place one of the thrust bearing rings onto the plate, with shiny ball track uppermost Place the ring of balls onto the race, and use a blob of grease to hold it in place. Then put the second race on top of the balls. Another blob of grease keeps the assembly in place.

8) Remove all traces of swarf from the crown wheel. Fit your home made gaiter round the hub. Fill the entire hollow with grease, avoiding any air pockets if possible. This is far more than needed - the excess will get squeezed out later.

9) Screw the crown wheel down onto the jack screw, and observe how a ring of grease appears round the edges of the gaiter. Leave it there. It's part of the bearing's defence against rust provoking salt water. Check that the stainless steel plate spins freely when the crown wheel is fully screwed onto the jack screw. If in doubt, remove it, and re-position the thrust bearing's components, and try again.

10) Insert the locking screw into the crown wheel. Nip up tight.

11) Continue with winding the jack screw back into the boat. Wrapping some paper or soft cloth round the crown wheel will reduce it's ability to shred your fingers with the sharp ends of the teeth.

12) As the jack screw moves into the boat, a point is reached where the stainless steel plate has to be held still, so that it's two location holes line up with the two studs projecting from the tabernacle stiffening plate. (It's at this moment you are glad you put the plate on the right way round.)

13) Keep on turning the jack shaft until it tries to lift the keel.

14) Replace the two M12 nuts that hold the stainless steel plate in place. Nip up tight, as when you dry out, almost the whole of the boat's

weight is hanging from these two studs. Don't worry, they are well over the top in terms of tensile strength.

15) Pick up the pinion assembly, and give it a good cleaning. Finish off with applying some thin oil to the gap between the bronze pinion shaft and the black plastic. The objective of the oil is not to lubricate the self lubricating plastic, but to discourage sea water from drying out into abrasive salt crystals.

16) Bolt pinion assembly back onto the side of the tabernacle. There should be a little 'play' between the pinion's teeth, and those of the crown wheel.

17) Pick up the keel counter, and make a note of the number. Wipe it clean, and apply good glob of grease to it's shaft between the sprocket and plastic body. Turn the shaft around a bit to encourage the grease to enter the shaft hole in the plastic. Leave the rest of the grease on the shaft, as this will discourage salt water from entering, and wrecking, the steel bits inside the plastic housing.

18) Roughly re-position the keel counter, so that it's sprocket teeth engage with the crown wheel's teeth.

19) Use the keel raising winch handle to spin the crown wheel very slowly, and check that crown wheel's teeth engage with the pinion properly for at least two turns. When the crown wheel was made of plastic, the bronze pinion teeth could deform the plastic teeth slightly, and thus produce a good contact face over the full length of the teeth. Stainless steel will not 'give' like plastic, and if the pinion is not correctly aligned, the softer bronze will be stripped away rapidly. (The debris looks like golden finger-nail clippings.)

20) Use the keel raising winch handle to spin the crown wheel, and allow you to correctly position the keel counter. Make sure that the number in the window is the same as you first saw when you finally nip up the location screws.

21) Apply a generous to excessive amount of grease to the crown wheel's teeth. Wind the winch handle to spin the crown wheel, and spread the grease into the tooth pockets with the pinion. (The bronze pinion is working at around it's maximum bearing pressure before excessive wear takes place, now that it is up against the unforgiving faces of the stainless steel crown wheel's teeth. Anything you can do to ease the life of the pinion will be greatly appreciated by the soft bronze. Hence also, the liberal greasing of the whole length of the jack screw, as it will help the jack screw turn more easily in the threads of the self lubricating plastic block. If it turns more easily, the bronze pinion's life is easier. There is always a weakest component in every structure or mechanical system, and in this case it's the teeth of the bronze pinion that will wear the fastest.)

22) Content that the keel counter is properly engaged with the crown wheel's teeth, and there is a surplus of grease to help the bronze pinion, you are just about ready to replace the cover. All you need do is wipe the window of the keel counter clean.

23) Replace the cover, and use a bit of grease on the screws to help prevent the aluminium threads in the tabernacle from corroding, and making future access difficult.

24) Apply a piece of transparent water-proof Sello-tape over the hole in the cover plate that you squint though to see the keel counter. The transparency of the tape can be improved by sticking it to a small square of transparent plastic, cut from a bit of packaging material. The objective of this is to stop water getting to both the keel counter and the thrust bearing. If the thrust bearing cracks, the effort needed to raise the keel increases considerably, and the bronze pinion starts shredding bits of it's teeth. If you think of how the wind can blow sea water onto the fore-deck when going to windward, you will realise how much salt water could be showered down onto your expensive keel raising kit. Five minutes of snipping up a bit of thin transparent plastic does a lot to keep the kit dry.

(Don't use Scotch tape for the window pane - I find their products are cheap copies of Sello-tape, and rapidly fail.)

25) Wind the keel up and down a few times as far as it can travel, being very aware of any change in the amount of effort required.

26) Wash hands thoroughly whilst contemplating a pint of beer.
I hope these thoughts help.

Colin Haines will be pleased to advise further. Please E-Mail clanderlaw@btinternet.com