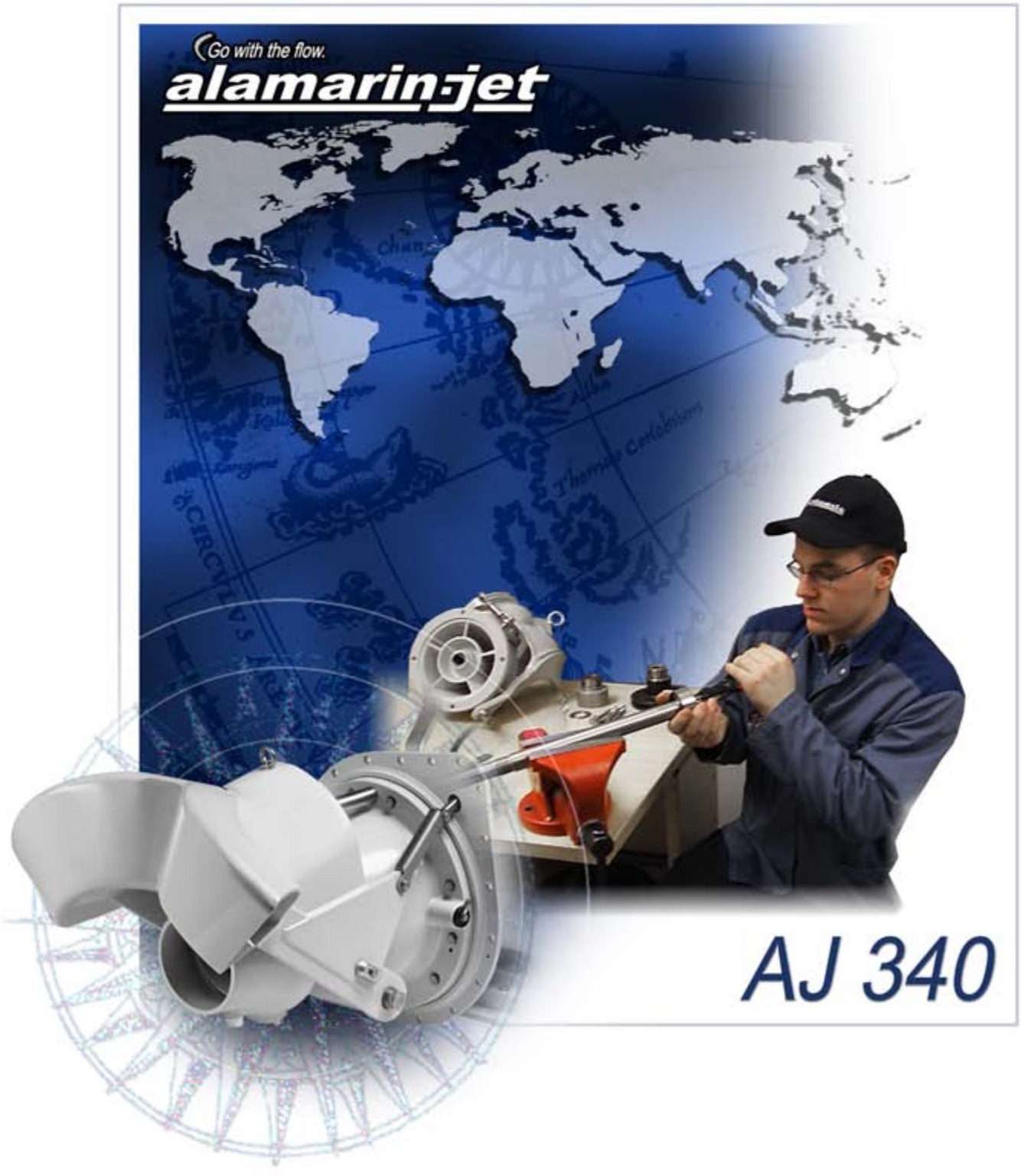
Repair manual



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1. Introduction

This is the repair manual for Alamarin-Jet's AJ 340 water jet propulsion unit. This manual is intended for the owners, users, and repair persons of boats that are equipped with the Alamarin-Jet water jet propulsion unit. With the help of this manual, they can carry out the most common repair procedures for AJ 245 water jet propulsion units.

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1.1. Safety precautions

Read these instructions carefully before carrying out any procedures. Always follow these instructions and the safety precautions shown below.

- Only a person with adequate training is allowed to carry out the procedures described in this manual.
- The person carrying out the procedures must always wear the appropriate protective equipment.
- The work premises must be sufficiently large, safe and well-lit.
- The tools that are to be used must be clean and appropriate for the intended purpose.

1.2. Symbols

Please refer to table 1 for a description of the symbols used in this manual.

Table 1. The symbols used in the manual

Icon	Description
	DANGER Negligence in the performance of a procedure can cause a threat to your life.
	WARNING Negligence in the performance of the procedures can lead to personal injury, breakdown of equipment, or serious malfunction of the equipment.

Icon	Description
	CAUTION The procedure involves minor danger or a possibility of minor damage to equipment.
	WARRANTY The warranty is voided if the procedure is carried out incorrectly.
	NOTE Important notice or fact.
	TIP Additional information that facilitates the performance of work or a procedure.
	MAINTENANCE ON LAND The boat must be lifted out of the water for maintenance.
	MAINTENANCE IN WATER The maintenance procedure can be carried out in water.
	CARRIED OUT BY ONE PERSON One person can carry out the procedure.
	CARRIED OUT BY TWO PERSONS Two persons must carry out the procedure.
	INDICATOR ARROW
	ARROW DESCRIBING MOTION

Please note that this instruction uses the terms "jet" and "jet propulsion unit". They mainly refer to the same thing.

2. Main shaft and bearing

The power from the engine that runs the jet is transmitted to the main shaft using an intermediate shaft. The intermediate shaft is attached to the coupling flange in one end, and either the gear box or the engine flywheel adapter in the other end. The intermediate shaft is often acquired and installed by the manufacturer of the boat and can, therefore, not be discussed in detail in this document. However, some central issues related to it are described at a general level in the section 2.3. *Intermediate shaft*, page 22.

The main shaft of the jet is a direct shaft (figure 1, point A), supported at both ends with bearings. At the front end of the shaft is a coupling flange (figure 1, point B), to which the intermediate shaft is connected. The shaft is also equipped with an impeller connected with a sleeve and a parallel key (figure 1, point C). The impeller generates pressure as it rotates.

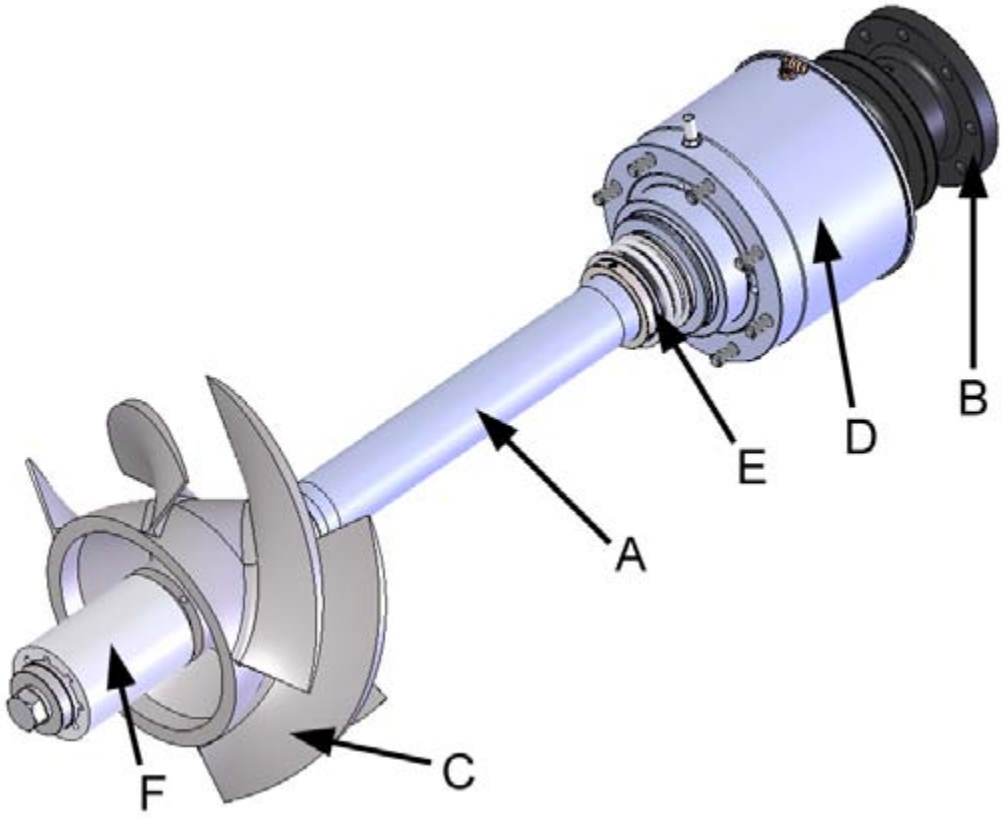


Figure 1. Main shaft and bearing

A	Shaft
B	Coupling flange
C	Impeller
D	Bearing housing
E	Mechanical rotary seal
F	Rear bearing

The front end has a triple row angular contact ball bearing, receiving axial thrust and radial loads in every direction. The bearing is inside the housing (figure 1, point D), and it is oil-lubricated. The bearing housing seal on the

intake duct side is a mechanical rotary seal (figure 1, point E). The shaft seal is on the engine room side.

The rear bearing (figure 1, point F) is attached to the stator. The rear bearing is either a water-lubricated slide bearing or a grease-lubricated rolling-element bearing.

2.1. Front bearing

2.1.1. Front bearing disassembly

Before the bearing can be disassembled, remove

- the stator (section 6.1. *Removing the stator*, page 63)
- the impeller (section 3.2. *Removing the Impeller*, page 25).

Then, remove

- the intermediate shaft from the coupling flange
- the oil pump of the reversing deflector's actuating cylinder (section 4.3.1. *Removing the hydraulic pump*, page 44).

Make sure you also have a container into which you can drain the old oil from the system.

Front bearing disassembly:

1. Detach the lubricating oil reservoir hoses from the bearing housing connectors (figure 2, point A) and drain the oil from the system.

   Drain the oil from the ends of the hoses into a suitable container. Depending on the length of the hoses, the oil reservoir and hoses contain approximately 1 to 2 litres of oil.

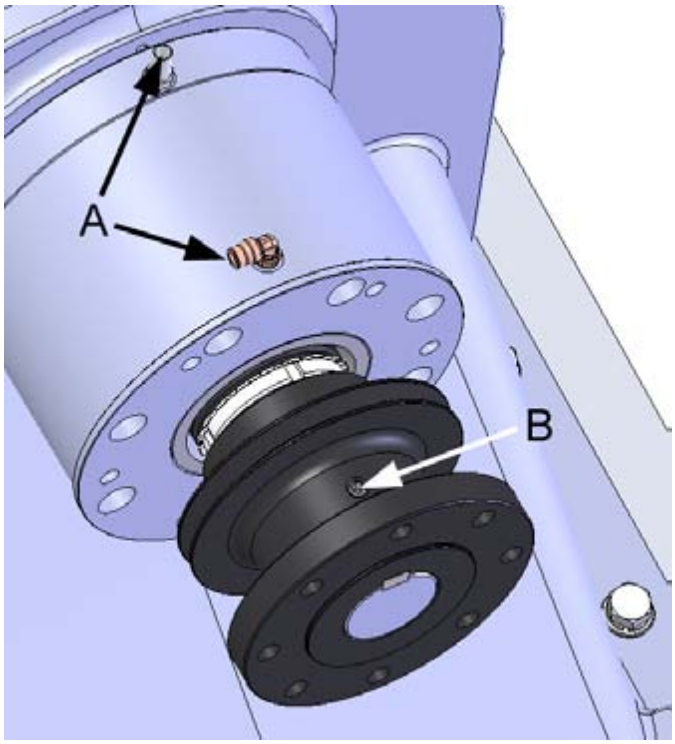


Figure 2. Lubricating oil reservoir connectors

2. Remove the coupling flange.

   If you need to replace the entire bearing, including the shaft, you can leave the coupling flange in place.

   First remove the set screw located on the side of the bearing housing body (figure 2).

3. Pull the coupling flange off the shaft.

4. Remove the key from the shaft by opening the screws holding it in place (2 pcs, figure 3, point A).

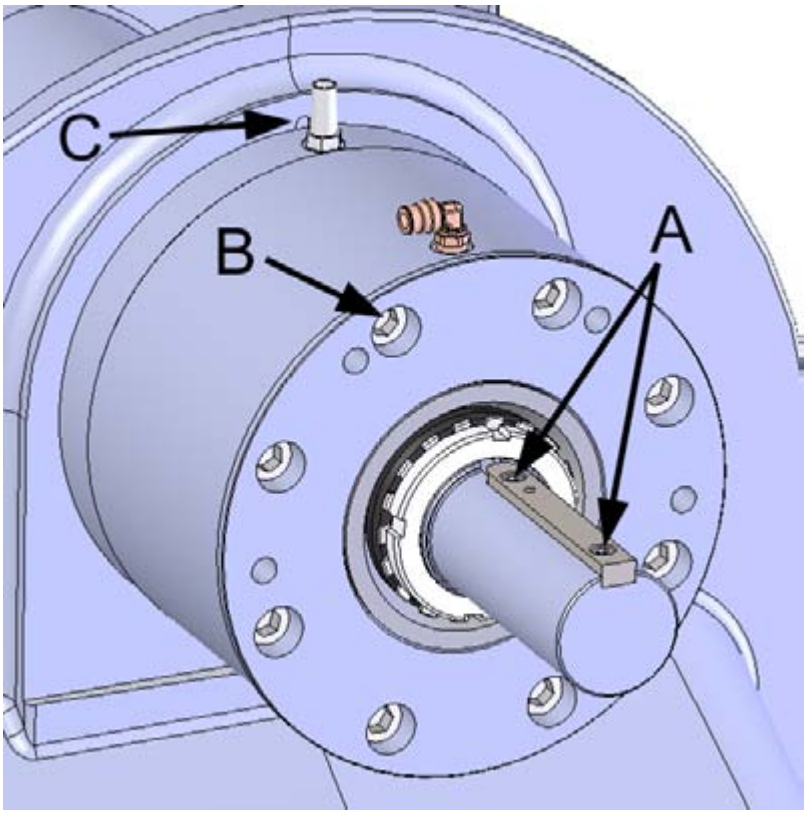


Figure 3. Removing the bearing housing

5. Open the bearing housing screws (6 pcs, figure 3, point B).

6. Pull the shaft off of the frame.

   Make use of the two grooves on the frame of the jet. You can use a screwdriver, for example, to loosen the bearing housing from the frame of the jet (figure 3, point C, 2 pcs).

   The bearing housing comes loose together with the shaft, bearings, and the mechanical seal. If the shaft does not come off with the bearing housing, pull off the bearing housing and then carefully loosen the shaft using the grooves on the sides of the seal housing (figure 8, point B).

7. Pull the bearing housing off the bearings (figure 4).

   The bearing housing comes off along with the shaft seal (figure 4, point A).

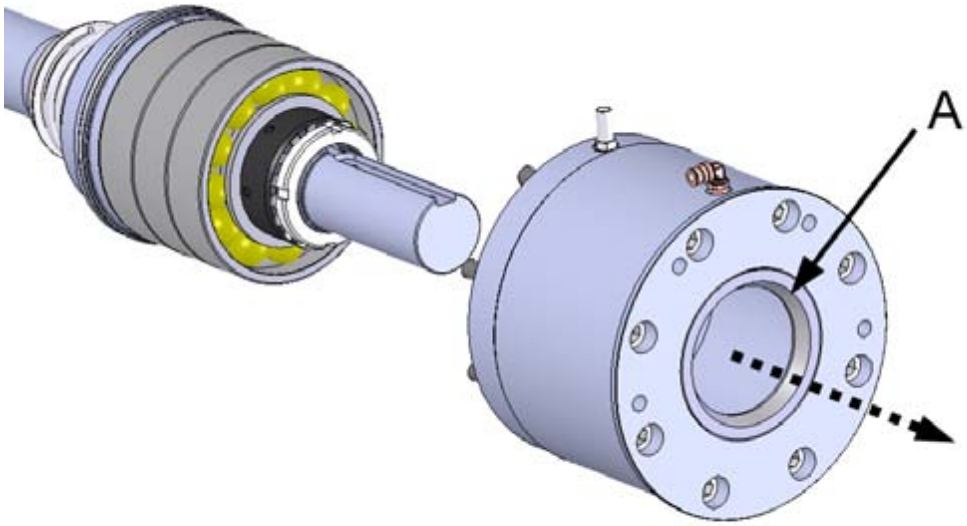


Figure 4. Bearing housing, shaft, bearings, and mechanical seal

8. Turn the lock washer tooth (figure 5, point A) up from the shaft nut groove, and unscrew the shaft nut (figure 5, point B).

