

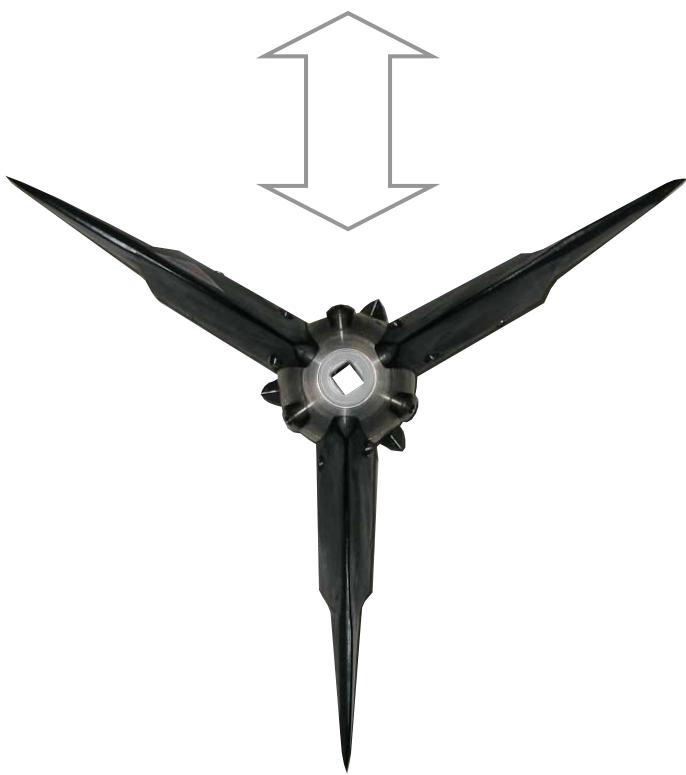
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BOSS ASSEMBLY - STAGE I

Assembly Instructions to Stage 1

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- A Boss with the correct Spline or Shaft size
- A SS Spring Handed Opposite to the Prop
- A Blade Carrier which is common to all propellers
- A Nose Cone which will be either Saildrive or Shaft
*Lombardini Saildrive Units have a smaller OD .. see Drawings
Volvo Saildrives have an extended Nose Cone ..*
- A Nut to match the mounting from the schematic above
- A Tripod casting finished Left or Right Hand provides the pitch stops
- Three blades of the required diameter from the soak tanks where they are kept
- Three Reversing Rollers with 316 SS 1/4" UNC or BSW Attachment Screw
- Two Locking Grub Screws M8 x 10 mm for the Nut in SS 316
- Three pitch adjustment screws M8 x 30 mm in SS 316
- Three 1/2" x # 4 SS Pozi Self tapping screws
- Three 1/4" x 28 mm Nickel Silver Blade attachment pins
- Four SS 316 1 1/2" x 1/4" UNC Cap Screws to attach the nose cone
- Loctite™ for the reversing rollers
- 3M 5200 for the nose cones
- Shell Marine Grease
- Appropriate Tools, Turpentine & Cleaning rags etc

3: GENERAL

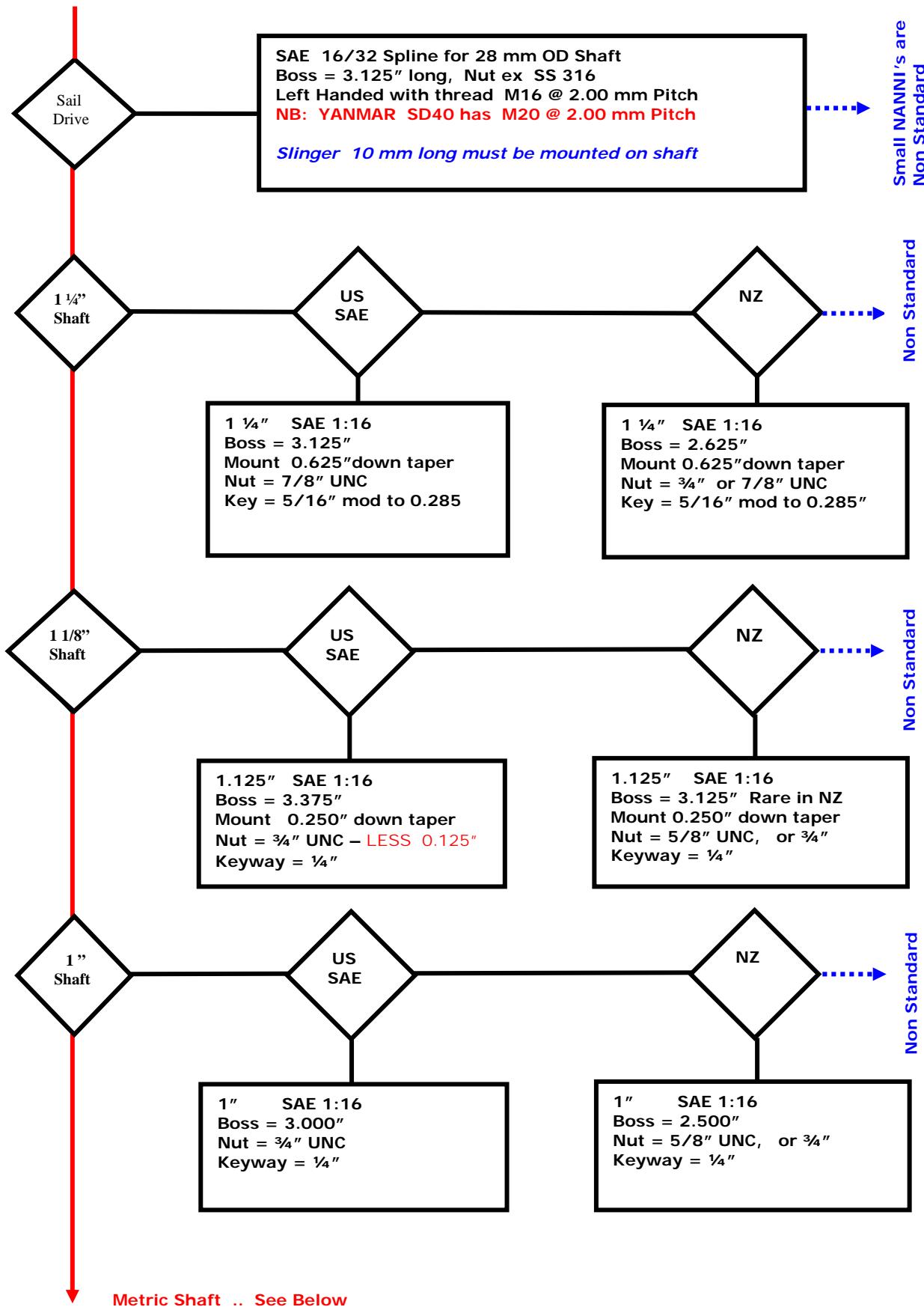
The following Chapters describe the Assembly of the various sub- components that go to make up a Boss Assembly which is held in stock by mounting type.

