

## 8: INSTALLING THE REVERSING ROLLERS

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Wash the unit with soap and water to remove any CRC and dirt.  
Rinse and place each hole under the tap to ensure they are scrupulously clean.

Match 3 Roller & Screw sets to ensure they are operating correctly and most importantly that a flat protrudes  $\sim 0.015''$  from the base of the screw upon which it can pull up whilst leaving the roller free to turn on the shank of the screw.

**Grease the screw shank to prevent Loctite™ penetrating post assembly.**

Mount the boss again in the vice surface protected with the first hole vertical.

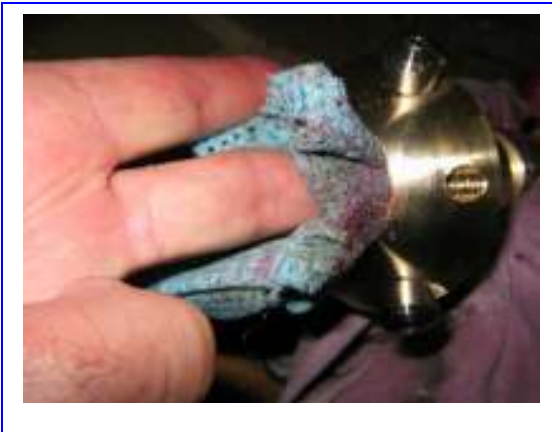
Obtain the Loctite™ from the fridge and squirt a drop ensuring it goes right around the thread inside. Wipe off any on the top surface as it will bind with the roller. Insert a rag in the nut recess to ensure no Loctite runs into the inner recess where it would interfere with the nut clearances. Wipe off any surplus.



Smear a small coating of grease into the reverse roller surfaces that interface with the screw.  
This will prevent the Loctite™ causing the reverse rollers to bind together later

Holding the roller up on the screw to prevent it catching under the lip insert the screw using a ball headed Allen Key. At the end of the thread mount the long handle of the Allen Key and quite firmly but not over stressing - turn the screw so that the shoulder pulls down firmly onto the ground surface.

The screw will go very tight quite quickly when this occurs.  
Check at this stage that the roller is turning freely.



**TORQUE TO 10 Nm with a TORQUE WRENCH - DO NOT TIGHTEN WITHOUT A TORQUE WRENCH**

**CHECK THE CONTACT SURFACES WITH THE BLADE CARRIER VERY CAREFULLY TO ENSURE NO BURRS**

**REMOVE WITH A FINE RIFFLER FILE IF REQUIRED.**

**STORE SO NO DAMAGE CAN RESULT TO THE BOSS UNTIL FINAL ASSEMBLY.**

Wipe any excess **Loctite™** from the inside to prevent it running down and interfering with the taper or spline when it hardens and is very difficult to remove.

**NB: Ensure there is no Loctite on the flat which will seep into the roller set and very effectively lock the roller onto the screw and prevent it rotating when engaging the reverse function.**

Repeat for the other 2 screws.  
Check again that all rollers are still turning quite freely.

**At this stage insert the 2 M8 x 10 SS 316 Locking Socket Screws into the boss and screw in sufficiently so that the heads are below the spherical surface and will not interfere with the blade roots when they are installed.**

The boss is now ready for the next step in assembly.

**NB: Any attempt to move the position of the rollers will result in a failure of the unit to operate in reverse from insufficient leverage about the pivot.**

**This distance also sets the reverse pitch.**

**To prevent reversing overload situations the solution is to reduce the diameter of the propeller.**

**In extreme situations small Pozidrivs can be inserted to limit the reverse pitch.**

**NB: Once set the rollers can only be removed with heat from a gas torch. Any attempt to remove them without heat will simply result in the screw twisting off and the loss of the boss.**

**NB: REFER DRAWINGS MANUAL FOR SPECIFIC DRAWINGS OF ROLLER REGISTRATION ON BOSS**

## 9: SELECTING THE SPRING

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**LEFT HANDED** Propellers use a **RIGHT HANDED SPRING** and vice versa.

**RIGHT HANDED** Propellers use a **LEFT HANDED** spring.

All springs are manufactured by Curtis in Otahuhu from 4 mm Stainless and then heat-treated.