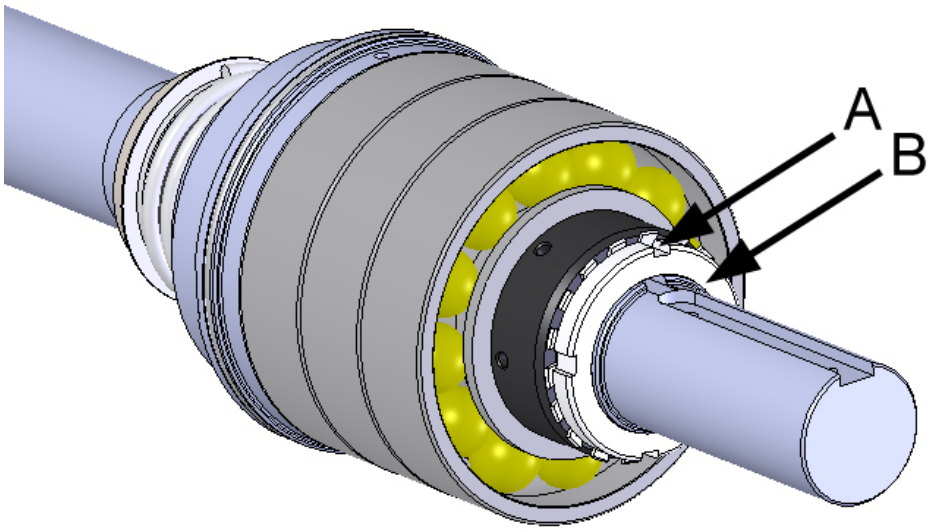


Figure 5. Removing the lock washer

9. Pull the bearings (figure 6, point C) off the shaft.

Before removing the mechanical seal (figure 6, point E), remove the support ring's (figure 7, point F) set screws (3 pcs, figure 7, point G).

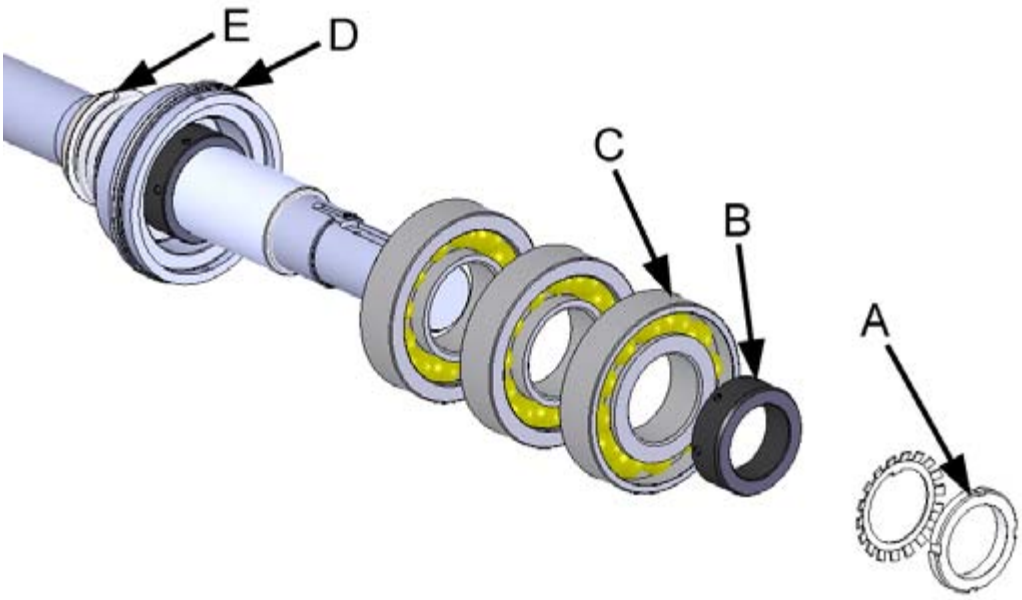


Figure 6. Removing the bearings from the shaft

A	Shaft nut
B	Sleeve
C	Bearing
D	Seal housing
E	Mechanical seal

Seals

Mechanical seal

The mechanical seal consists of several parts (figure 7).

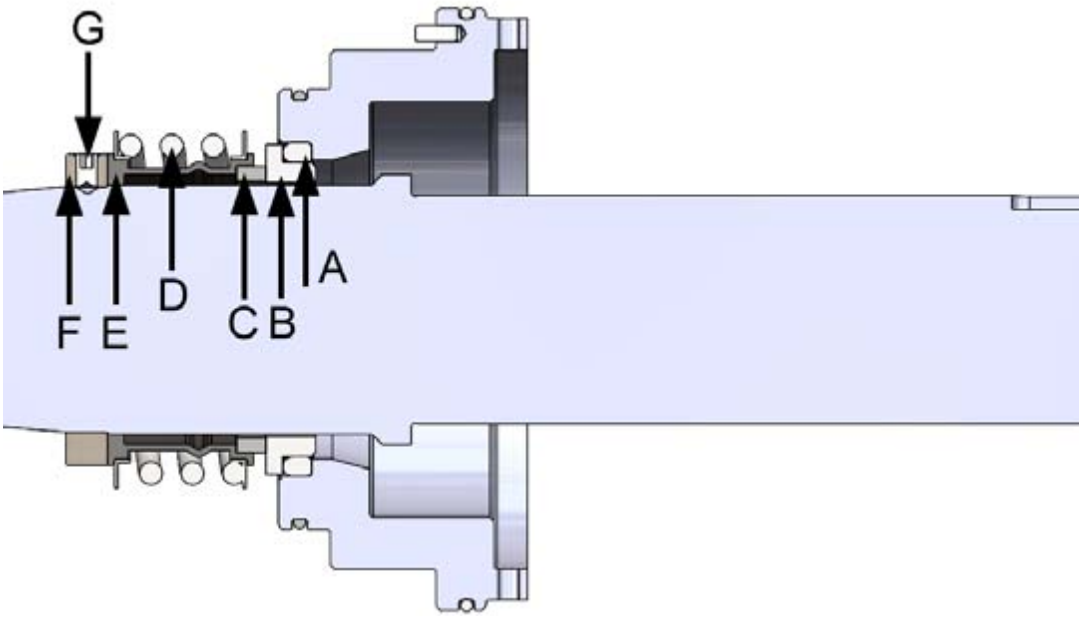


Figure 7. Mechanical seal

A	Static slip-ring seal
B	Static slip-ring, pressed to the bearing housing together with the seal
C	Rotating slip-ring
D	Spring for pressing the sealing faces against each other
E	Rubber bellows
F	Sealing support ring
G	Support ring set screws (3 pcs)

The slip surfaces are of silicon carbide, which is an extremely durable material. In order to achieve a high level of sealing, the surfaces must be perfectly smooth. If the slip surfaces show signs of mechanical damage, the seal must be replaced.

The water on the outside and the oil in the bearing housing both lubricate and cool the slip surfaces.

Parts A and B (figure 7) are removed by pushing them from the bearing side.

O-ring

An o-ring is used as sealing between the bearing housing and the frame of the jet (figure 8, point A).

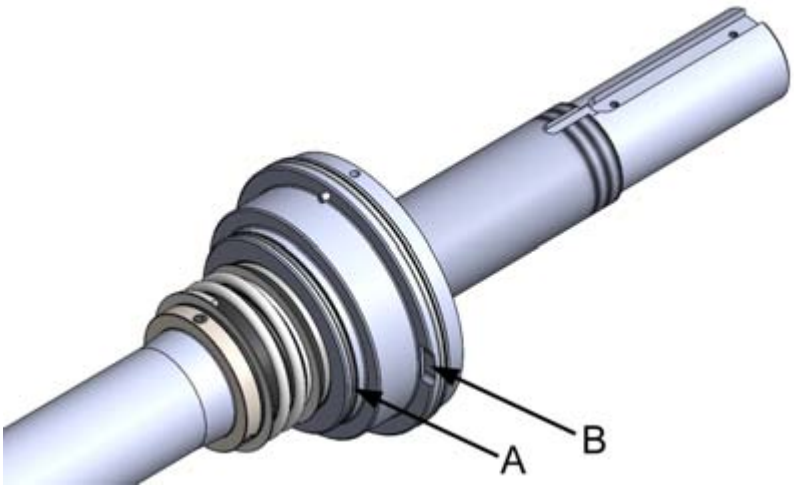


Figure 8. O-ring

When opening the bearing housing, there may be small amounts of white oil in the rubber bellows of the mechanical seal and the joint surface of the slip-ring. This is a sign of water in the bearing housing. This is completely normal and will not cause any problems. When the shaft rotates, the oil circulates through the oil reservoir and the water gathers at the bottom of the reservoir.

Shaft seal

A shaft seal that seals the front end of the bearing housing is attached to the bearing housing. The seal lip rubs against the surface of the sleeve (figure 6, point B). The shaft seal detaches towards the coupling flange and is crimped to the bearing housing. The seal can be replaced without detaching the bearing housing from the frame (figure 9).

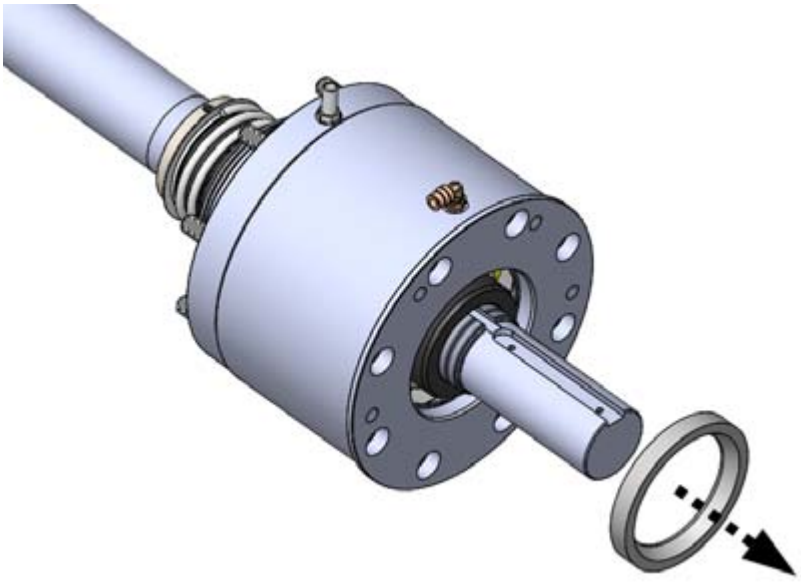


Figure 9. Shaft seal of the bearing housing

2.1.2. Repairing the front bearing

Under normal circumstances, the operating life of the front bearing is thousands of driving hours. However, if the lubrication weakens due to, for example, the failure of the seal or dirty oil, the operating life of the bearing will decrease rapidly. Using a worn rear bearing also shortens the life span of the front bearing. A worn bearing will make noise and may cause the bearing housing to overheat.

The wearing parts of the front bearing include the bearings, mechanical seal, and front shaft seal. All of the wearing parts should be replaced every time the bearing is replaced.

When replacing the bearings, check the following issues:

- straightness of the shaft
- location of the mechanical seal on the shaft (the surface must be free of scratches)
- external condition of the bearing housings
- external condition of the coupling flange

Measuring the straightness of the shaft

The straightness of the shaft is measured from three points.

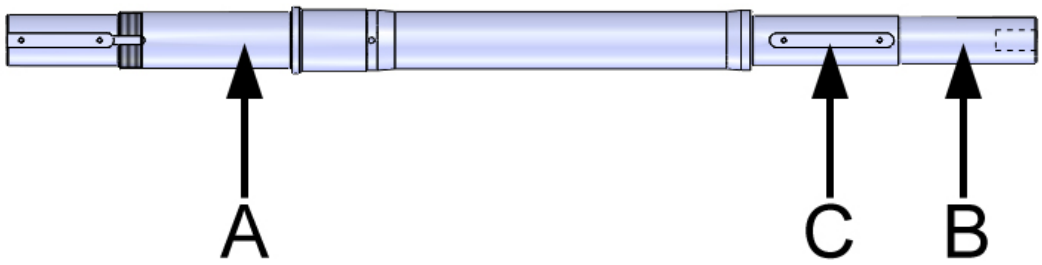


Figure 10. Measuring the straightness of the shaft

A	Supporting point 1
B	Supporting point 2
C	Measuring point

The maximum permissible deviation measured from the surface of the shaft is 0.15 mm, in which case the dislocation of the centre line is 0.075 mm.

NOTE!

Measure the straightness carefully.

Excessive deviation in the straightness will cause several problems, the most significant being the excessive wearing of the impeller and bearings.

2.1.3. Assembly of the front bearing

The front bearing must be assembled before it can be reinstalled. Clean all parts of old lubricants and dirt before assembly.

Assembly of the front bearing:

1. Install the mechanical seal.

   Be careful not to damage the slip-ring (figure 11, point D) during installation. If the seal is pressed into its place in a slanted position, and the slip-ring can scratch the surface of the shaft, the slip-ring may be damaged.

   1.1. Lubricate the surface of the shaft where the rubber bellows rest (figure 11, point A).

   1.2. Fit the parts of the mechanical seal onto the shaft together with the sealing housing from the rear end of the shaft. Follow the order shown in the figure (figure 11).

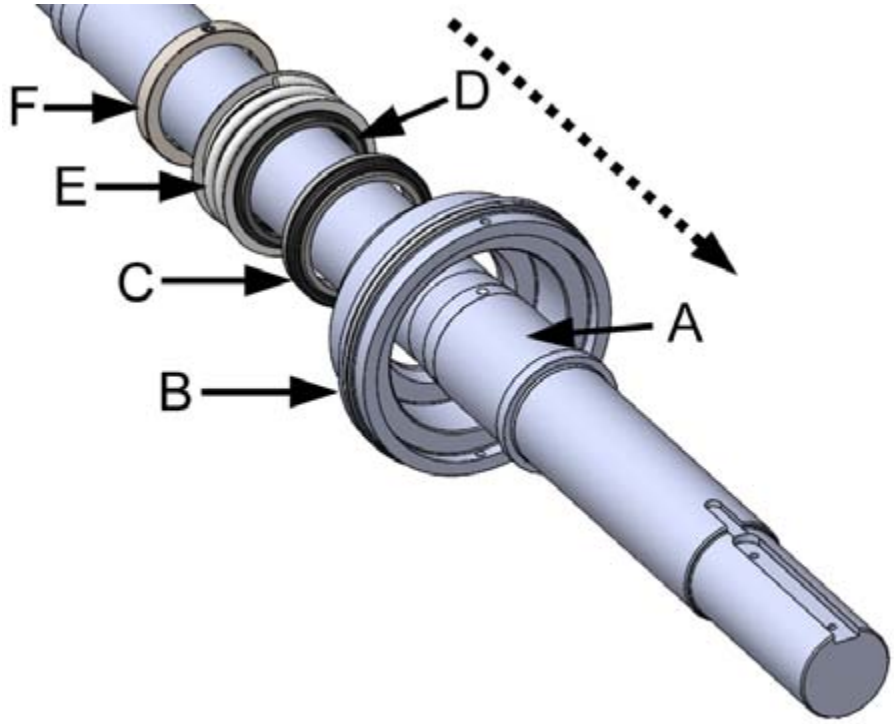


Figure 11. Installing the mechanical seal

A	Surface to be lubricated
B	Seal housing
C	O-ring and the static part of the mechanical seal
D	Slip-ring
E	Rubber bellows
F	Support ring

1.3. Fit the support ring in place and tighten the set screws.

The rubber bellows will not move on the shaft surface if it is not lubricated.

CAUTION!

Only special lubricating gel that vaporises between the rubber and shaft may be used for the lubrication.

If the lubricant used for the rubber bellows contains oil, the bellows might rub against the shaft surface and thereby cause insufficient sealing.

If the gel is not available, the bellows may be lubricated with a small amount of water.

The rubber bellows is pressed tightly against the support ring.

1.4. Push the rotating part of the mechanical seal (figure 7, points C, D, and E) into place against the support ring.

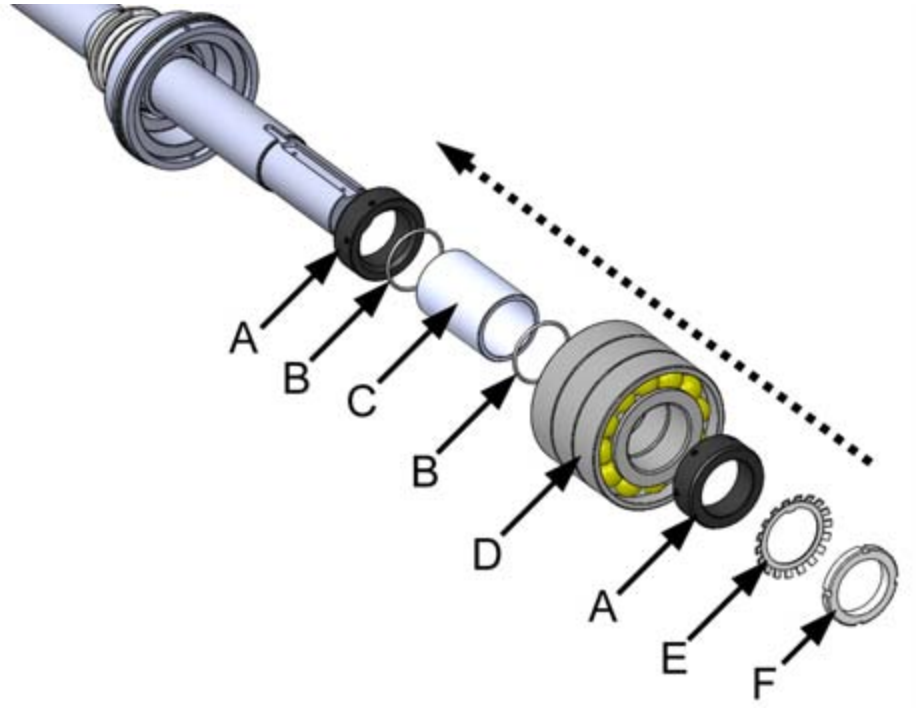


Figure 12. Pushing the bearings onto the shaft

A	Sleeve (2 pcs)
B	O-ring (2 pcs)
C	Shaft sleeve
D	Bearings
E	Lock washer
F	Shaft nut

2. Assemble the bearings.

   Note that the components must be fitted on to the shaft from the front end of the shaft.