Only when a specific Customer Order is received are the Bosses then numbered and the appropriate blade set mounted and the Pitch set to the specific order requirements.

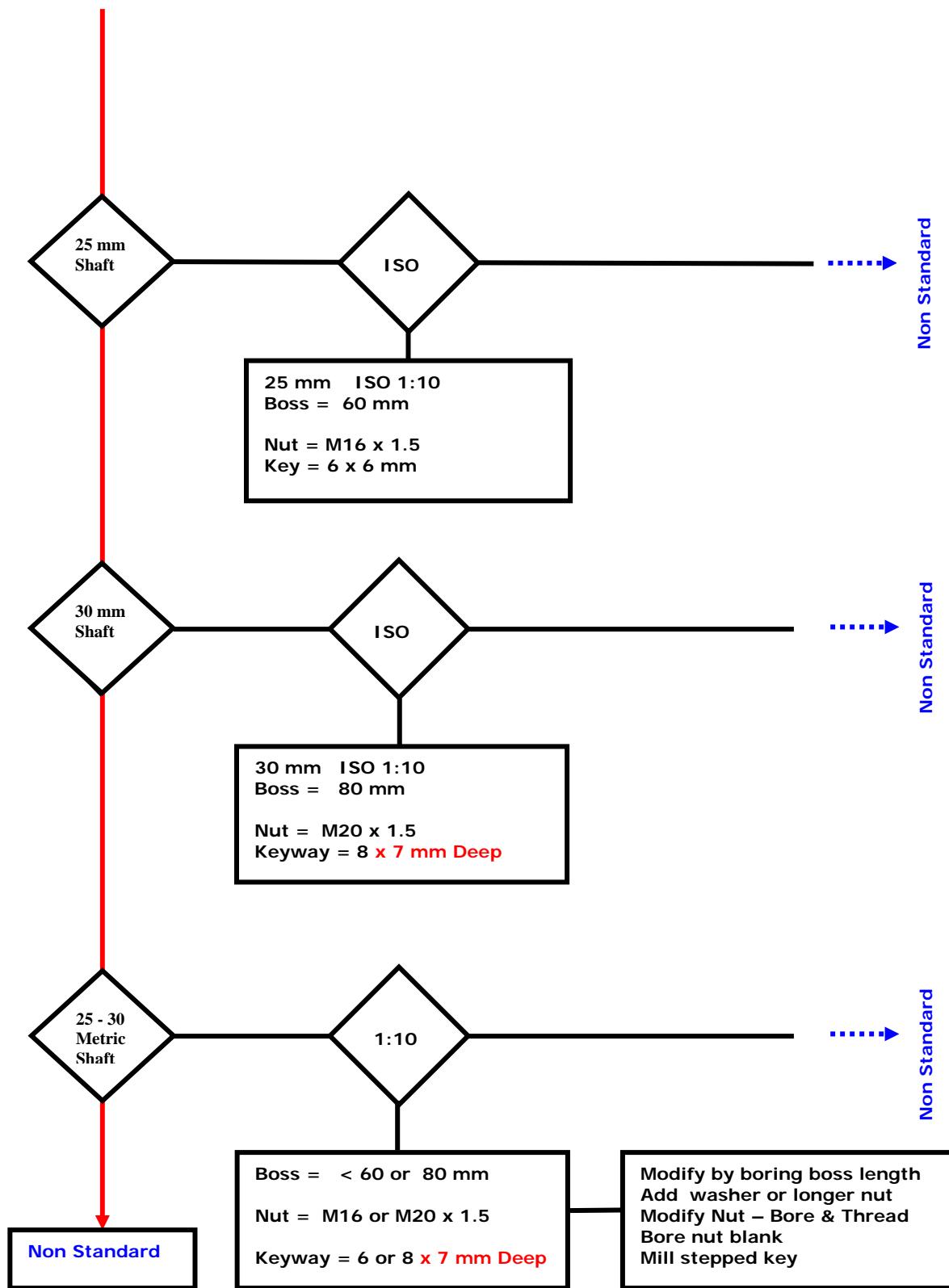
The actions described below relate to one specific assembly.