**NB: REJECT ANY SPRING WHERE THE LEGS ARE NOT AT RIGHT ANGLES IN BOTH PLANES**

The springs will always be in separate boxes appropriately marked but each must be checked that it is as marked. *A right handed spring will screw inwards when rotated to the right ie Clockwise.* Conversely a left handed spring will screw in when rotated to the left or Anti Clockwise.

**Check that both ends of the spring when inserted into the spring hole on the blade carrier will go down such that the coils lie flat against the face. This caters for a user subsequently reassembling the unit.**

**It may be necessary to countersink the recess in the Blade Carrier to ensure the spring lies flat**

**NB: Check that the ends of the spring have been ground at a 45 deg bevel to ensure they mount easily into the Nose Cone when assembled .....**

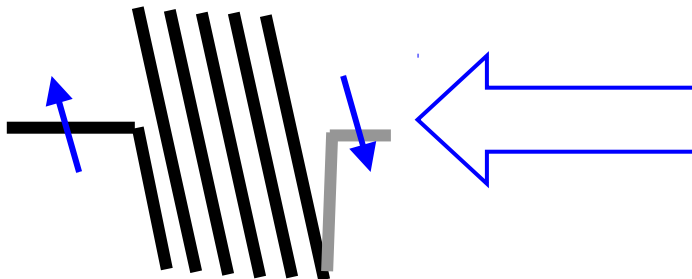
There is little spare room in the tripod casting that contains the spring. Checking both ends ensures that if ever reassembled off site the spring will still fit.

Add the spring to the other items required for the subassembly.

**NB: Label carefully when assembling multiple units at the same time. The choice of the wrong spring rotation will cause much difficulty if discovered at final assembly when the spring will not preload without jamming.**

The spring shown would wind itself in the direction of the arrow if rotated clockwise or **RIGHT HANDED** viewed from the perspective of the arrow.

It is thus a **RIGHT HANDED** Spring.



**NB: For comparison purposes a normal Right Handed thread on any bolt will also follow this convention**



**Grind and bevel both ends of the torsion spring to ensure that it slides easily into the Acetal Nose cone. Any sharp edges will bind during final assembly**



**Check that the spring goes down the hole so that the first coil lies flat against the Blade Carrier, This requires that the fairing section above the hole is correctly positioned.**



**Mount the Boss over the wooden spigot as shown with the Blade Carrier in the correct registration. See Above.**

**Check that the spring mounts easily over the boss without interference, as it should if the legs of the spring are at the correct angles and of the correct length.**

**This assumes the hole is bored to spec in the blade Carrier**

## 10: FINAL BOSS ASSEMBLY - TOOLING REQUIREMENTS

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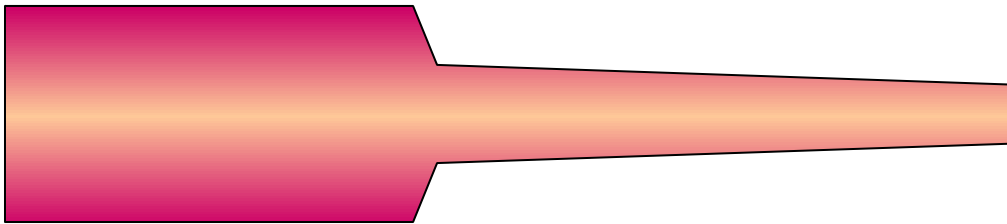
*This section of the chapter only relates to the tooling required or assembly and can be ignored in normal assembly operations once the tools have been completed. Turn to next page if tools are already available.*

### TOOL FOR STAGE 1 ASSEMBLY:

We have found that a piece of dowel mounted vertically in a small vice with a square end to ensure it is held firmly with a flat to ensure the propeller stays at the correct height for ease of assembly is critical to the overall assembly operation.

The dowel should be tapered to allow for the smaller end of the tapered bosses to be mounted firmly.

A tapered length of 100 mm or 4 ins with a small end diameter of 18 mm tapering down from 25 mm is ideal. Allow additional length to mount in the vice and ensure the unit is held above the vice.