2.1. Fit the sleeve, the o-rings and the shaft sleeve on to the shaft in the order shown in the figure (figure 12, points A, B and C).

It is advisable to lightly lubricate the o-rings using waterproof petroleum jelly, for example, before installation. This will prevent them from wearing down during installation.

2.2. Push the bearings onto the shaft.

Note that the bearings must be installed in the correct way (figure 13).

2.3. Fit the sleeve onto the shaft (figure 12, point A).

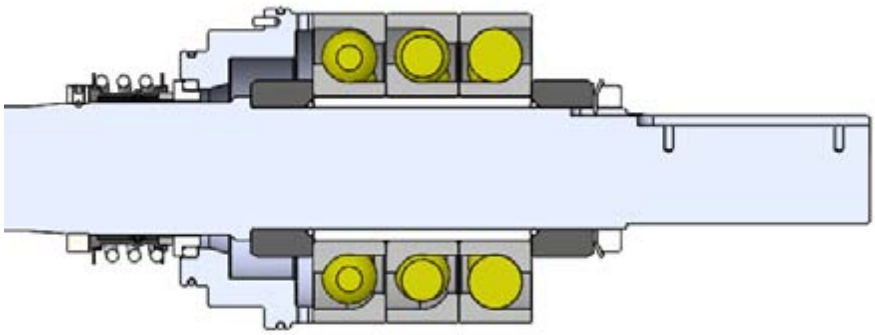


Figure 13. Bearings (cross-section)

3. Fit the lock washer onto the shaft (figure 12, point E) and screw the shaft nut (figure 12, point F) into place.

Tighten the nut by first tightening it against the bearings by hand and then use a shaft nut wrench to tighten it enough to make one of teeth of the lock washer connect with the groove in the nut. Finish by turning the tooth of the lock washer into the shaft nut groove (figure 14, point B).

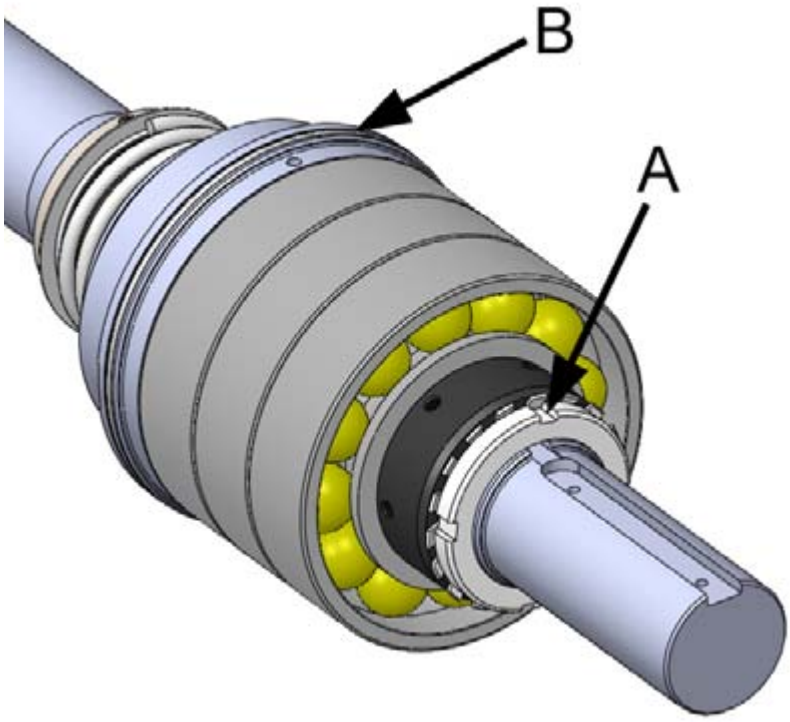


Figure 14. The lock washer and the shaft nut

4. Lubricate the inner rims of the bearing housing and press the shaft seal into the bearing housing, making sure that it is correctly oriented (figure 15).

   If the shaft seal is incorrectly oriented, oil will leak out from the front bearing. Make sure that the o-ring between the seal housing and the bearing housing is in place (figure 14, point B).

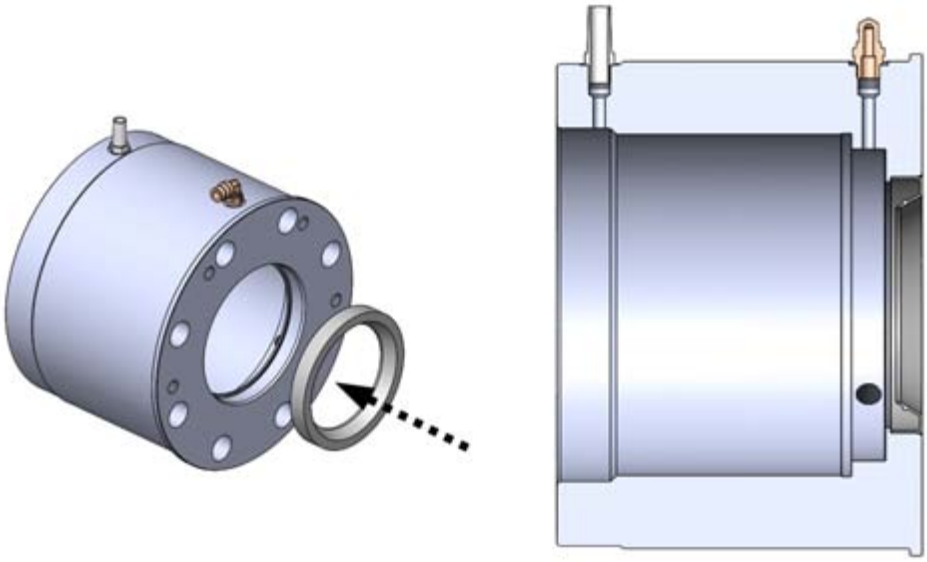


Figure 15. Installing the shaft seal into the bearing housing and a cross-section of the installation

5. Push the lubricated bearing housing onto the bearings.

   Make sure that the bearing housing's hose fittings (figure 16, point A) and the dowel pin on the front surface of the sealing housing (figure 16, point B) are aligned. This way the hose fittings are correctly oriented on the top of the bearing housing.

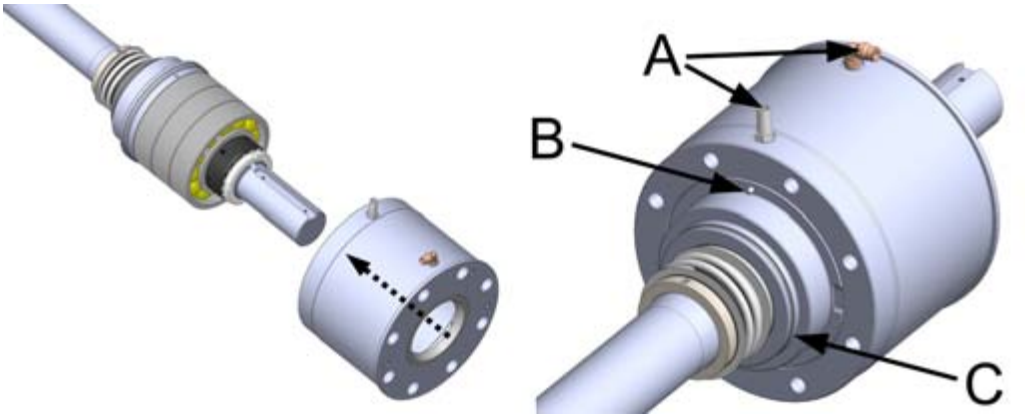


Figure 16. Installing the bearing housing

6. Place the bearing housing fastening screws (8 pcs, figure 17, point C) in the holes and install the coupling flange.

   6.1. Place the parallel key in the key seat (figure 17, point B) and tighten its fastening screws (figure 17, point A, 2 pcs).

   6.2. Push the coupling flange onto the shaft.

   6.3. Tighten the set screw on the side of the coupling flange (figure 2, point B).

   It is advisable to apply some petroleum jelly between the coupling flange and the shaft before installing the coupling flange. This will make the coupling flange easier to remove in the future.

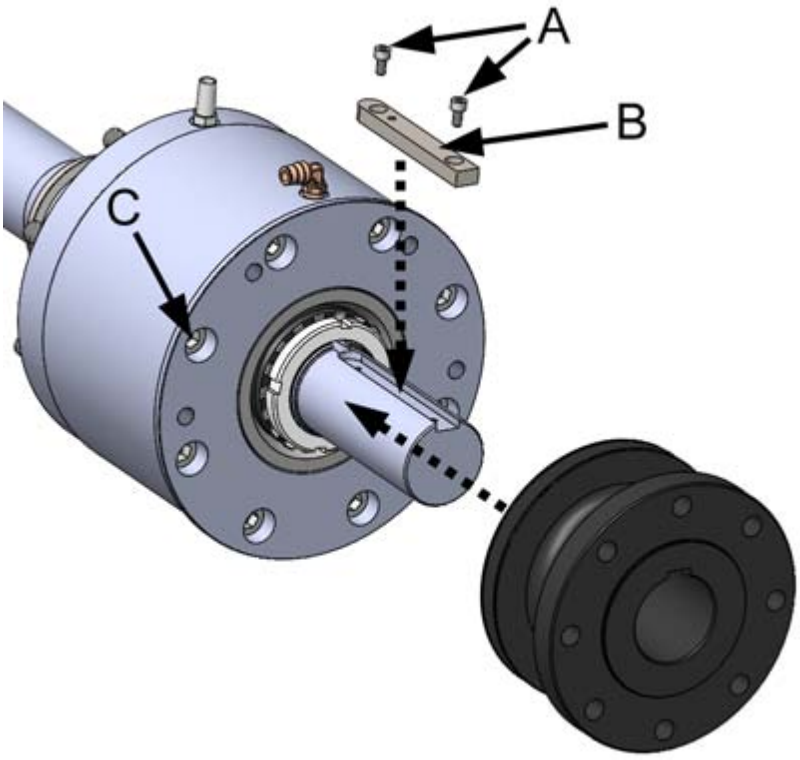


Figure 17. Installing the coupling flange

2.1.4. Installing the front bearing

Assemble the front bearing before installing (section 2.1.3. *Assembly of the front bearing*, page 11).

Front bearing installation:

1. Clean the part of the jet's frame where the bearing housing is to be installed.

   The installation surface must be free of any old sealing compound or other impurities and be straight.

2. Ensure the seal is tight by spreading sealing compound (such as Sikaflex 221) on to the innermost shoulder (figure 18).

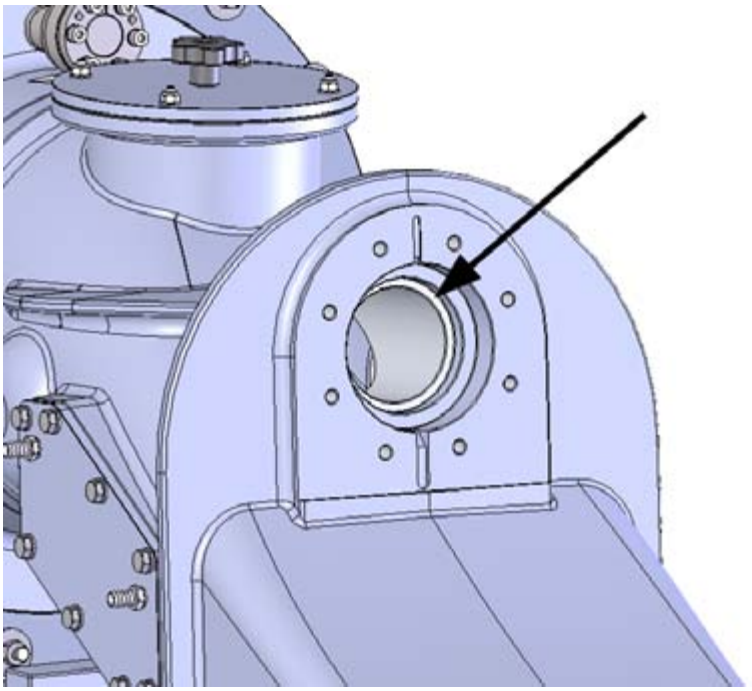


Figure 18. Shoulder

3. Make sure that the o-ring that seals the sealing housing against the frame of the jet (figure 16, point C) is in place.

4. Push the shaft bearing into its place through the hole in the frame of the jet (figure 19, point A), and tighten the bearing housing fastening screws (8 pcs, figure 19, point B) using an Allen wrench. Use a thread locking compound (such as Loctite 242).

CAUTION!

The shaft bearing assembly is heavy. Ask your assistant to hold the shaft from the other end of the impeller duct while you push the shaft bearing in through the hole on the frame of the jet.

Note that the sealing housing dowel pin (figure 16, point B) fits into the hole on the frame of the jet (figure 19, point C).

The tightening torque of the screws is 75 Nm.

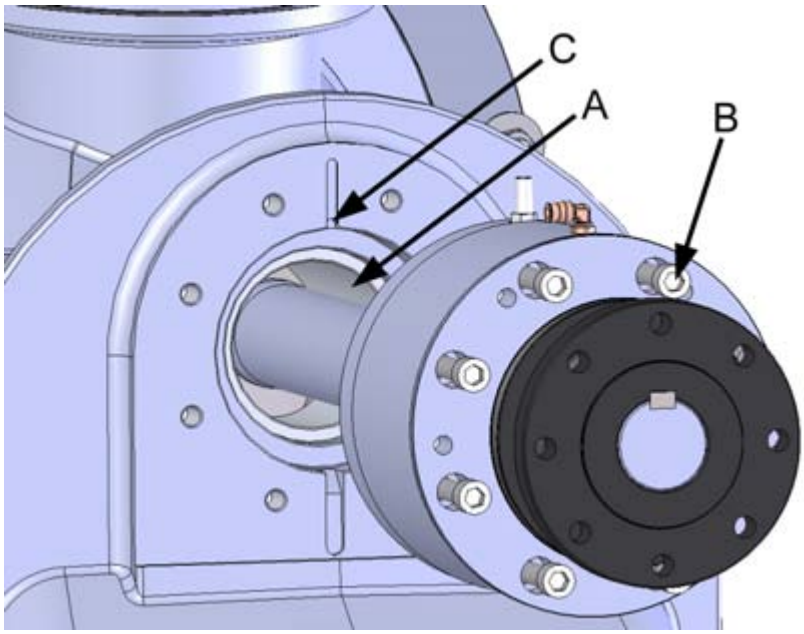


Figure 19. Attaching the bearing housing

5. Install the impeller (section 3.4. *Installing the impeller*, page 27).

6. Install the stator (section 6.3. *Installing the stator*, page 67), the steering nozzle (section 5.1.3. *Installing the steering nozzle*, page 53and the reversing deflector (section 4.1.3. *Installing the reversing deflector*, page 33)

7. Install the hydraulic pump (section 4.3.3. *Installing the hydraulic pump*, page 47).

2.2. Rear-end bearing

2.2.1. Rear-end bearing disassembly

1. Remove the stator (section 6.1. *Removing the stator*, page 63).

2. The water-lubricated rear end bearing is attached to the stator as an interference fit. The water-lubricated bearing is detached by pulling it out of the stator using an expanding extraction tool.

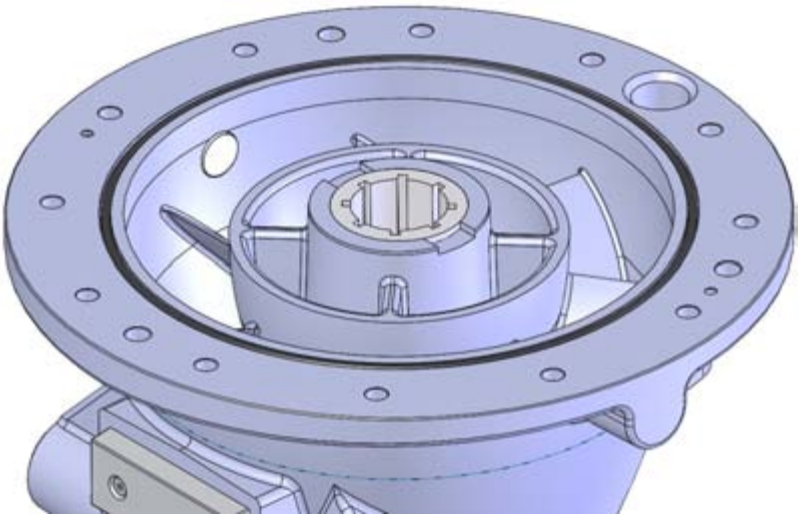


Figure 20. Detaching the rear end bearing from the stator

2.2.2. Repairing the rear end bearing

Bearing

The water-lubricated bearing cannot be repaired. As a result, it must always be replaced with a new one when it is detached from the stator.