Normally these would be assembled in small batches to make it simpler and easier to remember the assembly routines.

4: BOSS SELECTION CRITERIA - IMPERIAL



4: BOSS SELECTION CRITERIA - METRIC



TURNING THE SHAFT DOWN TO A STANDARD IS THE BEST SOLUTION FOR NON STANDARD TAPERS

5: PREPARING NOSE CONE

All propellers have either a Saildrive or Shaft Nose Cone irrespective of any other features such as shaft diameter or rotation. The Saildrive nose unit is designed to fair the body of the propeller to the larger gear casing of the Saildrive. The shaft drive nose unit is designed to fair the body of the propeller down to the much smaller shaft dimensions.

NB: LOMBARDINI NOSE CONES ARE REDUCED IN DIAMETER TO 3.5" OD – Refer to Drawings

In each case the nose cone performs two other critical functions which are not obvious from a cursory examination.

First the protruding rim inside each unit fits into the groove on the boss and absorbs all the forward thrust of the propeller. It transfers this initially from the blade carrier thru the pitch stops and tripod casting thru the boss to the shaft to provide forward motion.

Second the nose contains a hole into which one end of the torsion spring is mounted so that it can absorb the torsion of the spring and transfer this thru the nose to the boss. It also provides the facility to preload the torsion spring and adjust the amount of tension to ensure proper operation of the propeller and ensure that the blade carrier always returns to a position which will allow the blades to feather. This it will not do unless the blade carrier is held in the neutral position with the spring.

While the external profile of these components is very different the internal dimensions and method of attachment are absolutely identical.

The same comments thus apply to either unit.

Once the Saildrive or Shaft choice has been made every other instruction for preparation is common.

Insert the long $\frac{1}{4}$ " BSW SS rod at the cutoff saw into the threaded side of the hole nearest the front of the nose unit from the outer surface - This is the face that faces forward.

Check that the rod is only in far enough to maintain alignment and does not go near half way where it would interfere with the saw blade when the cut is made.

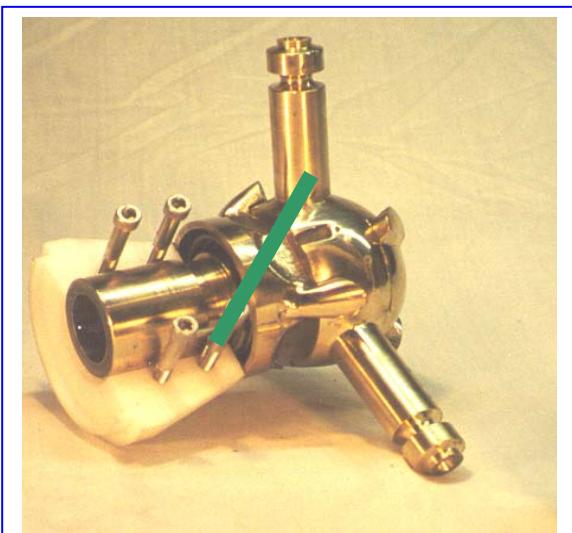


Mount the nose cone over the wooden spigot and ensure it pushes down to the base of the unit. Align the SS Rod with the pencilled line which thus ensures the $\frac{1}{4}$ " holes are at right angles to the saw. Holding the rod to prevent the nose from turning when it starts to separate with the left hand, operate the cutoff saw.

The saw is automatically fully shielded so as to never expose the blade at any section of the cut.

Take the lower half of the cone which contains the threaded portion of the nose cone and insert the same rod above into either the left hand side for a left handed prop or the right hand side for a right handed prop. This is to ensure the torsion spring is providing a compression load on the Acetal rather than a tension load where the Acetal is not as strong.

The diagram below shows the above:



SS Rod with $\frac{1}{4}$ " BSW (= UNC) thread inserted for Left Hand Prop as a guide to prevent subsequent interference with SS $\frac{1}{4}$ " Screw at assembly time. [Braze rod into head of a socket screw]

Hole at 4.4 mm and countersink are bored $\frac{1}{4}$ " in from inner face to ensure spring does not cut into inner body past the thrust rim as shown by the red arrow. Use jig provided.

Calculated as .125" rim + 0.125" into the body leaves 0.062" clearance on the inner wall.

A Right Hand Prop is processed the same but as per the green arrow on the other side of the nose to ensure the spring provides a compression load rather than tension in the Acetal

Following completion of the boring operation it will be necessary to ensure both faces ex the saw are ground flat with a touch on the face sander.