### TOOL FOR STAGE 2 ASSEMBLY: SPLINES & TAPERS:

To ensure the ability of holding the unit while the internal torsion spring is pre-tensioned it is essential to have mounted vertically on a work bench at least two stub shafts. The spline (broken thread - obtained from a friendly Yanmar dealer) will have a flat plate welded to it for mounting vertically by screwing the plate to the work bench. The ability to align the mounting screws of the Acetal nose cone with the operator is critical to ease of assembly. On a spline this can always be achieved by simply turning the unit to the required position and then sliding onto the spline where it will be held firmly to assemble.

For shaft mountings with a taper it is necessary to have a strong engineers vice mounted on the workbench - preferably with jaws which take a round shaft of ~ 1.50" or 35 mm in diameter.

It will also be necessary to have 2 stub shafts turned from rod stock. One an ISO taper of 1:10, the other an SAE taper of 1:16 ie The shaft will reduce in diameter by 1/16 " every 1 " of length. Similarly for the ISO shaft which will reduce in diameter by 1 mm every 10 mm.

The ISO shaft will reduce from a minimum of 30 mm to 19 mm and is thus 110 mm long. The SAE shaft will reduce from > 1.250" to 0.750" and is thus 8 ins long.

In each case a small key of less than 6 mm width and < 3 mm height will be brazed to the shaft as the shaft will need to absorb the pre tensioning torque of the spring during the assembly operation. Tapping two small screws ( which must be in line ) can also achieve the ability to hold all sizes of taper.

These two stub shafts will then accommodate the 25 and 30 mm shafts plus 1" - 1.125" and 1.250".

The reason a vice is required is that because the keyways are cut anywhere on the perimeter of the boss, the only way to ensure the cap screws of the Acetal are facing away from the bench for easy access is to mount the unit, and then turn it to the required position with the shaft before tightening the vice. Simple - Cheap - and Effective.

## 11: FINAL BOSS ASSEMBLY

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First mount the tapered wooden spigot in one vice and the appropriate stub shaft in another so that the unit may be mounted firmly to preload the internal spring. This requires that the boss does not turn under the spring while the nose cone is being tightened up.

Remove the nose cone and tripod so that you can hold the boss in one hand and allow the blade carrier to fall down two inches or 50 mm to expose the drive dogs.

First check again the register with the two locking screw holes aligned with the blade carriers pins. With two internal dogs and three blades the drive dogs can only engage correctly in one position.

**The other position is incorrect. See the earlier pictures showing this registration**

Without turning the blade carrier relative to the boss – by using a knife insert ~ one teaspoon of Shell Nautilus Marine Grease into each side of the boss and the blade carriers sectors that receive the dogs. Smear the entire bearing mating surfaces on the Boss to ensure smooth rotation after assembly.

**NB: ENSURE THE ENTIRE BOSS BEARING SURFACE IS COVERED WITH GREASE  
DRY AREAS HAVE THE POTENTIAL TO BIND UNDER INITIAL OPERATION**

Lower the boss into the blade carrier without rotation so registration is maintained. Pull the boss down fully and turn either way to ensure it is operating smoothly and any surplus grease is squeezed out which will then need to be wiped off with a clean rag.

Mount this subassembly onto the wooden spigot over the nut recess with the nose of the unit up.

Mount the tripod back onto the blade carrier remembering to put the internal mark over the spring hole in the blade carrier to ensure a known fitted position.

Now using the knife again insert more of the grease into the groove between the tripod and the boss where the spring is to go. Attempt to keep the areas adjacent free of grease to ensure a clean surface.

**NB: Leave the area over the spring hole free so it can be subsequently located visually.**



Now insert the spring into the groove with one end of the spring going into the hole in the blade carrier. Press it home into the recess. Using a clean rag and Mineral Turps carefully clean all around the boss including the thrust groove which is going to take the spigot on the nose cone and which will contain the 3M 5200.

Remove the 3M 5200 Fast Cure from the freezer where it is kept in a dry atmosphere to avoid curing between units. Cut the masking tape cover free.