Shaft sleeve

There is a sleeve at the rear end of the shaft (figure 21, point A). A worn sleeve can be replaced. There is a spacer (figure 21, point C) at the end of the shaft, pressing the sleeve and the impeller into place.

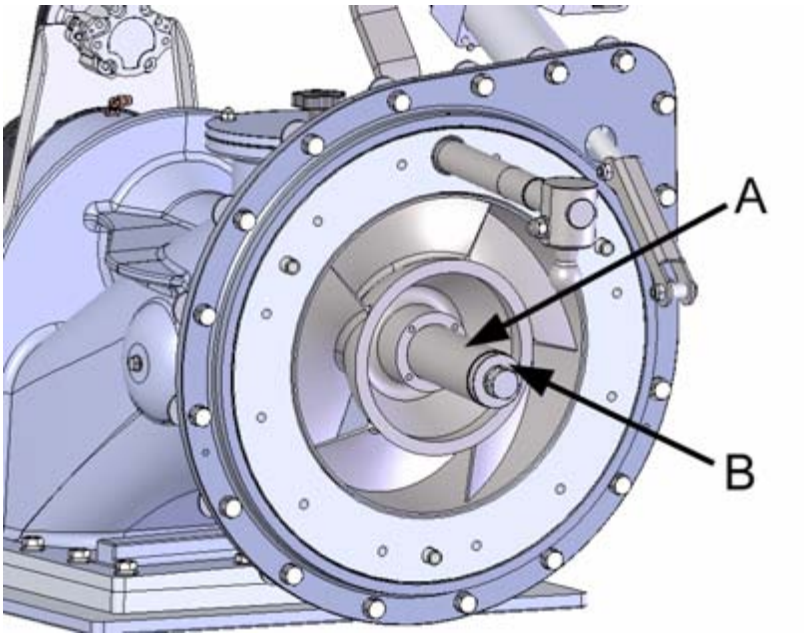


Figure 21. Shaft sleeve

Removing the shaft sleeve:

Open the screw at the end of the shaft and pull the sleeve off the shaft.

2.2.3. Installing the rear end bearing

Before installation, ensure that the bearing housing hole in the stator is clean and intact.

Push the slide bearing into the stator hole (figure 22, point A) until the front surface of the bearing (figure 22, point C) is flush with the edge of the stator hole (figure 22, point B).

The fit is tight, so it is advisable to use a press, for example, to help with the installation of the bearing. The bearing should preferably be pushed into place using a press area the size of the bearing's outer diameter, so that pressure is evenly distributed. This will reduce the risk of damage to the bearing during installation.

TIP!

If possible, cool down the bearing in a freezer, for example, to shrink it down. This will make installation easier.

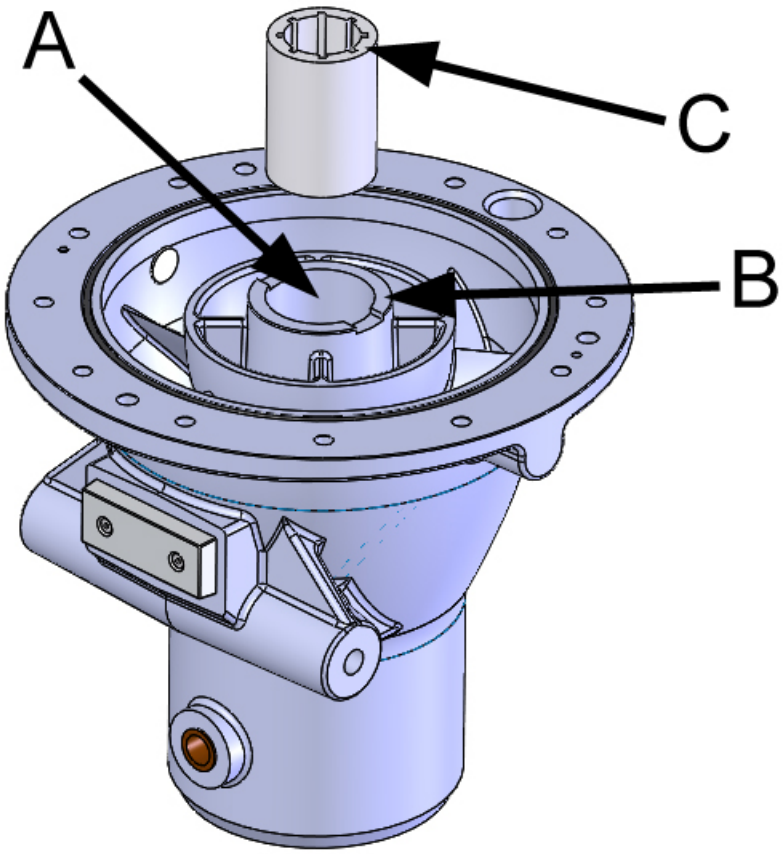


Figure 22. Rear end bearing installation

2.3. Intermediate shaft

The intermediate shaft is the transmission shaft between the motor and jet. Usually, the intermediate shaft has been acquired and installed by the boat manufacturer.

The most common types of intermediate shaft are the constant speed shaft and the cardan shaft. In addition, various flexible shaft couplings are used.

The intermediate shaft is attached to the jet's coupling flange and the flywheel or gearbox. An adapter flange can be used between the jet and the shaft.

The manufacturer's instructions must always be followed in the maintenance, repair, and installation of the intermediate shaft.

3. Impeller

The impeller (figure 23, point A) is attached to the jet's main shaft. As the impeller rotates, it generates pressure that is then transformed into the flow rate.

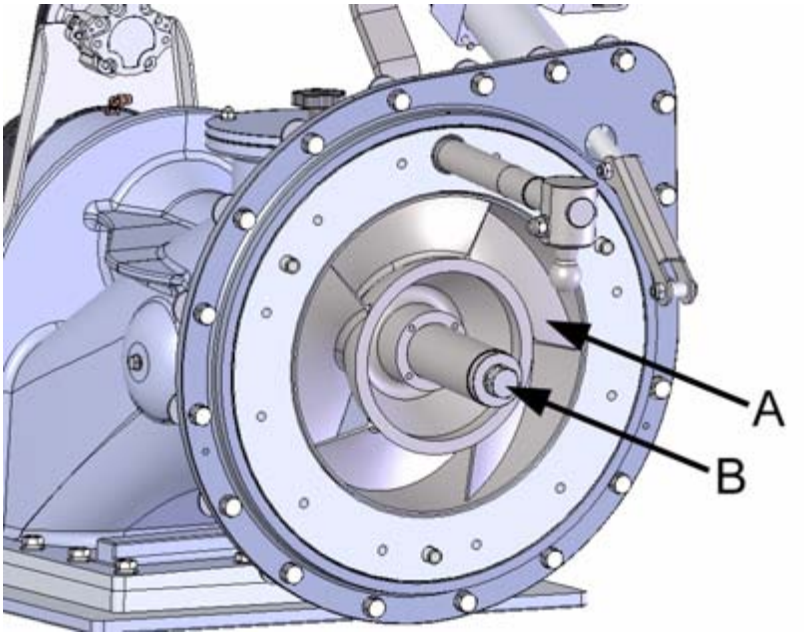


Figure 23. Impeller

The impeller is attached to the shaft with a screw located at the end of the shaft (figure 23, point B), which presses the impeller through a spacer and a sleeve against the shim washers located at the front of the impeller (figure 24, point A). The torque is transmitted to the shaft using a key (figure 24, point B).

The impeller is located in the cone duct, which allows the gap between the blade and the duct wall to be quite small.

There are shim washers of various thicknesses (figure 24, point A) on the front side of the impeller. These define the location of the impeller in the duct and transmit the thrust from the impeller to the shaft.

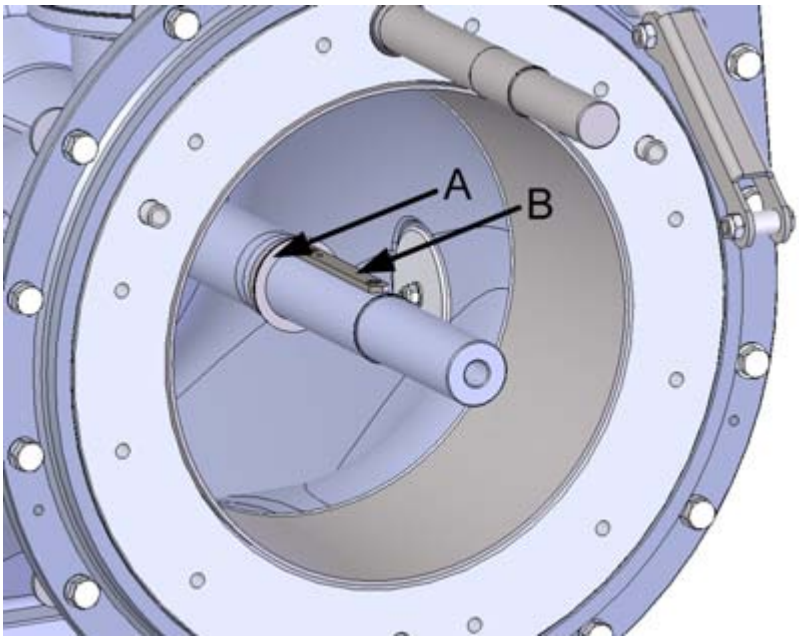


Figure 24. Impeller key and shim washers

3.1. Impeller type

The type of the impeller is defined according to the number, pitch, and surface area of the blades. The number and total pitch of the blades are unambiguous, but the surface area may vary according to the diameter and length of the blades.

The impeller type that is used varies according to the situation because the AJ 340 can be attached to various types of motors. Therefore, each impeller must be type-marked. The type marking has been punched into the rear of the impeller hub (figure 25). The type of the impeller must be declared, for example, when ordering a new impeller. The format of the type marking is "340-X/N+T.

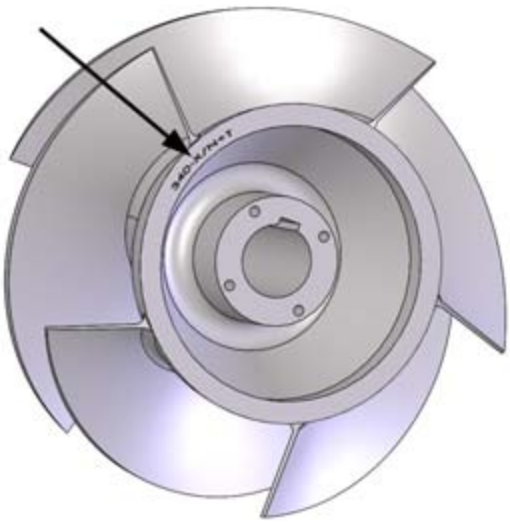


Figure 25. Impeller type marking

3.2. Removing the Impeller

Before removing the impeller, remove the stator (section 6.1. *Removing the stator*, page 63).

Removing the impeller:

1. Unscrew the screw located at the end of the shaft (figure 26, point A) and pull out the spacer (figure 26, point B) and the sleeve (figure 26, point C).

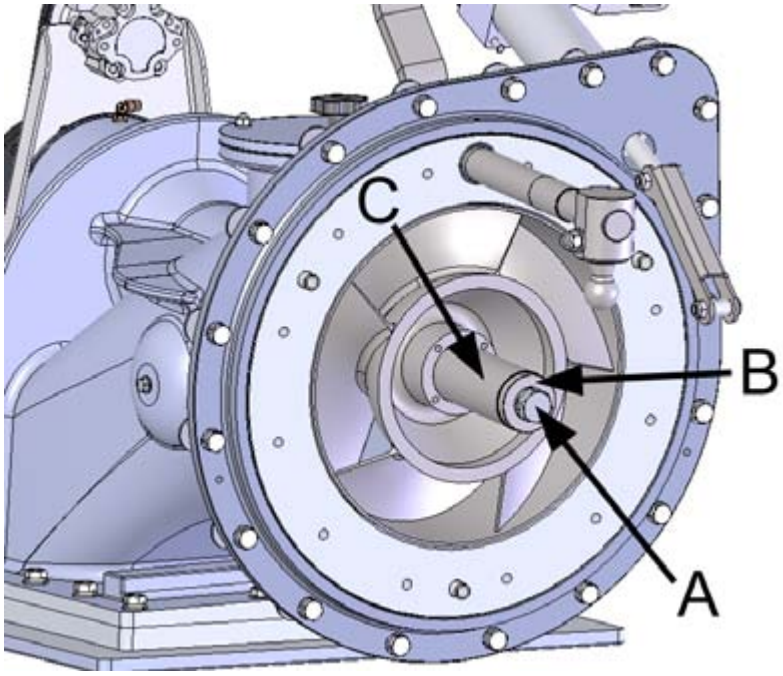


Figure 26. Removing the sleeve and the spacer

2. Remove the impeller.

   If needed, use an extraction tool. Fit the extraction tool over the shaft, push the screws through the holes on the flange of the extraction tool (figure 27, point B) and tighten them into the threads located at the end of the impeller (figure 27, point C). Pull out the impeller by tightening the screw at the end of the extraction tool using an Allen wrench (figure 27, point D). There is a pusher at the other end of the screw that presses against the jet's main shaft.

   The impeller extraction tool is available as an accessory. The product code is 11131.

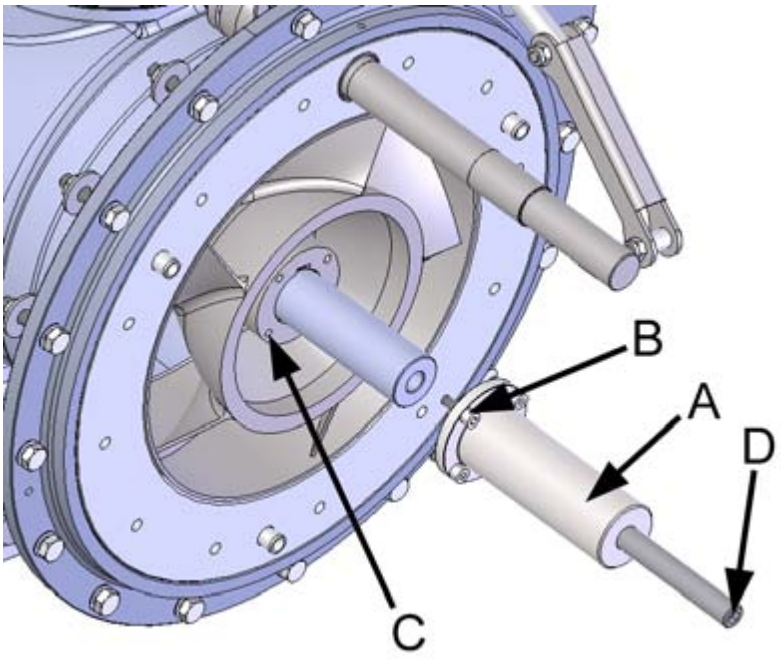


Figure 27. Impeller extraction tool

3.3. Repairing the impeller

Minor damages on the impeller can be repaired. Examples of this are dents to the front edge that can be ground out, and slightly bent blades that can be hammered back into their original position.

NOTE!

The impeller must be balanced after any repair operations.

If the diameter of the impeller becomes too small, the impeller must be replaced. The diameter of the impeller has become too small due to wear when the impeller gap grows too large and can no longer be reduced by removing shim washers (figure 24, point A).

The impeller is manufactured from acid-proof steel 1.4460.

Sanding the front edge

If necessary, a worn front edge can be sanded down. Please note that the front edge may not be too sharp or too round. A suitable rounding is approximately r = 1 mm (figure 28).

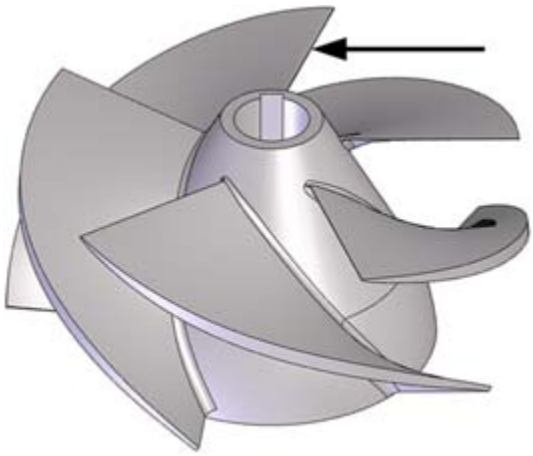


Figure 28. Front edge

Repairing bent blades

Slightly bent blades can be repaired by bending the blade with a forked tool.

3.4. Installing the impeller

New and repaired impellers are fitted in the same way.

Installing the impeller:

The thrust caused by the impeller is transmitted to the shaft through the sleeve (figure 29, point B) and the spacer ring (figure 29, point A). The sleeve consists of shim washers of varying thicknesses. The length of the sleeve can be adjusted in increments of 0.5 mm (approx. 0.02") by changing the number of shim washers. This way the impeller gap on the outer race becomes fit.