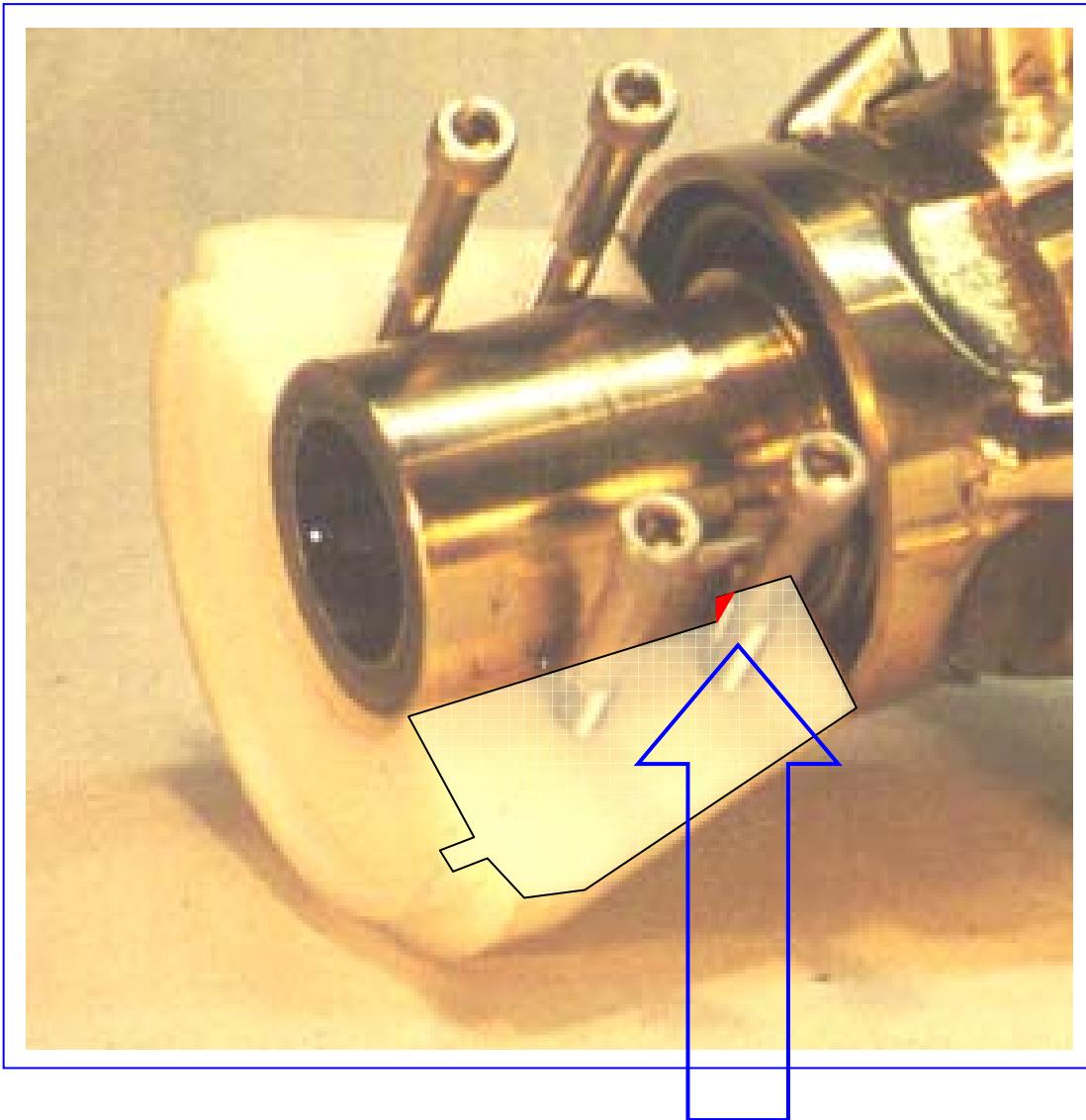
The objective is not to grind the faces further down but to remove any imperfections that may have resulted from de-stressing the Acetal and or inaccuracies in the cut.

Finally the inner lip on the side nearest the spring hole is ground off on the face sander as shown in the diagram above.

This makes assembly of the unit much easier when loading the nose cone onto the spring. This corner tends to catch on the lip with final assembly. The red pyramid section shows this removal for a Left Handed Prop. Right handed is the same.

Scrape all the edges to remove any furring with a sharp Stanley knife

The nose cone is now ready for fitting to the boss blade carrier and tripod sub- assembly.



To ensure ease of assembly it will be necessary to remove the corners marked red above shown by the blue arrow above. The smaller diameter spigot which takes the forward thrust of the unit requires removal of the corners on both sides of the lower half containing the threads which can catch when assembling the nose cones.

This can be done over the disc sander with new faces of ~ 0.125" or 6 mm generated.



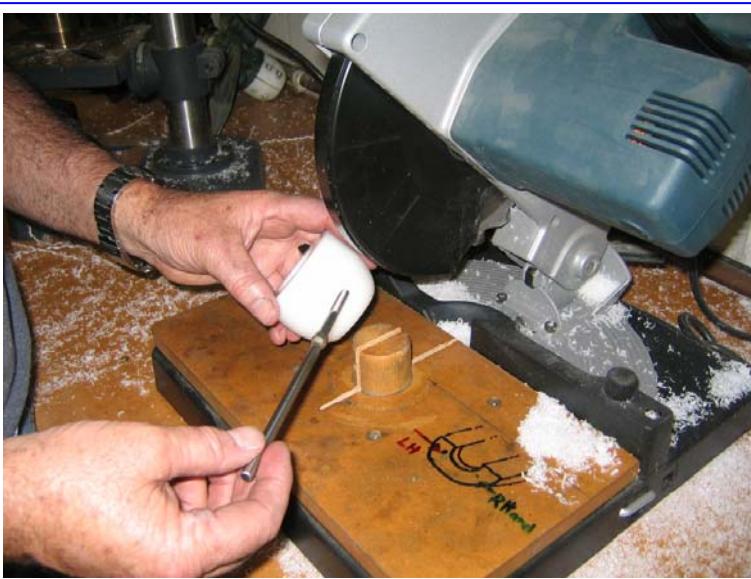
Insert the tool into the lower 1/4" UNC thread as shown.