***Ideally this should be removed from the freezer and allowed to climb to room temperature at least an hour before use.***

While rotating the boss on the spigot extrude a small bead at the upper or nose end of the thrust groove around the entire circumference. Place further beads around the area under the nose cone to ensure that under assembly it will all receive a thin film. Typically six vertical beads of ~ 2 mm will suffice

Now smear a light coating of grease around the perimeter of the nose cone face that will move against the tripod. Check that the nose cone is clean in particular the thrust spigot on both halves. Clean with Mineral Turps if necessary and a clean rag.

Using a small screw driver ease the spring spigot out so that the bottom half of the nose cone that contains the threaded section of the nose cone can be slipped over the spring and then pushed home so that it lies as it should around the boss and into the thrust groove completely.

Now squeeze further 3M 5200 onto the two vertical faces of this bottom section of nose cone, sufficient to ensure it will fill the two gaps formed from the saw cut that split the nose cone into two.

The finished space will be of the order of 1/8" or ~ 3 mm and just sufficient 3M 5200 should be used.

Mount the other half of the nose cone onto the boss after checking again to ensure it is clean.



Mount the tripod into the grooves as shown for a Left Handed unit.

A Right Handed unit will occupy the alternate grooves



Check that the spring bottoms correctly onto the base of the Blade Carrier

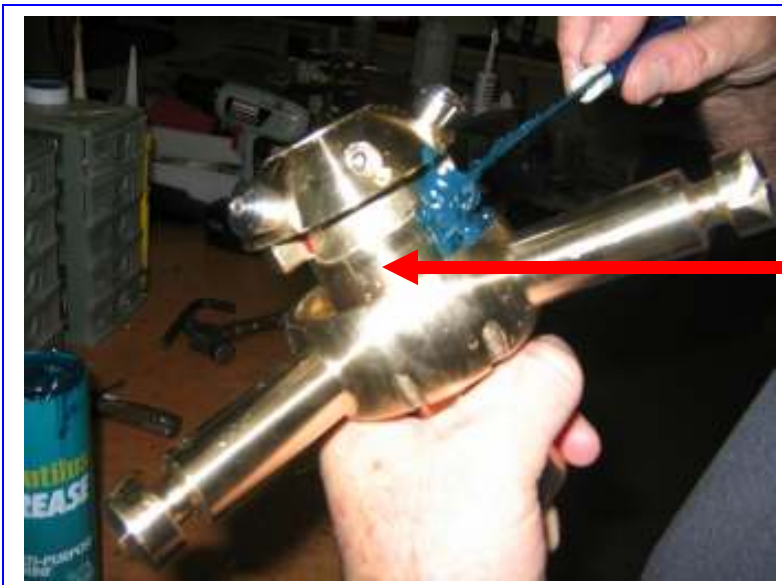
**REMEMBER:**

**LEFT HANDED PROPS USE RIGHT HANDED SPRINGS AND VICA VERSA**

**CHECK YOU HAVE THE CORRECT SPRING**

**MOUNT THE PETP SLEEVE AND REAR WASHER AT THIS STAGE**

**CHECK FULL AND FREE MOVEMENT**



After lowering the Blade Carrier by about 50 mm insert grease into the grooves swept by the dogs using a knife or spatula

**ENSURE THE ENTIRE BEARING SURFACE AS SHOWN IS SMEARED WITH GREASE**

**THIS WILL PREVENT ANY DRY AREAS CAUSING BINDING IN INITIAL OPERATION BEFORE THE GREASE CAN WORK IT'S WAY DOWN THE ENTIRE BEARING SURFACE**

**GREASE THE AREA UNDER THE PETP**





**BEFORE FINAL ASSEMBLY – CHECK AGAIN THE CONTACT SURFACES HAVE NO BURRS TO ENSURE SMOOTH MOVEMENT POST ASSEMBLY**

Ensure the boss is aligned as previously shown with the Blade Carrier when in the driving position

Rotate the Boss in the driving direction viewed from astern facing forward

**THIS IS CRITICAL**

**THE LOCKING SCREWS MUST ALIGN WITH THE LEGS AT THE ENDS OF EACH MOTION**



Mount the boss over a wooden spigot to enable ease of assembly

At this stage rotate the boss with a knife holding grease to ensure a liberal amount of grease over the area where the spring will go