1. Find the right sleeve length by testing.

2. Push the spacer ring (figure 29, point A) and the sleeve (figure 29, point B) onto the shaft.

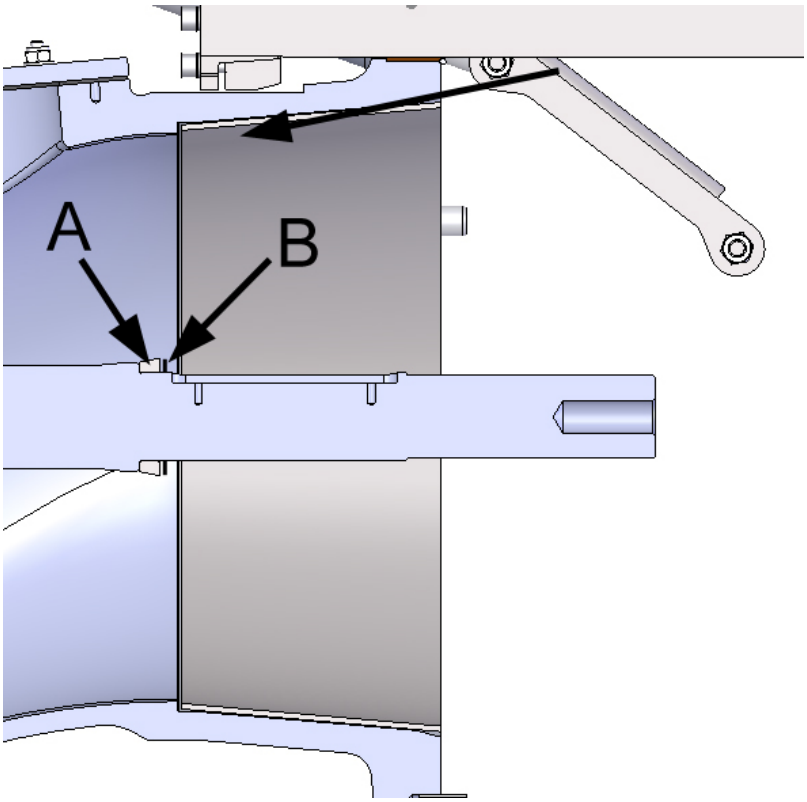


Figure 29. The spacer ring and the sleeve on the shaft

3. Place the impeller into the duct.

4. Measure the gap on the impeller outer race.

   The optimal gap is 0.4–0.7 mm for every blade.

   When you measure the gap, note that the shaft is not centred when the stator is removed, but the shaft's rear end hangs low and the whole gap is visible in the upper part of the duct.

> **CAUTION!**
>
> If the gap is too big, it will cause loss of power and reduce performance.

5. When you find the right sleeve length, place the key in the key seat (figure 30, point A), tighten the screws (2 pcs, figure 30, point B) and push the impeller on the shaft against the sleeve.

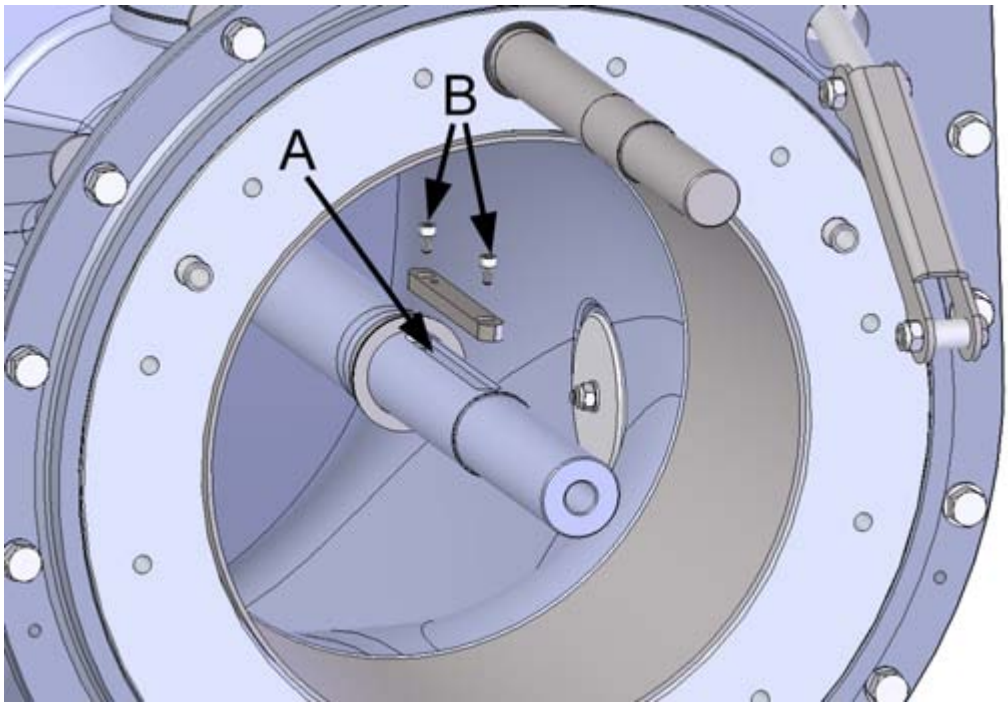


Figure 30. Key seat

6. Install the shaft sleeve, the spacer and the screw in place in reverse order to that when removing them (figure 21).

7. Install the stator and the steering nozzle in place in reverse order to that when removing them (section 5.1.3. *Installing the steering nozzle*, page 53).

4. Reversing deflector and operating hydraulics

The purpose of the reversing deflector is to create sufficient reverse thrust for reversing the boat. When the deflector (figure 31, point A) is lowered in front of the jet flow, it will turn the jet flow entirely or partially towards the bow, creating thrust. The operating principle allows for stopping even from high speeds because the deflector can be lowered even at full speed.

The reversing deflector is used through a hydraulic cylinder, controlled mechanically (figure 31, point B). A cable runs from the handle in the cabin to the operating lever of the cylinder (figure 31, point C). The hydraulic cylinder receives its power from a pump integrated in the jet (figure 31, point D), rotated from the coupling flange with a V belt.

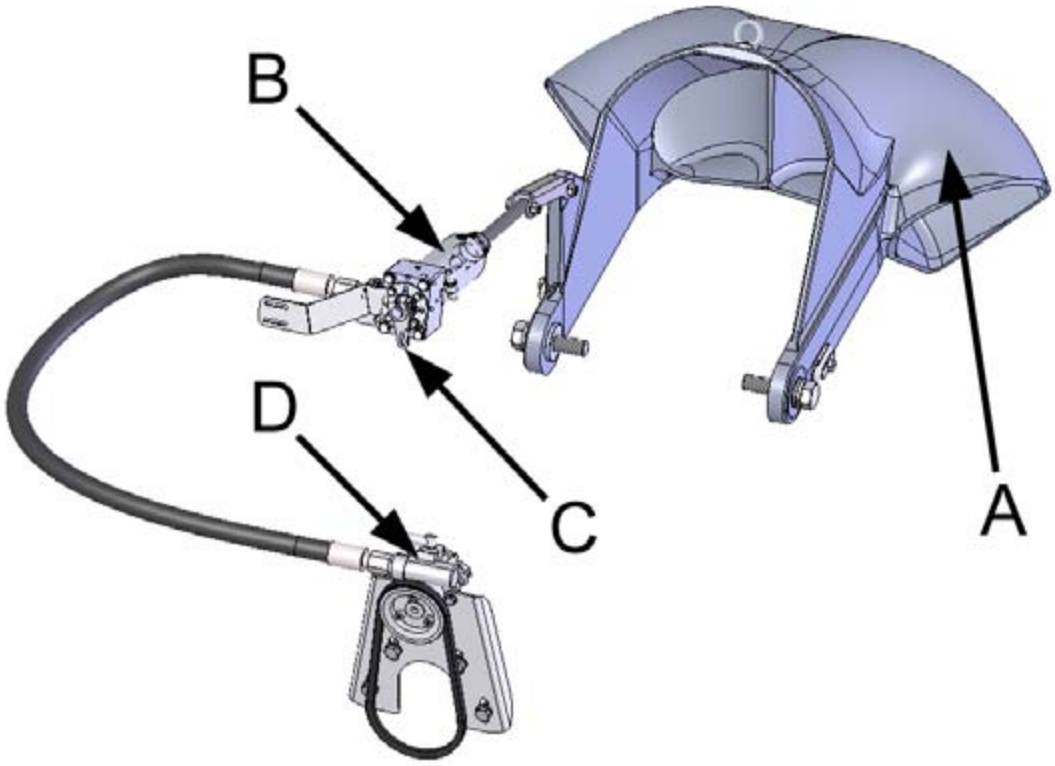


Figure 31. Reversing deflector and operating hydraulics

4.1. Reversing deflector

4.1.1. Removing the reversing deflector

Removing the reversing deflector:

1. Lower the reversing deflector past the steering nozzle.

   The steering nozzle must be centred when the reversing deflector is lowered.

2. Open the pivot bolt of the intermediate bar that connects the hydraulic cylinder to the reversing deflector (figure 32, point A).

It is advisable to hold the reversing deflector up while removing the pivot bolts so that the deflector does not accidentally fall down.

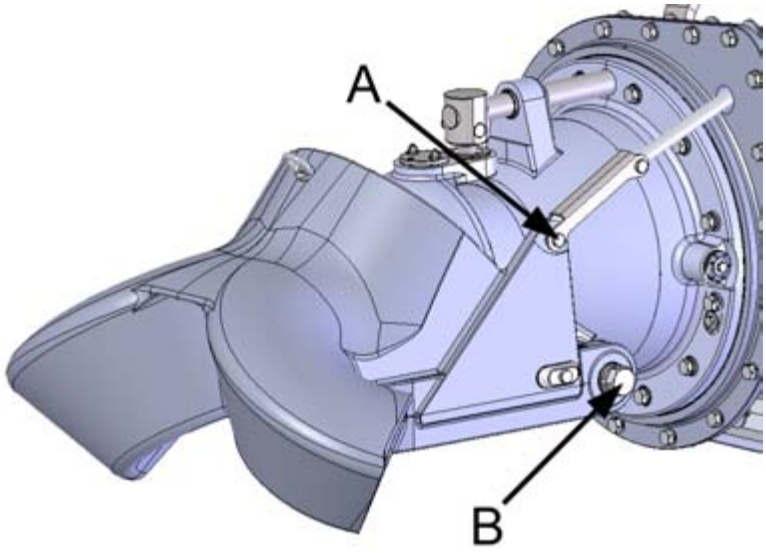


Figure 32. Removing the reversing deflector

3. Open the stator fastening screws (2 pcs, figure 32, point B).

> **WARNING!**
>
> Be careful not to drop the deflector.
>
> The deflector weighs approximately 25 kg.

4. If you need to replace the plastic bearings on the pivot bolts, they can be removed with a suitable mandrel.

   The plastic bearings are pushed to their place and can be removed by pushing (figure 33).

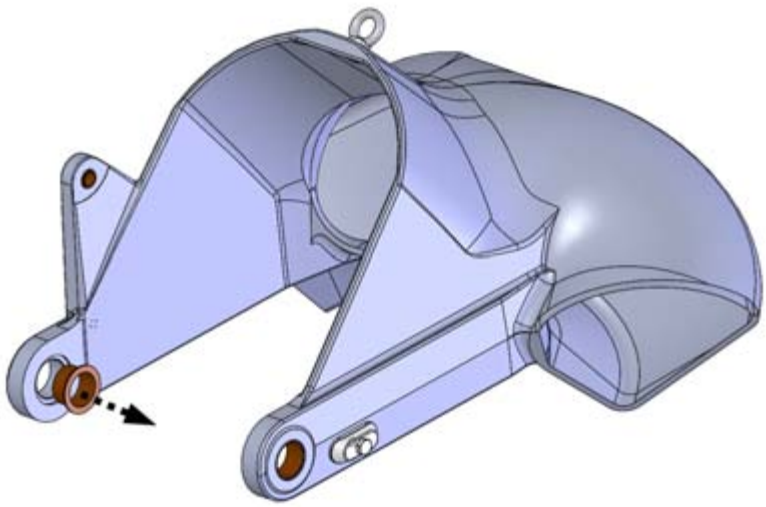


Figure 33. Removing the plastic bearings

4.1.2. Repairing the reversing deflector

The wearing parts of the reversing deflector are the plastic bearings and anodes. When the gap in the plastic bearings of the pivot bolts expands too much, the bearings must be replaced. The greatest permissible radial clearance is +1 mm. The articulation bearing of the hydraulic cylinder intermediate bar must also be replaced as necessary. The greatest permissible radial clearance is +1 mm.

The reversing deflector is cast aluminium (AlSi7Mg), and minor breakages can be repaired by welding. The filler metal for the welding is AlMg5. If the arms show breakages, the deflector must be replaced, not repaired.

NOTE!

Bare aluminium areas must be painted when welding the deflector. Use paints suitable for aluminium. Check the correct paint type from the paint supplier.

4.1.3. Installing the reversing deflector

The reversing deflector is attached to the holes on the frame of the stator using two M24 bolts. There is a plastic bearing and a sleeve between the bolt and the reversing defector on both sides of the deflector (figure 34).

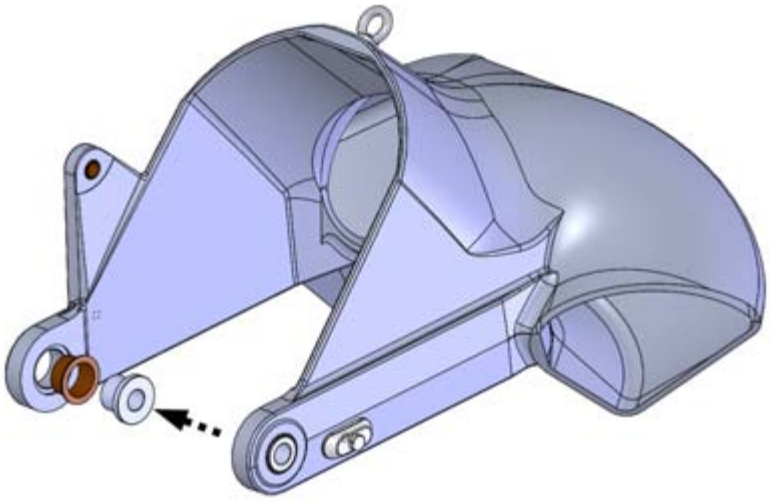


Figure 34. Plastic bearing and sleeve

1. Lift the reversing deflector into place in such a way that the holes in the deflector and the frame of the stator are aligned.
2. Set a spring washer (figure 35, point B) and a washer (figure 35, point C) to the ends of the bolts (2 pcs, figure 35, point A) and push the bolts through the holes on the reversing deflector (figure 35).

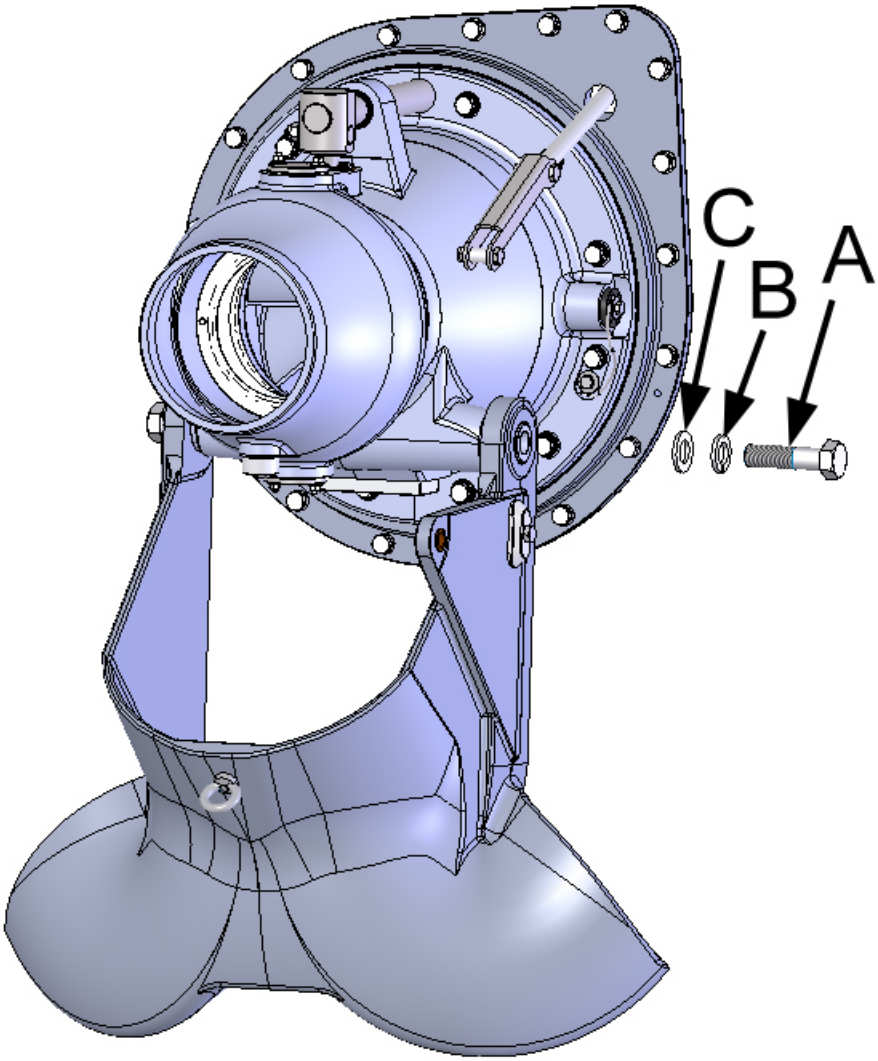


Figure 35. Installing the pivot bolts

3. Tighten the bolts.

   The tightening torque of the M24 bolt is 250 Nm.