It must go this side to fit the cutting off jig

Only screw in a few turns or it will interfere with the saw blade

NB: White Nose Cones are PETP

Black units are Glass Filled Polypropylene and are now used on all new units



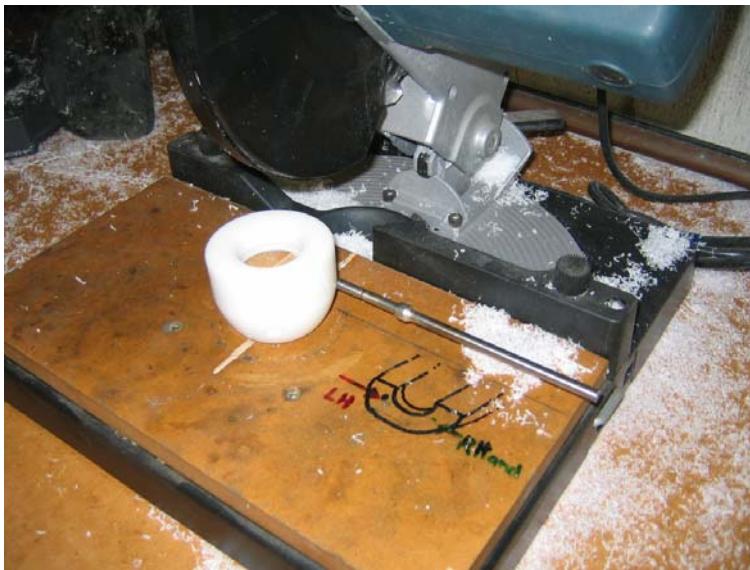
Mount on the jig as shown

Note the two options for Left Handed and Right Handed units marked on the cut off saw base as to where the spring hole is bored for each.

The tool is screwed into whichever is appropriate prior to mounting on the drilling jig



Align tool with mark to ensure cut is at right angles to bolt holes



Split in two with cut off saw holding the tool still at right angles by maintaining alignment with the marks



Mount on jig to bore and recess spring hole.

The tool now has a wooden face to ensure the spring hole is in the same position for each spring – both LEFT & RIGHT

Depth is controlled by the C/Sunk creating a recess of OD ~ 6 mm at the surface

DO NOT RECESS MORE THAN NECESSARY



Grinding off the inner corners to enable easy assembly subsequent assembly.



De-burr all the cut surfaces using a de-burring tool.

Include the 8 x holes and front internal diameter which was cut off on the lathe

BLOW WITH AIR AND WASH TO ENSURE THERE IS NO SWARF LEFT THAT WILL INTERFERE WITH FINAL ASSEMBLY



NB: Any dust or swarf left on the Nose Cone will come loose at assembly time and after catching on the grease of the tripod casting cause interference and binding during the reverse function testing

NB: IT IS ESSENTIAL TO DEBURR THE OUTER EDGE OF SPRING HOLE AS THE BURRED EDGES WILL INTERFERE WITH THE TRIPOD FACE AND CAUSE BINDING WHEN ROTATED INTO REVERSE

6: FITTING THE TRIPOD

The SS316 tripod performs three functions for the propeller.

First it provides stops for the pitch screws to come up against and then to transfer the forward thrust they generate onto the nose cone and thence the boss.

Second the body of the casting takes the forward thrust from the blade carrier and transfers that onto the nose cone and then the boss. Remember the blade carrier is free to slide down the boss.

Thirdly it provides a cover for the spring housed inside to ensure it remains lubricated over time.

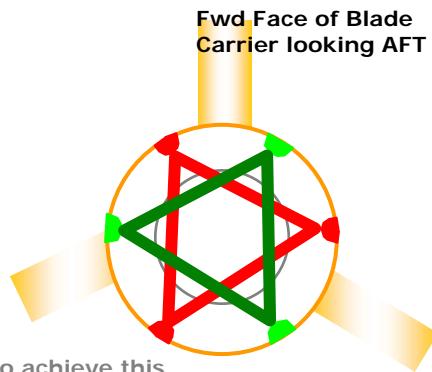
Whilst the tripod itself is symmetrical and is not handed it must be located in different positions depending upon the rotation of the propeller. This keeps inventory at a minimum while the trade-off is extra grooves in the front of the blade carrier to accept both rotations.

The tripod must be located so that when in the ahead position the blade will come up against the pitch stops.

This will not happen if the incorrect groove set is selected.

Select the **RED** grooves for **LEFT HANDED** units

Select the **GREEN** grooves for **RIGHT HANDED**



The tripod can obviously be rotated in three separate positions to achieve this.

Check the root of the tripod inner surfaces for swarf or casting imperfections both of which can interfere and hold the tripod off the blade carrier surface. **CHECK THE GREASE HOLE IS BORED**

The investment cast Stainless units unit will be identical with each leg and will be able to be mounted anywhere on the 3 positions that are available for each handed unit.

First mount the tripod - legs to Chuck (Missing any Chuck Recess). Rough Cut to Parallel the outer face at ~ 1.030" . Reverse and only clean up inner face between legs to about 90 % to ensure subsequent alignment on Blade Carrier. Ensure Grease Hole has been bored.

This should have been done in previous batch mode. CHECK IT HAS BEEN PERFORMED.

The next stage is to machine the length of the tripod to correct for longitudinal cumulative machining errors generated during production of the various components and provide the correct clearances for the moving surfaces of the boss assembly post final assembly with sealants.

We need to cater for any small distortions that may be introduced into the Acetal Nose Cones when the screws are tightened up finally. The target length is 1.000" +/- cumulative tolerance errors **MINUS** 0.008" or 0.2 mm which is the required clearance between the Nose Cone and the Tripod.