**MOUNT THE TRIPOD MAKING SURE THE ROTATION IS CONFIRMED IN THE CORRECT POSITION**



WIPE THE BOSS CLEAN BEFORE INSERTING SPRING

**INSERT 2 x 0.006" CLEARANCE FEELER GAUGES TO ENSURE CORRECT CLEARANCE POST ASSEMBLY UNDER TRIPOD**

**THIS ENSUES THE THRUST SURFACES ARE CORRECTLY ALIGNED INTERNALLY PRIOR TO TIGHTENING WHEN THEY ARE REMOVED AGAIN**



After ensuring the boss surface is clean – hold the spring tail out with a screw driver and mount the lower half of the Nose Cone onto the boss

**NB: Ensure no swarf is loose as it will fall onto the grease and cause subsequent binding of the Nose Cone on the Tripod casting during the reversing function operation.**

**ENSURE A SMEAR OF GREASE IS ON THE TRIPOD SURFACE THAT WILL CONTACT THE NOSE SURFACE TO ASSIST ASSEMBLY AND SMOOTH OPERATION**



Place a small portion of 3M 5200 on the ends of each of the 4 Socket Head screws

This will ensure they are locked into the Nose when dried

**ENSURE THE FEELER GUAGES ARE IN**

Wind in the Cap Screws with a slow variable speed battery drill.

Do not over tighten at this stage as the nose cone has to still rotate and hold the spring tension while it is finally assembled.

The knurled finish will make rotation of the Nose Cone quite difficult once more than a small amount of tension is applied to the Cap Screws.

The objective is to ensure only sufficient tightening of the cap screws to ensure the Nose Cone will not rotate with the pre load spring tension that is going to be applied



Transfer the unit to the appropriate too or spline vice mount so it can be rotated to access the Cap Screws easily

**AT NO STAGE USE A HAMMER OR ASYMETRIC FORCE ON THE LEGS AS THIS HAS THE POTENTIAL TO SCORE THE BEARING SURFACE AND CAUSE SUBSEQUENT SEIZING DURING NORMAL OPERATIONS**

Mount the tool into the heads of the Cap Screws so the internal spring can be pre-tensioned

It is easier at this stage to turn the mounting shaft in the vice to bring the heads of the Cap Screws so as to face the operator for ease of tightening and control

**CHECK THE SPRING TENSION SCHEMATIC BELOW TO GIVE THE DIRECTION OF SPRING TENSION LOADING BY TYPE**

**THIS ALSO DEPENDS UPON THE DIRECTION THE UNIT IS MOUNTED**

**THE DIRECTION IS MARKED BY THE TOOL**



### **ADJUSTING THE SPRING TENSION**

Mount the tool into the Cap Screw heads and holding the blade rotate the spring towards the trailing edge of the blade.

This is a **RIGHT HANDED** unit so the nose is being rotated Counter Clockwise or Left Handed from this perspective

**FOR SAILDRIVES USE A SCREWDRIVER IN THE HOLE BETWEEN THE CAP SCREWS TO ROTATE THE NOSE CONE**



Adjacent is a **LEFT HANDED UNIT**

**Note the Nose Cone now being rotated in a clockwise direction viewed from above to pre-tension the spring**

### **CHECKING THE MOTION OF THE SPRING**

**NB: It is at this stage any swarf will cause binding and prevent the smooth operation of the reversing function against the torsion spring.**

**Follow the instructions on cleaning the Acetal Nose Cones very carefully .....**



**IT IS ESSENTIAL TO SET THE SPRING TENSION ACCURATELY TO ELIMINATE ANY MANUFACTURING TOLERANCES BETWEEN INDIVIDUAL SPRINGS.**

**THIS WILL ALSO ENSURE THE CORRECT REVERSING FUNCTION WHICH IS DEPENDENT UPON THE CORRECT SPRING TENSION**

**A SPRING BALANCE WILL ESTABLISH THE SPRING TENSION ACCURATELY**



**EXAMPLE:** Pre loading the torsion spring on a **RIGHT HANDED** propeller unit:

Mount one end of the spring balance in a leg groove and ensuring that the tension is always at right angles to the leg – adjust the spring tension so that a force of :

**~ 2.5 Kg or 5.5 lbs**

is required to **initiate** movement of the leg against the spring from a feathered or returned position.