4.2. Operating hydraulics

4.2.1. Removing the cylinder

Before you remove the cylinder, make sure you have a container for draining the oil from the hoses. Please note that it may not be necessary to completely drain the system: you can also put plugs at the ends of the hoses.

Removing the cylinder:

1. Remove the cable from the cylinder.

1.1. Remove the cable angle joint (figure 36, point A) from the control lever.

1.2. Remove the saddle fastener from the cable bracket (figure 36, point B).

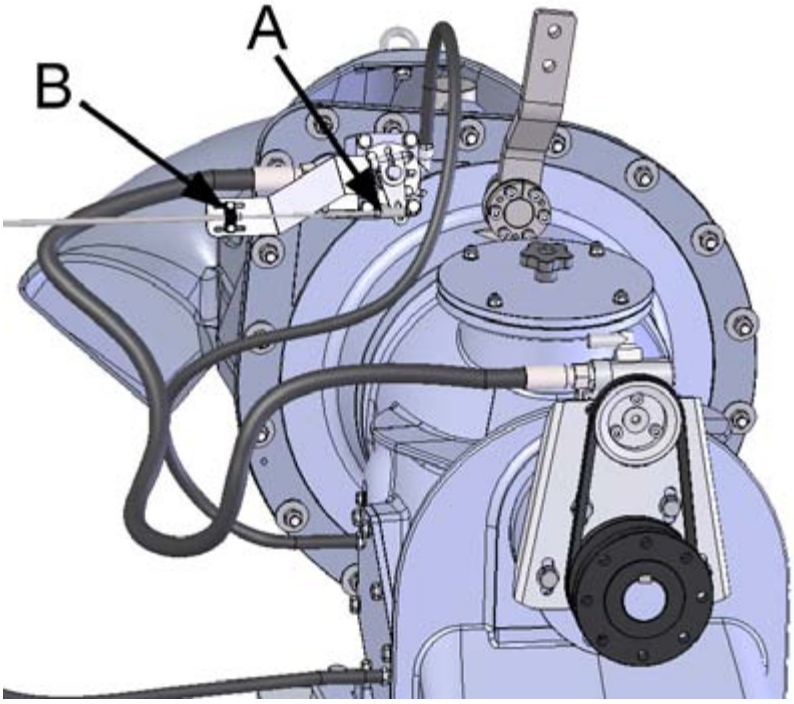


Figure 36. Removing the cable

2. Remove the cylinder pressure hose (figure 37, point A) and return hose (figure 37, point B) from the valve and drain the oil into a container.

   Alternatively, you can plug the ends of the hoses.

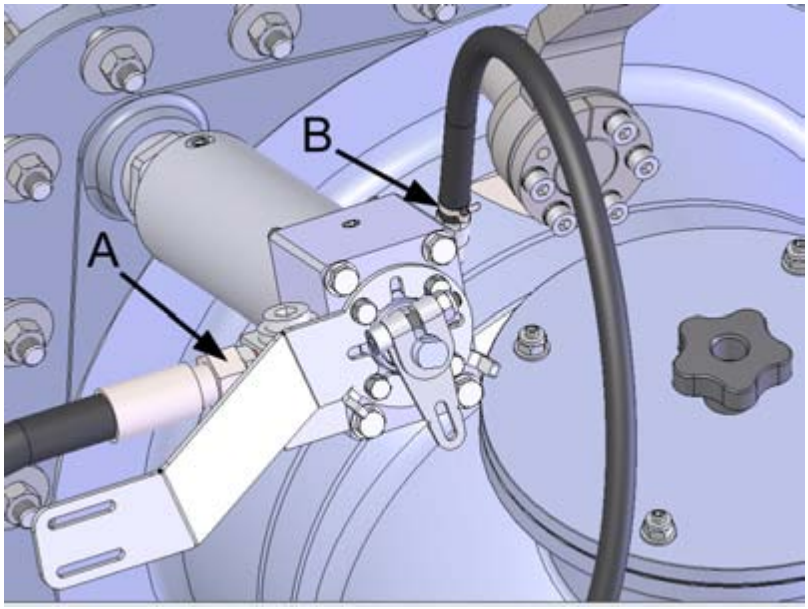


Figure 37. Removing the hoses

3. Open the pivot bolt of the intermediate bar that connects the hydraulic cylinder to the reversing deflector (figure 38, point A).

   It is advisable to hold the reversing deflector up while removing the pivot bolts so that the deflector does not accidentally fall down.

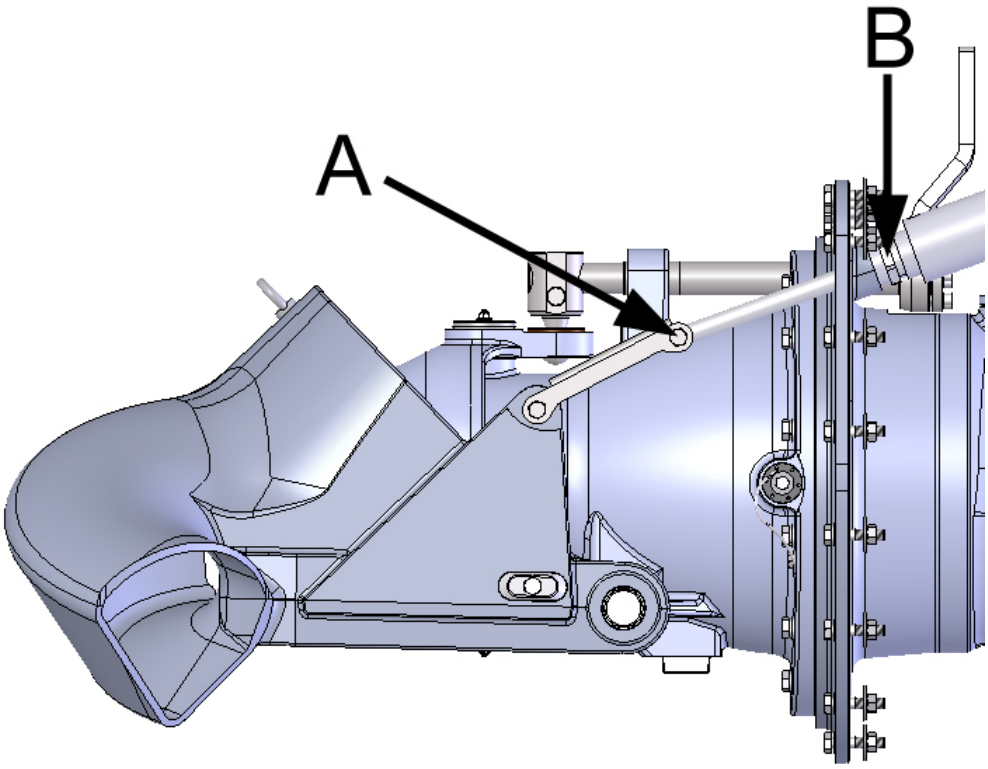


Figure 38. Removing the cylinder

4. Open the fastening nut of the hydraulic cylinder (figure 38, point B).

   If you cannot open the nut with conventional tools, you can use special tool 10718.

5. Unscrew the cylinder from the frame of the jet towards the engine room (figure 39).

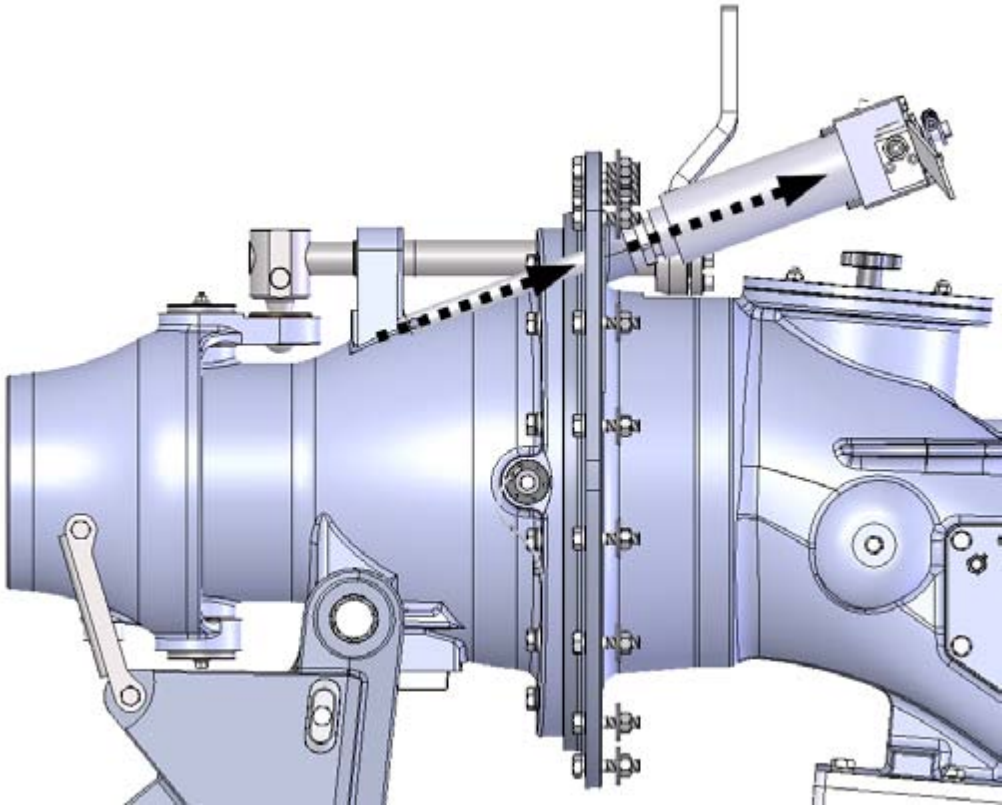


Figure 39. Pushing the cylinder

4.2.2. Repairing the cylinder

Worn or damaged parts of the cylinder can be replaced.

The product code for the sealing kit is P9904.

NOTE!

Only a person with appropriate training is allowed to open the cylinder or carry out the maintenance and repair operations of the cylinder.

For more information on training courses, please contact the manufacturer or your local retailer.

4.2.3. Installing the cylinder

The cylinder is installed in the reverse order to which it was removed.

1. Treat the threads of the hydraulic cylinder nut (figure 40, point A) with sealing compound (e.g. Sikaflex 221).

2. Screw the nut all the way down on the thread at the end of the cylinder pipe (figure 40, point B).

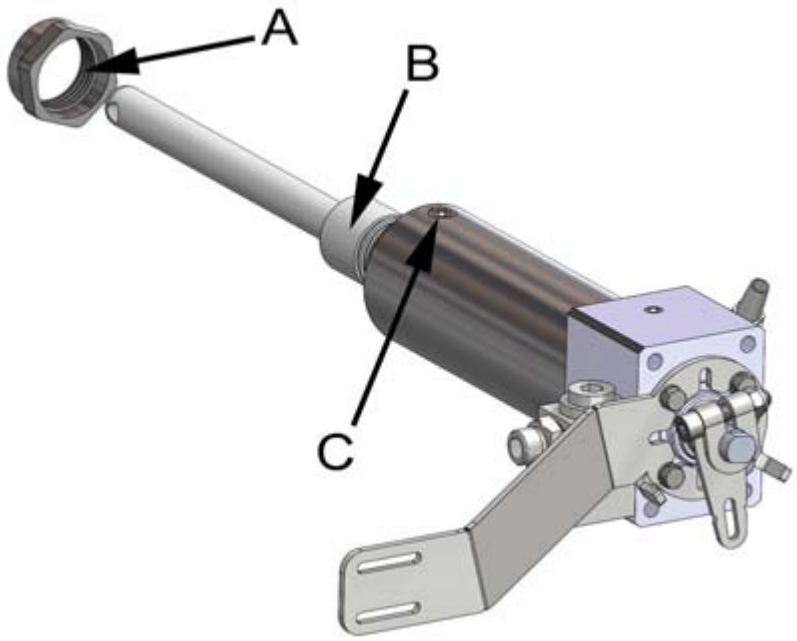


Figure 40. Installing the cylinder

3. Apply sealing compound (e.g. Sikaflex 221) on the bushing thread of the adapter part (figure 41, point A) so that the bushing hole is sealed completely.

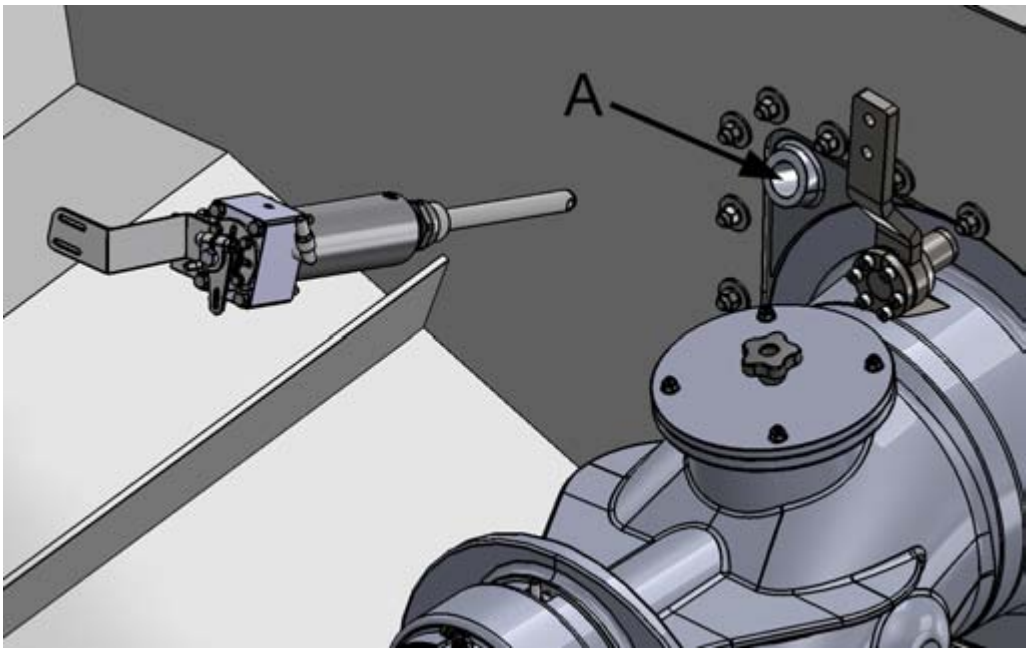


Figure 41. Attaching the hydraulic cylinder

4. Screw the hydraulic cylinder onto the adapter bushing (figure 41).

The hydraulic cylinder must be screwed far enough onto the threads to reach the correct measurement (X=31 mm, figure 42). The correct orientation of the hydraulic cylinder is determined by the desired direction of the outlets and the control cable.

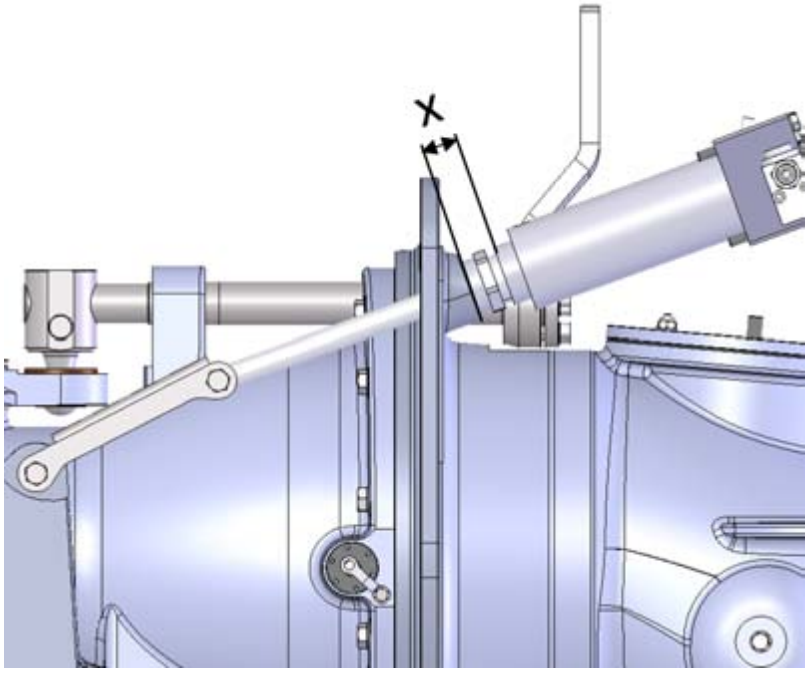


Figure 42. Cylinder position

5. Tighten the nut against the adapter part.

   The nut prevents the hydraulic cylinder from moving on the adapter bushing thread.

6. Ensure that sealing compound has been squeezed out of the seams throughout, and wipe the excess compound off the piston rod.

7. Once you have installed the reversing deflector, install the intermediate bar between the cylinder and the deflector (figure 43).