This allows for any distortion of the Nose Cone post assembly.

NB: THIS CLEARANCE MUST BE MEASURED BETWEEN THE NOSE AND THE TRIPOD USING THE GUAGE WHICH IS NULL WITH THE LATHE SET UP TOOL AND WILL REQUIRE .. LESS 0.2 mm

Now mount the blade carrier in the correct registration over the boss and lie rollers down on a flat surface. Mount the split nose cone over its grooves and now pick up the whole assembly and turn it over.

This allows the weight of the unit to eliminate any slack in the thrust groove.

NB: IMPORTANT Remember the thrust of the prop will force the nose cone down the boss to eliminate any clearance in this direction of thrust.

Measure the distance between the nose cone perimeter and the front face of the blade carrier by using the expanding screw jig to set this distance and transfer to the lathe set up.

Mount the jig shown in the drawings with the now machined face in towards the three jaw chuck.

NB: DO NOT OVERTIGHTEN THE CHUCK AS IT WILL DISTORT THE CASTING

Expand the jaws to mount the tripod internally. Remember the outer face is as cast and will be some thou out of center. Ensure the three small dogs on the inner tripod faces are accommodated in the center of the jig so that the inner face lies tight against the face of the jig.

Take the slack out of the top slide by winding in towards the chuck. **Remember to lock the carriage.**

Load a carbide tipped Left Handed facing tool at the correct height as checked by the gauge provided. Ensure the cutting angle is correct.

Engage the cross feed option on the carriage.

Select A feed and # 2 Gear. Start the lathe at ~ 350 rpm spindle speed.

Bring the carriage along until the tool is just starting to skim the face. Lock the carriage down with the set spanner provided on the carriage.

Wind out the cross feed and then select a cut which equals the difference between the two readings written down earlier by feeding in the third compound slide on the dial the correct distance in thousandth of an inch. **NB: The SS 316 units will need multiple roughing cuts prior**

Make the cut twice to ensure a smooth finish. Wind out the tool while still running to improve finish. Remove the outer edge with a lathe file while the lathe is still running. Remove the tripod and now remove any inside aris with a light cut of the deburring tool provided. Be careful not to slip as it will make a very nasty cut in flesh ! **File any burrs from the Grease Hole is still present.**

Now mount the tripod again.

The Boss should be firm but not tight to turn with no slack in the assembly. Check with feeler gauges if necessary.

REMOVE ANY BURRS WITH A LATHE FILE - ROLL THE OUTER EDGE - TURN INNER CHAMFER

Carefully repeat the above process as required. The unit should turn quite freely when finished.

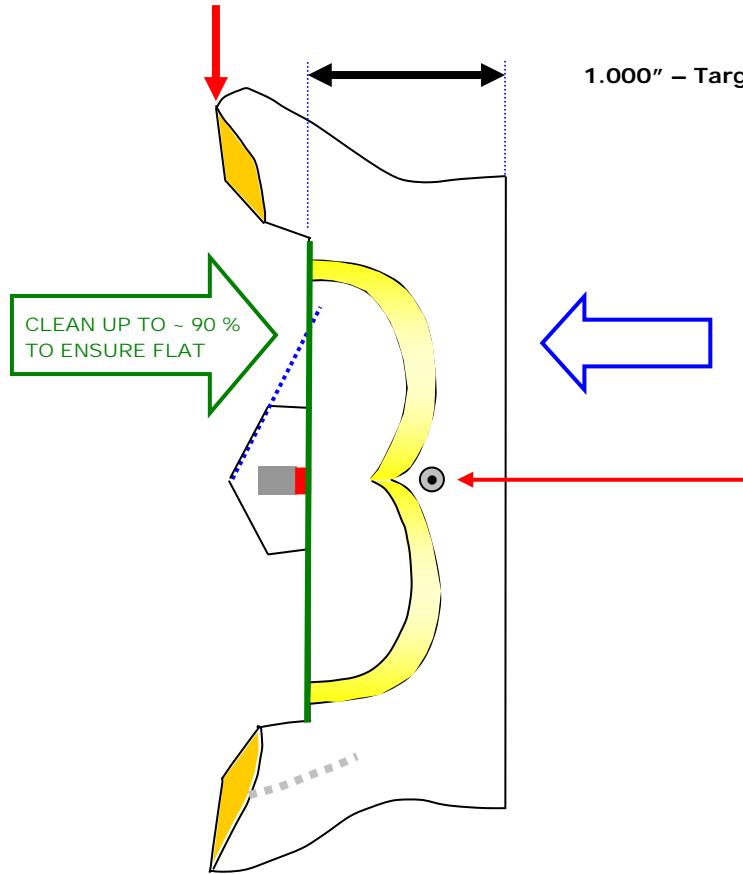
CAUTION: THE ASSEMBLED 0.008" = .20 mm CLEARANCE IS CRITICAL !