This obviously assumes a smooth motion with no sticking forces are present

This will ensure an adequate but not excessive spring tension which can impact on reversing engagement – particularly with small low powered motors.



The blade should now rotate freely and fully into the reverse position against the internal drive dogs and be returned by the spring without binding to a feathered position.

**NOW TIGHTEN THE 4 x CAP SCREWS HOME WITH A TORQUE WRENCH TO 3.5 N.m**

**NB: ADD TORQUE TO PRE USED NOSE CONES**

**WAIT 20 SECS THEN REPEAT TIGHTENING**

**CAUTION: THE ABOVE STEP IS CRITICAL AS IT ALLOWS THE 3M TO CREEP OUT**

This will ensure the nose cone is stable on the boss against the spring tension while the 3M 5200 sets which will take at least 24 hours.



**CONDUCT A FINAL FULL AND FREE TEST BY ROTATING THE UNIT FULLY INTO THE REVERSE POSITION AT LEAST 5 TIMES TO ENSURE SMOOTH OPERATION WITH NO BINDING OF THE BLADE CARRIER ON THE BOSS**

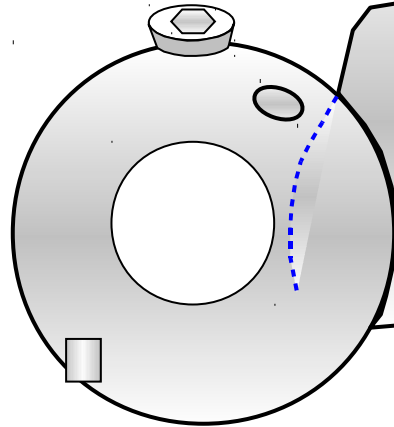
Clean up holding the unit as shown to access the nose with a clean rag and clean mineral turps.

Finish with a clean dry rag.

## SPRING TENSION SCHEMATIC

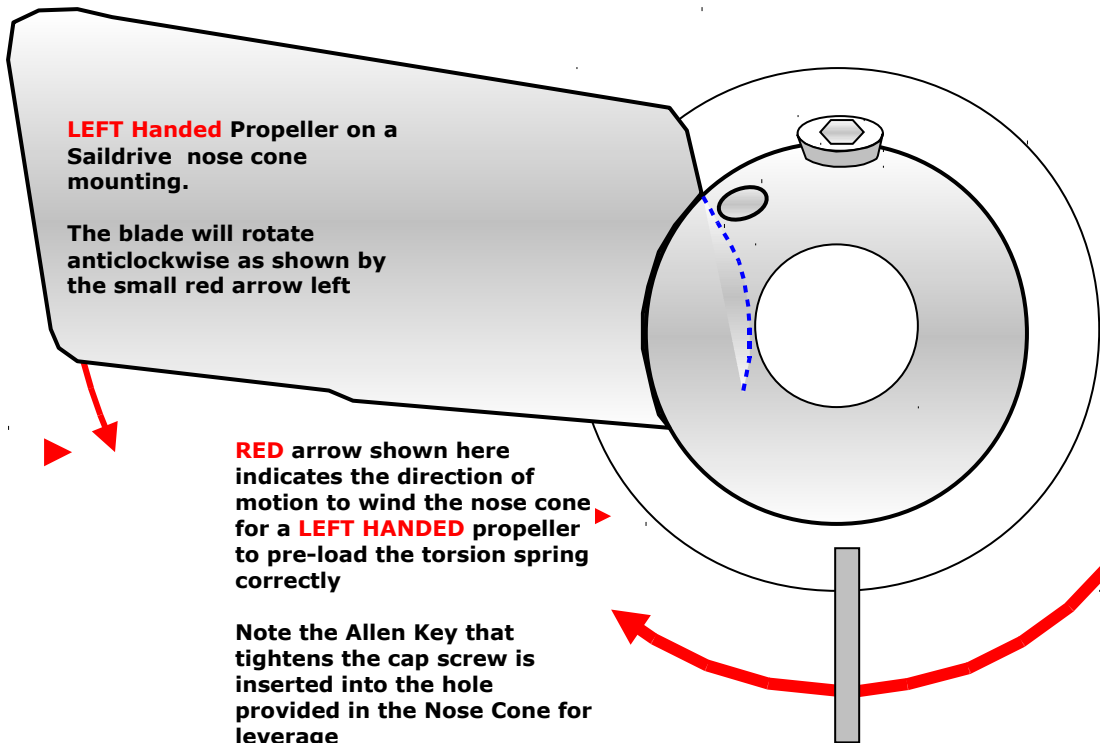
**GREEN** arrow below indicates the direction of motion to wind the nose cone for a **RIGHT HANDED** propeller to pre-load the torsion spring correctly