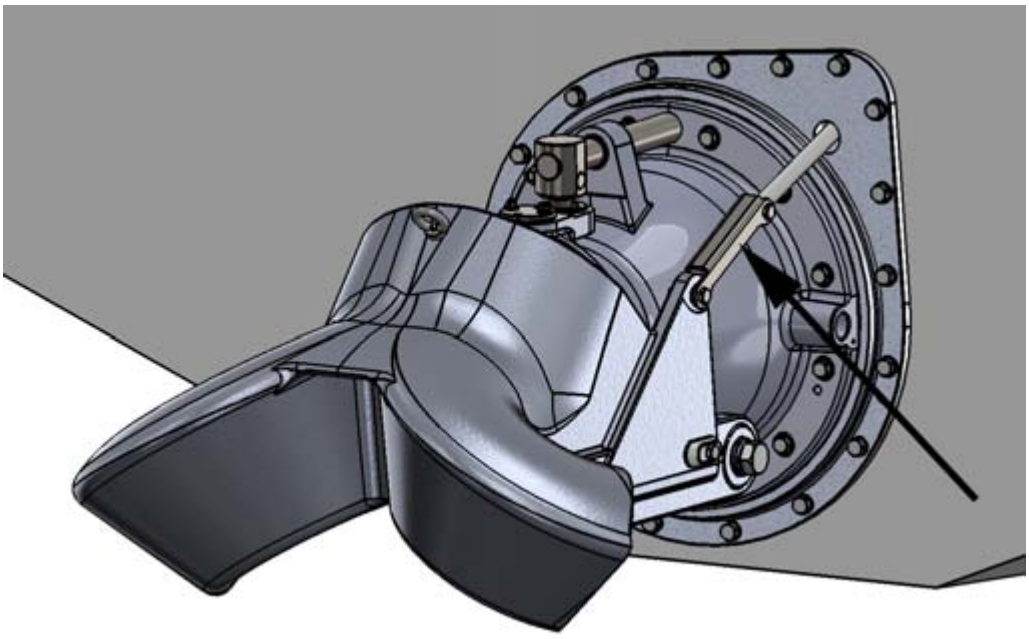


Figure 43. The intermediate bar between the hydraulic cylinder and the reversing deflector

4.2.4. Cylinder adjustment

When you start the engine for the first time, make sure that you have oil available to add to the reversing deflector control hydraulic system.

Fill the reservoir with oil before you start the engine. After you start the engine and put it into forward gear, the oil is transferred from the reservoir into the system and the pump automatically removes air from the system. If the oil level decreases in the reservoir, add some oil through the oil reservoir cap. There is a dipstick in the reservoir that you can use to check the oil level (figure 44). Every now and then, move the hydraulic cylinder's operating lever back and forth (figure 45) so that the cylinder fills with oil.

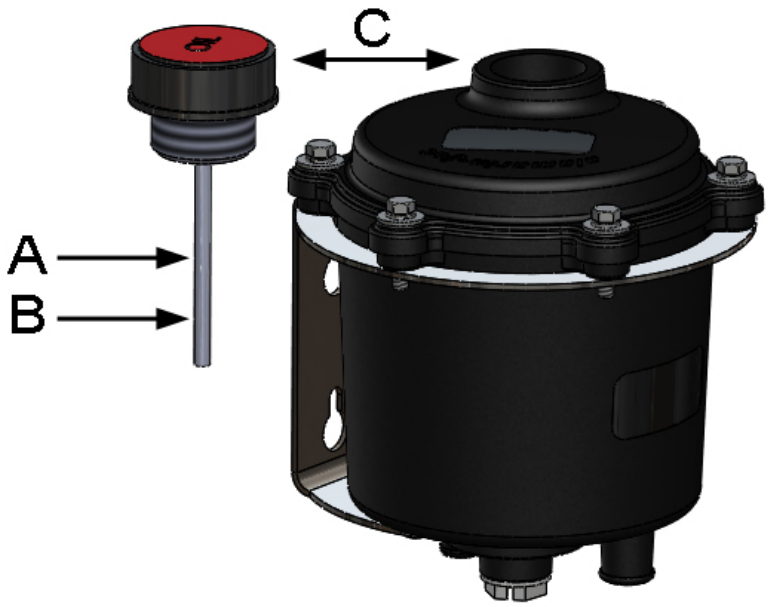


Figure 44. Checking the oil level

A	Maximum level
B	Minimum level
C	Cap

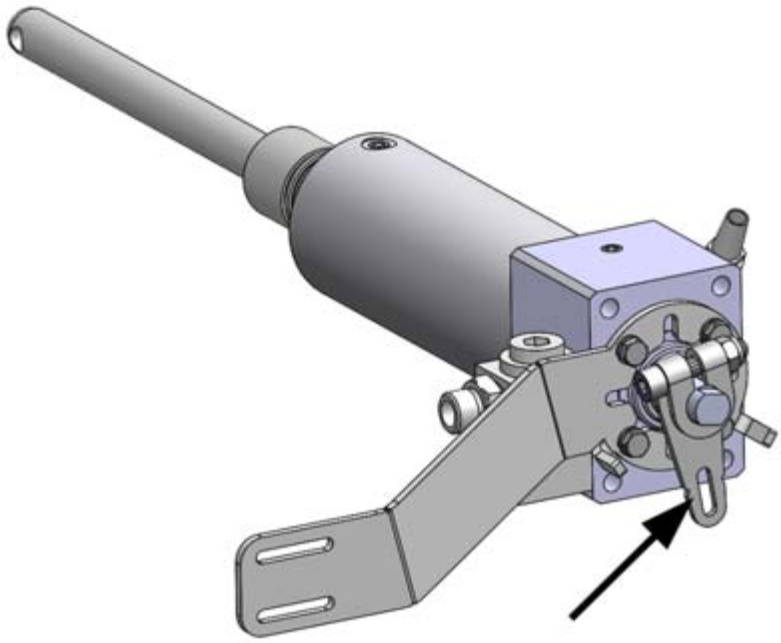


Figure 45. Operating lever

Adjusting the cylinder:

1. Detach the control cable from the end of the cylinder operating lever (figure 46, point A).

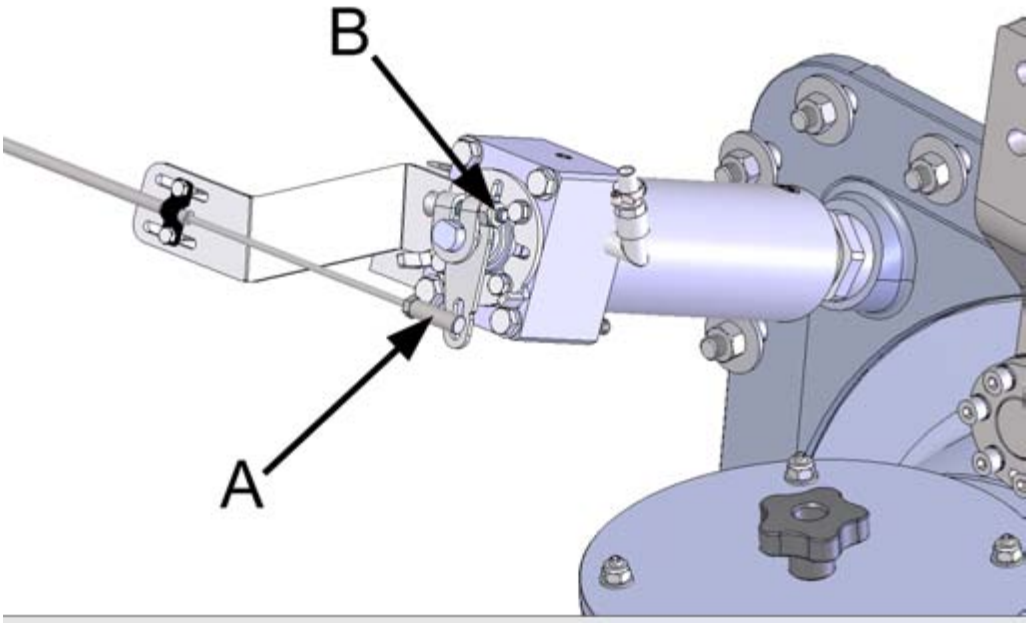


Figure 46. Removing the control cable

2. Loosen the operating lever screw (figure 46, point B) but do not pull the lever off the shaft yet.

3. Place the lever against the limiter on the shaft (figure 47, point A).

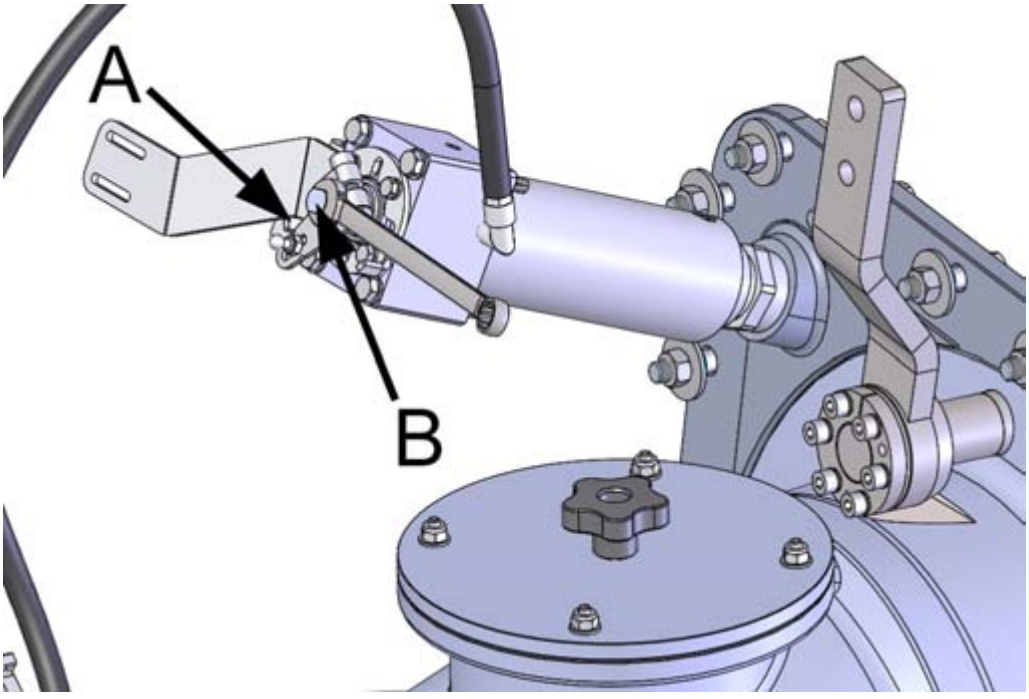


Figure 47. Operating shaft and limiter

4. Turn on the engine and put it into gear.

5. Using a 13 mm wrench, turn the operating shaft (figure 47, point B) clockwise so that the reversing deflector is in a downwards position, blocking the jet flow.

If you turn the shaft too much, it will no longer move smoothly, indicating that the cylinder has reached the end of its movement range. If this happens, turn the shaft back slightly.

6. Attach the operating lever to the shaft with a screw, and tighten the screw.

   The tightening torque is 10 Nm. Do not tighten the screw too much!

7. Attach the control cable to the screw at the end of the operating lever (figure 46, point A).

8. Use the control system in the cabin to check that the deflector can move to the up and down positions.

   In the up position, the deflector does not block the jet flow (figure 48). In the bottom position, the lower edge of the reversing deflector (figure 49) is parallel with the propulsion unit’s shaft.

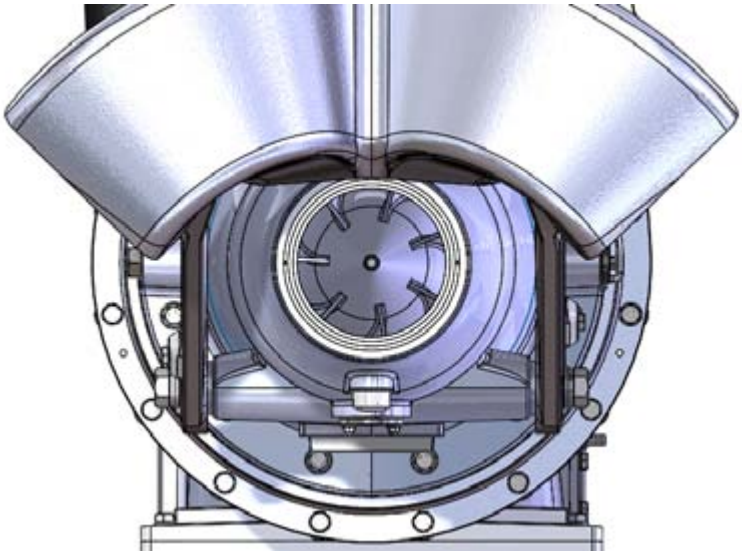


Figure 48. Deflector in the up position

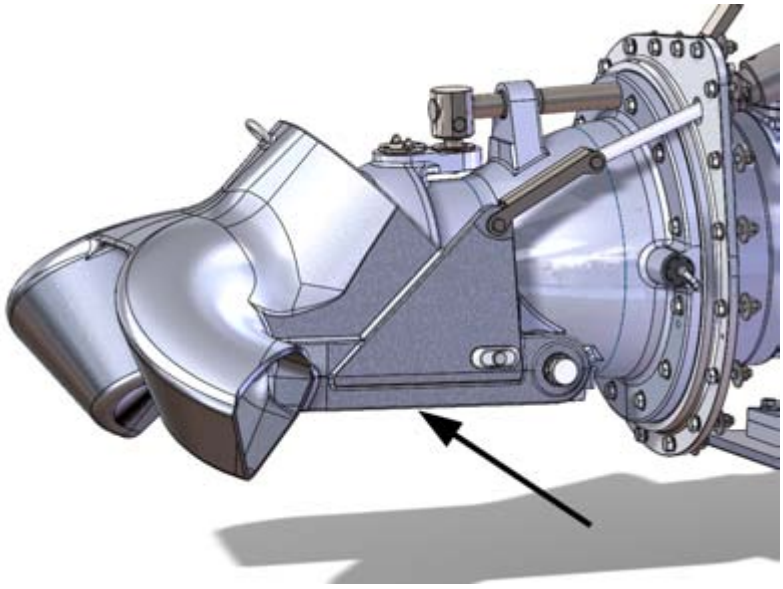


Figure 49. Deflector in the down position

4.3. Hydraulic pump

4.3.1. Removing the hydraulic pump

Before you remove the hydraulic pump, ensure that you have a container for draining the oil from the hoses. Please note that it may not be necessary to completely drain the system: you can also put plugs at the ends of the hoses.

Removing the hydraulic pump:

1. Remove the hydraulic pump pressure hose (figure 50, point A) and suction hose (figure 50, point B) and drain the oil into a container.

   Alternatively, you can plug the ends of the hoses.

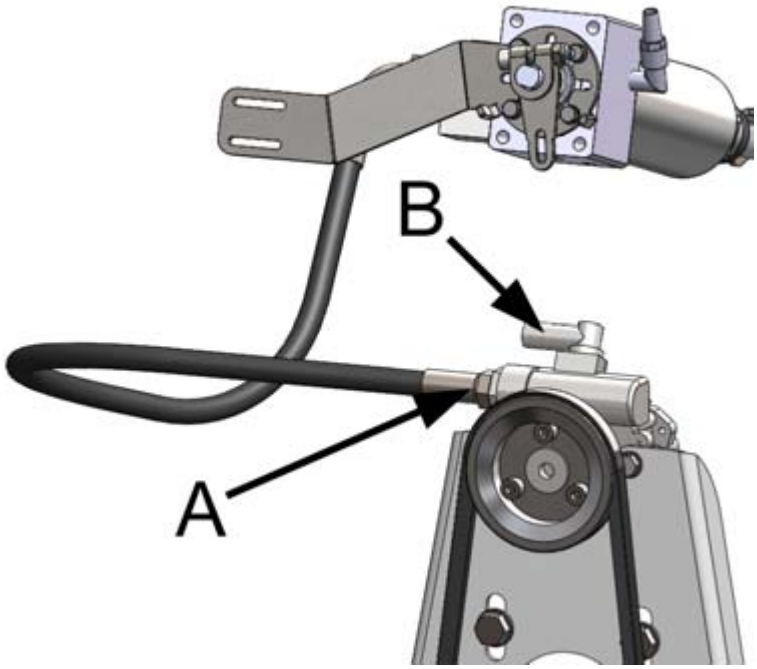


Figure 50. Hoses of the hydraulic pump

2. Remove the hydraulic pump bracket by opening its fastening screws.

   The bracket is attached to the front surface of the bearing housing with four screws, two on each side of the pump (figure 51).