The jig is threaded and fits over the Boss to be expanded by unwinding the two halves until a snug fit between the blade carrier and the nose cone which is held manually in place

EACH DIVISION = 0.010" - 0.25 mm

CHECK FOR PROTRUSIONS



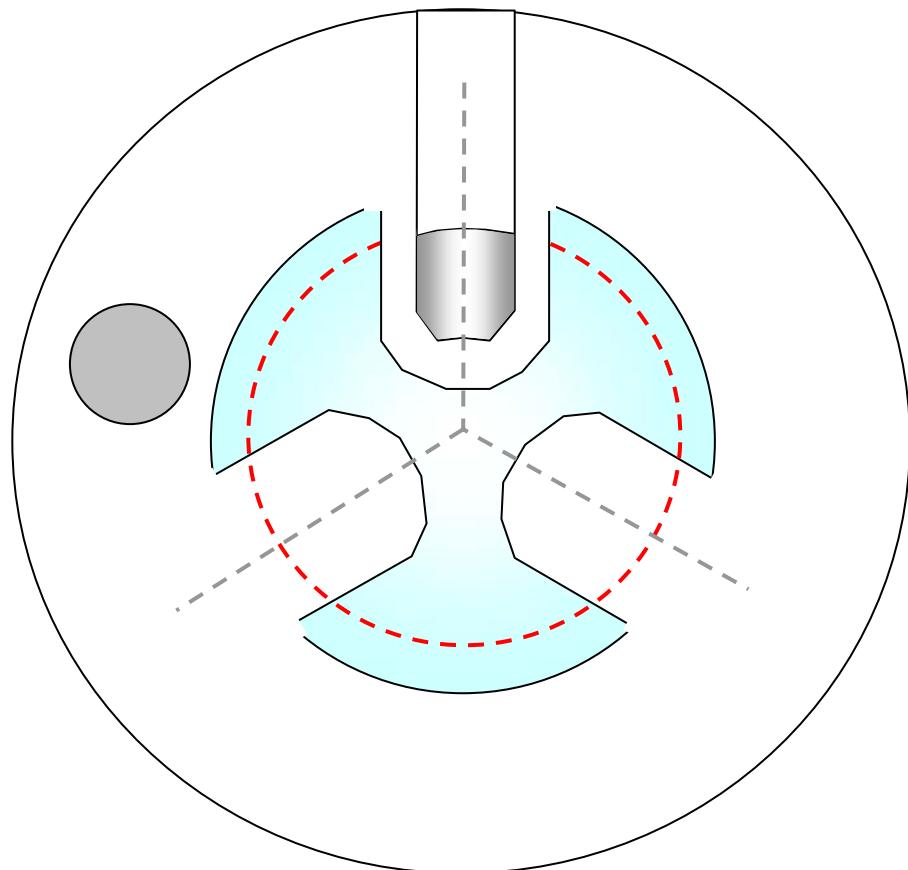
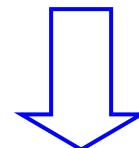
1.000" - Target +/- Tolerances LESS CLEARANCE

Machine this face initially using the cross feed in the lathe with the tripod mounted legs into the face of the 3-Jaw chuck.
Bypass the recess on the face of the chuck

CHECK FOR ANY PROTRUSIONS ON THE LEGS THAT WILL PREVENT ALIGNMENT

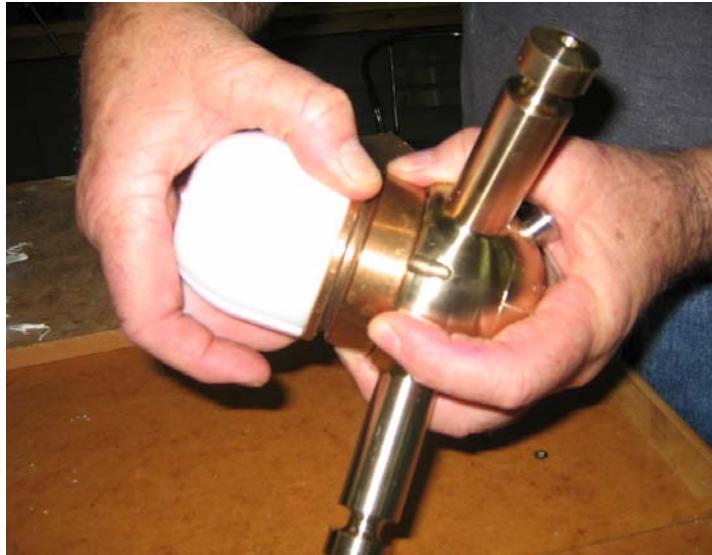
CHECK GREASE HOLE BORED ~ 1.7 mm

The jig pictured below mounts within the 3 – Jaw chuck which is then expanded to hold the tripod which is held the exact distance from the chuck of the jig



Chuck shown here is a typical 3 – Jaw chuck with the jaws set normally which allows the outer steps to be expanded to hold the internal faces of the tripod securely during machining operations

NB RECESSED AREA



Expand the jig by rotating the two components in each hand so as to undo the threaded portion of the jig

There are various ways to transfer the width of the tool to the cut off the tripod allowing for the required clearance.

THE JIG @ NULL = BRONZE TOOL

SET EQUAL THEN REDUCE by 0.008" 0.20 mm

Cut in on power feed and then slowly reverse out to remove any burrs.

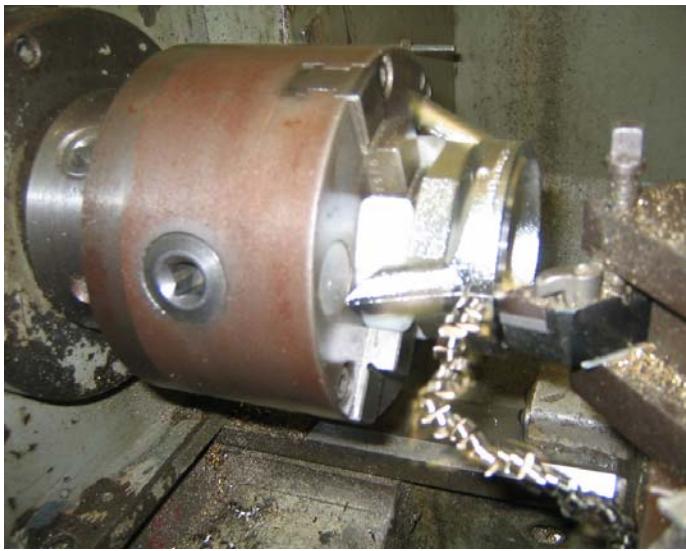
Aris off both edges with a flat and round file



Check the inner corner of the Tripod to ensure nothing protrudes that could impact upon a flush fit against the blade carrier

The inner face will be turned to ~ 90 % clean to ensure it lies flat and also operates as a seal to maintain the grease inside.