Note the tool that engages the cap screw to provide leverage



**RIGHT Handed** Propeller on a shaft nose cone mount.

The blade will rotate clockwise as shown by the small green arrow right



**LEFT Handed** Propeller on a Saildrive nose cone mounting.

The blade will rotate anticlockwise as shown by the small red arrow left

**RED** arrow shown here indicates the direction of motion to wind the nose cone for a **LEFT HANDED** propeller to pre-load the torsion spring correctly

Note the Allen Key that tightens the cap screw is inserted into the hole provided in the Nose Cone for leverage



**FINALLY: SEAL** the grooves in the Nose with 3M 5200 and the exist holes of the Screws on the Nose

Wipe the outside with a dry clean rag to remove the last traces of 3M



Transfer to a tray and let dry without any further contact of the 3M

Drying takes at least half a day

**DO NOT TOUCH AGAIN UNTIL DRY**



The next day – and not before .....

Punch a series of alignment holes choosing a leg where the Nose is free of grooves

**DO NOT PUNCH** near the edge of Boss or Blade Carrier as it can distort the metal and cause interference issues later.



Alignment marks high lighted with pen.

These are used to assist re-assembly for a user at a later date if ever required as they eliminate any spring pre tensioning issues.



Check the nut diameter and length are to spec. or are machined to spec.

**CHECK AGAINST THE ORDER FOR THREAD**

**REMEMBER THAT NEW YANMAR SD40 and SD50 SAILDRIVES REQUIRE A M20 x 2 NUT**

SAE 1 1/8" Bosses require 1/8" or 0.125" be removed from the threaded end of a standard 3/4" UNC Nut as used on an SAE 1" shaft.

**Chamfer the end and clean up.**

This reduces inventory for the limited volumes required of this size.



Seal the 3M by wrapping with masking tape and then placing into the freezer.

Remember to remove it prior to use next time and allow to thaw to ensure it flows freely.



## 12: SUMMARY OF ASSEMBLY OPERATIONS

The following notes provide an overview of assembly of a unit and may be used in conjunction with the previous chapters for specific cross reference where there is any elaboration required for a particular assembly operation.

### FUNCTION OVERVIEW ...

- 1: Select a boss using the Boss Selection Chart to match the particular orders to be assembled – Remove 5200 from freezer
- 2: Assemble the Boss with a Blade Carrier – Check for interference  
Clean and de-burr Blade Carrier
- 3: De-Burr Flats & Internal Tap burrs  
Wash with soap and water with Teepol  
Install the 2 x M8 locking screws  
Install the 3 x Reversing Rollers with Loctite – Check free
- 4: Fit the Tripod to the Blade Carrier

### CHECK CONTACT SURFACES FOR BURRS – HONE & FILE

- 5: Select the Nose Cone – Shaft or Saildrive ( Lombardini option )  
Split on cut-off saw Drill spring hole in jig  
Remove internal corners on Nose Cone  
Sand faces on Sanding Disc - De-burr all edges and clean internal spigot
- 6: Machine the Tripod to tolerances for final assembly

### INSERT FEELER GAUGES UNDER TRIPOD FOR CLEARANCE TOLERANCES

- 7: Select the Spring – Chamfer ends and check depth
- 8: Assemble the Boss with grease with 3M 5200 on the Locking Screws only

Preload the internal Torsion Spring

Seal the Nose Cone joins with 3M 5200 and exit holes of the screws

Torque Nose Cone screws down