CHECK FOR ANY STRAY BURRING



Machine face in two cuts to jig setting

Use speed of ~ 250 – 350 rpm

Winding the cross feed back slowly by hand after the final cut can help remove any roughness on the surface

SS 316 is inclined to tear without cutting fluids



Remove aris from outer edge while Lathe is running with file



Deburr inside edge with deburring tool

Winding in tool at last portion of cut will also help angle the inner edge

Remember to return tool to zero



Sand on wet and dry or emery paper to remove any burrs on the face from any tearing of the SS which has left other than a very smooth surface.

This wears on the Nose during the reversing function and must be smooth to avoid excessive wear

OR LAP ON A STONE TO ENSURE NO BURRS

ENSURE ALL SURFACES ARE CLEAN BEFORE REASSEMBLY TO AVOID MATERIAL BINDING ON THE BOSS / BLADE CARRIER BEARING



Now check the operation of the unit.

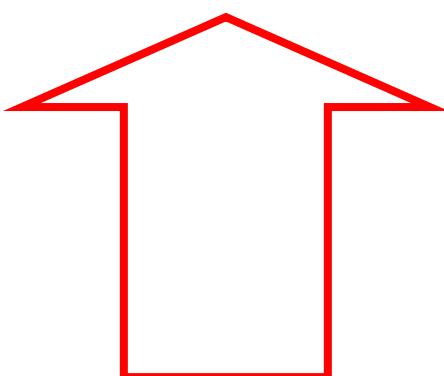
There should be the required 0.008" or 0.25 mm between the Nose and the Tripod prior to tightening the Nose Cone.

Post final assembly this tolerance will reduce to the designed 0.006"

UNITS WITH PETP NOSE CONES ARE STABLE IN WATER AND WILL RETAIN THESE LOWER CLEARANCES

CHECK NOW THE GREASE HOLE OF ~ 1.7 – 1.9 mm HAS BEEN BORED IN THE CASTING

CHECK ANY BURRS ON THE INNER FACE OF THE GREASE HOLE HAVE BEEN REMOVED



7: REGISTRATION BOSS AND BLADE CARRIER

Select a blade carrier from stock.

NB: CHECK THE SPRING HOLE HAS BEEN COUNTERSUNK

All units are identical and are a common component and are used without modification in every model of propeller. NB: REMOVE ANY BURRS FROM BOTH ENDS OF THE BLADE CARRIER BORE

HONE THE REAR FACE WITH STONE & CRC TO REMOVE ANY BURRS ON THIS SURFACE

Check for any inclusions in the castings not already detected and reject if necessary. Check that the internal surfaces swept by the dogs are clean.

Scrub the unit with soap and water paying particular attention to all the recesses on both faces which will cause excessive wear in the unit in use.

Mount the Boss selected into the blade carrier. Remember to ensure you have the correct hand.

Align the two locking screw holes with two legs of the blade carrier.

Turn the boss sharply back and forth. It must rotate freely and close with a distinctive click at the end of degree of freedom.

Holding it against the stops alternatively in each direction, slide the boss out and check to see first if it turns any further which would indicate some form of binding preventing it from closing correctly onto the faces of the dog.

When $\frac{3}{4}$ of the way out look down to ensure the dogs are engaging correctly and there is not for example some metal in the corner of the swept section of the casting which is again preventing the dogs closing fully and correctly. Again – this is unlikely to be an issue for Lost Wax and ex Rod Stock.

This is very important as it is always assumed this action is correct before commencing assembly.

If this action was to change over time, perhaps from a small casting fault that was eroded with use, then the position of the rollers would change and this would impact upon the correct feathering and or reversing action.

Hold the assembly up to the light and check that the faces at the circumference of each casting that coincide are meeting correctly and that no light is visible thru this joint.

On units that have been broached for a keyway ensure that any burr or rolled burr at the end of the internal keyway is removed using a screwdriver and file edge. This is required to ensure that the nut will pull up correctly on the flat internal face without binding.

NB: Remove any burrs remaining both on the inside of the taper and keyway and particularly at the nut end where the keyway broach has run out. Use a small chisel or screw driver to bend it off.

CHECK FOR BURRS AND HAIRS INSIDE THE SPLINE ON SAILDRIVE UNITS

CHECK THAT ALL VOLVO SAILDRIVES CAN BE MOUNTED FRONT FACE FIRST OVER THE GO SPLINE

This picture to the right shows how when the Blade Carrier is held and the boss rotated to a drive position – in this case in a **LEFT HANDED** or Anticlockwise direction – then it is essential for the two holes bored for the M8 locking screws to align with the legs on the Blade Carrier.

As there are 2 internal dogs and three legs there are two different registration positions that the Boss can adopt relative to the position of the Blade Carrier

All perspectives are from AFT facing FORWARD when referencing rotation

Note the boss being rotated in a **LEFT HANDED** direction