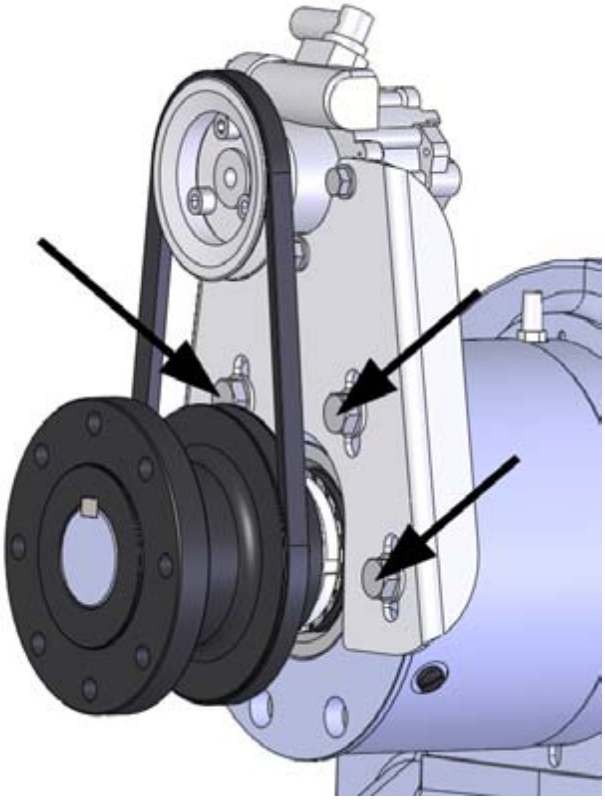


Figure 51. Hydraulic pump bracket fastening screws

3. Remove the hydraulic pump from the bracket by opening its fastening screws (3 pcs, figure 52).

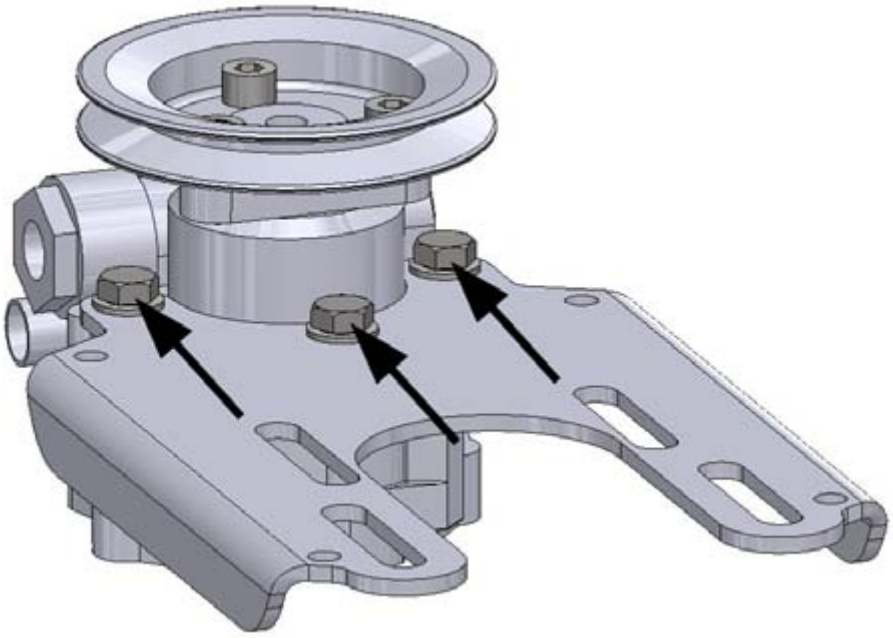


Figure 52. Hydraulic pump fastening screws

4.3.2. Repairing the hydraulic pump

A worn belt pulley in the hydraulic pump can be replaced. It can also be replaced with the pump attached to the bracket.

The pump's pressure relief valve may get clogged up with debris, which may cause the pump to malfunction. The pressure relief valve can be checked and cleaned even when the pump is attached to its bracket.

Replacing the belt pulley:

1. Loosen the fastening screws of the hydraulic pump bracket.

2. Open the screws that attach the belt pulley to the bracket (3 pcs, figure 53).

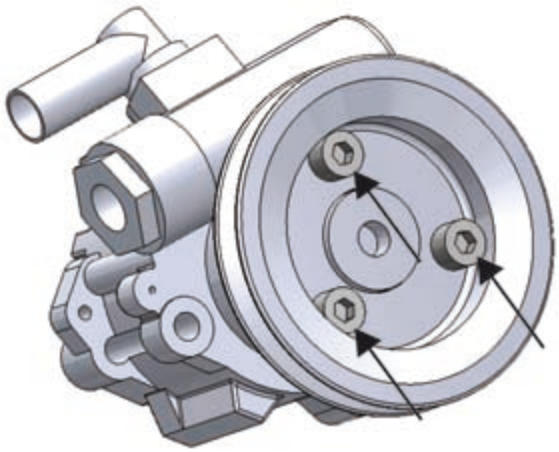


Figure 53. Belt pulley fastening screws

3. Remove the old belt pulley.

4. Fit in the new belt pulley.

5. Tighten the screws.

   The tightening torque is 25 Nm. Use thread locking compound.

Pressure relief valve disassembly

Reserve a container for this procedure into which you can drain the oil from the partially dissembled system.

1. Open the cylinder-side end of the pressure hose and disconnect the pressure hose from the pump.

   If the pump-side end of the hose is equipped with a banjo connection, the cylinder-side connector does not need to be detached.

2. Open the adapter nut (figure 54)

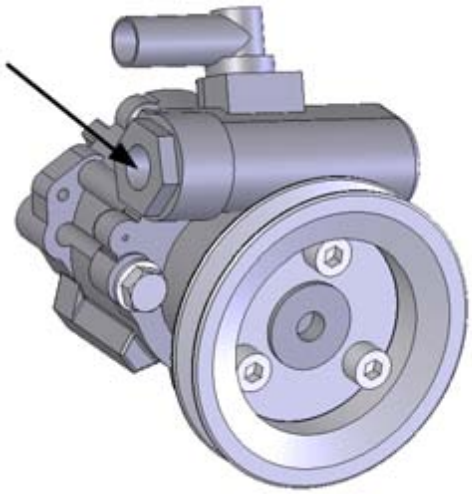


Figure 54. Hydraulic pump pressure relief valve

3. Lift out the pressure relief valve (figure 55) and clean it of any debris and impurities.

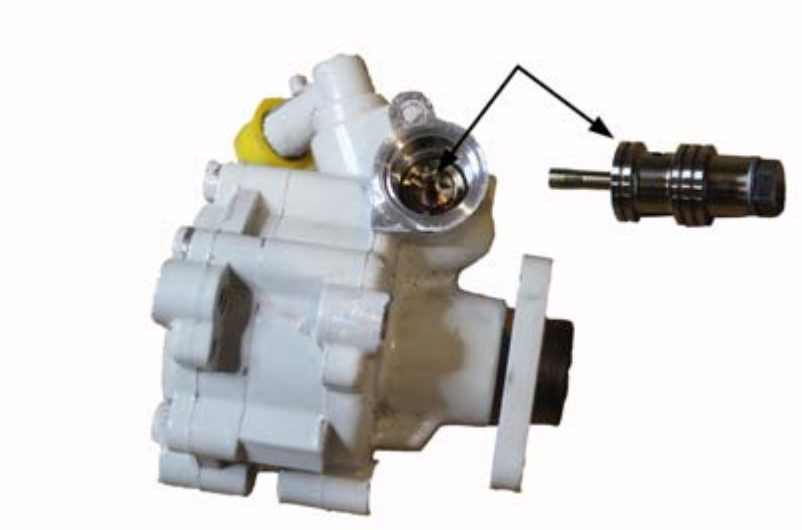
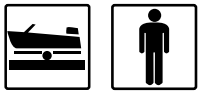


Figure 55. The hydraulic pump and the pressure relief valve

4. Set the cleaned pressure relief valve back in the pump.
5. Tighten the adapter nut.

   The tightening torque is 40 Nm.

4.3.3. Installing the hydraulic pump



Installing the hydraulic pump:

1. Mount the hydraulic pump in the bracket using fastening screws (figure 52).

The tightening torque is 25 Nm. Use thread locking compound.

2. Set the bracket against the front surface of the bearing housing and tighten the fastening screws (figure 51) loosely.

   Use thread locking compound.

3. Set the belt in its place and lift the bracket until the belt tightens.

4. Tighten the bracket fastening screws at the same time.

   The tightening torque is 50 Nm.

5. Install the pressure hose (figure 50, point A) and return hose (figure 50, point B).

6. Fill the oil reservoir with oil and use the system (motor running, in forward gear), moving the reversing deflector up and down several times.

   This removes air from the system.

4.3.4. Replacing the oil filter

The oil filter in the oil reservoir must be replaced after every 500 operating hours.

Replacing the oil filter:

1. Open the six cover screws (figure 56)

Figure 56. Oil reservoir cover screws

The filter is located under the cover and has a spring on top of it that keeps the filter in place (figure 57).

Figure 57. Oil filter spring

2. Remove and replace the spring and the filter.

   It is not necessary to replace the spring unless it is damaged.

3. Put the cover back into place.

   Make sure that the cover seal is correctly positioned in the groove (figure 58, point A). The cover must also be positioned correctly so that the spring is in line with its support (figure 58, point B).

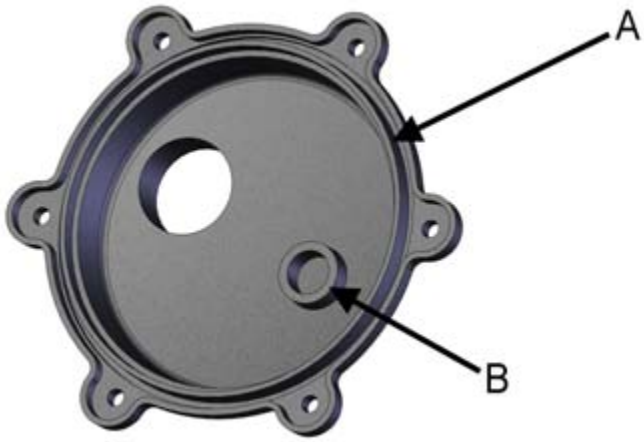


Figure 58. Oil reservoir cover

4. Reattach the six cover screws (figure 56).

5. Steering nozzle and operating shaft

The steering nozzle (figure 59, point A) is used to turn the direction of the water from the jet, causing the boat to turn. The steering nozzle is operated with the levers (figure 59, points B and C) and shaft (figure 59, point D).

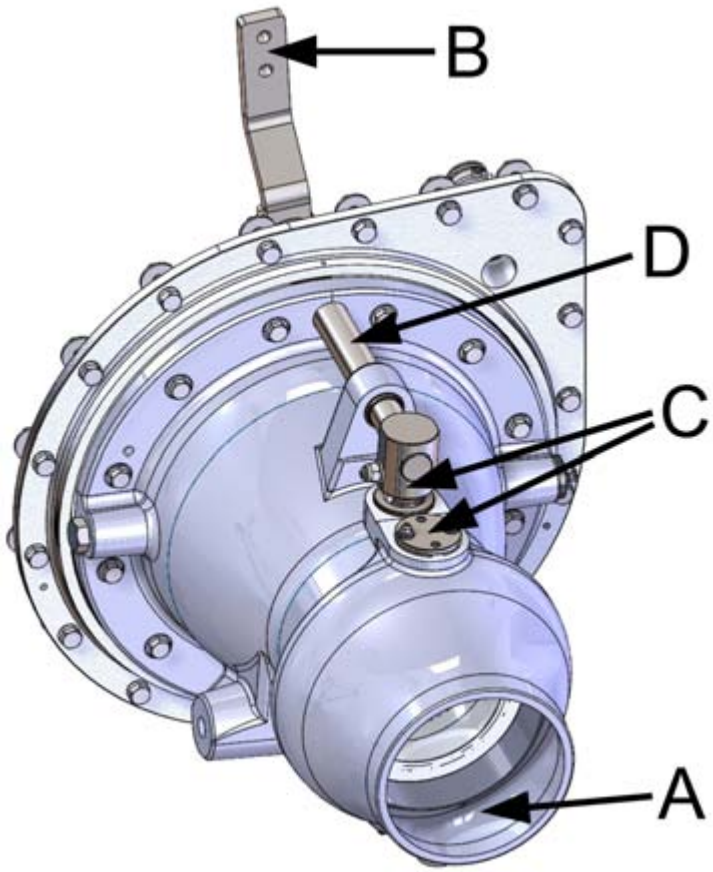


Figure 59. Steering nozzle and operating shaft

5.1. Steering nozzle

5.1.1. Removing the steering nozzle

1. Remove the dowel pin (figure 60, point B) that locks the shaft of the steering nozzle to the steering shaft (figure 60, point A).

   The dowel pin is attached to the shaft with a nut (figure 60, point C). At this point the reversing deflector should be in the down position.

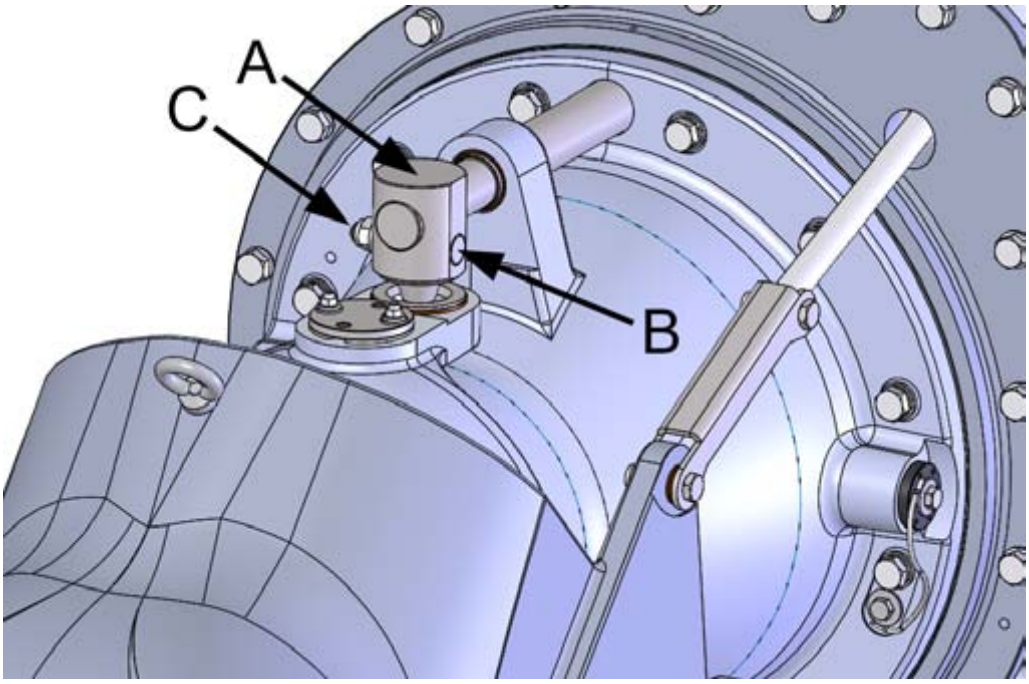


Figure 60. The shaft and the dowel pin

2. Open the locking nuts of the steering nozzle spindles (4 pcs, figure 61, point A) and pull out the spindles (figure 61, point B).

   You can make use of the extraction holes on the spindles (figure 61, point C). Note that there are two spindles, one at the top of the steering nozzle and one at the bottom.

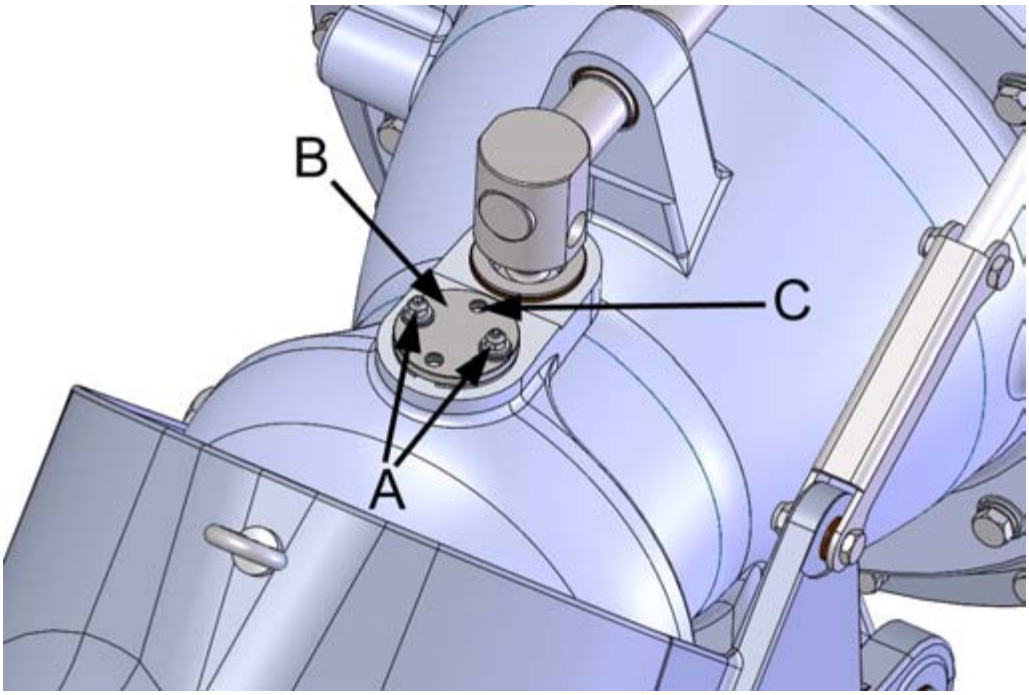


Figure 61. Steering nozzle spindles

3. Lift steering nozzle off.

5.1.2. Repairing the steering nozzle

A worn or damaged sleeve 10889, spindles 10892 (2 pcs) and anode 10409 can be replaced from the steering nozzle. The plastic bearings of the steering nozzle are also replaceable.

The steering nozzle is cast aluminium (AlSi7Mg), and minor breakages can be repaired by welding. The filler metal for the welding is AlMg5. If the swinging arm or shaft holes show breakages, the steering nozzle must be replaced, not repaired.

NOTE!

Bare aluminium areas must be painted when welding the steering nozzle. Use paints suitable for aluminium. Check the correct paint type from the paint supplier.

5.1.3. Installing the steering nozzle

The procedure can also be carried out with the reversing deflector in place.

1. Fit the steering nozzle and the stator steering shaft (figure 62, point A) into place, making sure that the spindle holes (figure 62, point B) are aligned. At the same time, push the shaft of the steering shaft onto the steering shaft.

   It is advisable to apply some petroleum jelly onto the end of the steering shaft to make it easier to install the shaft.

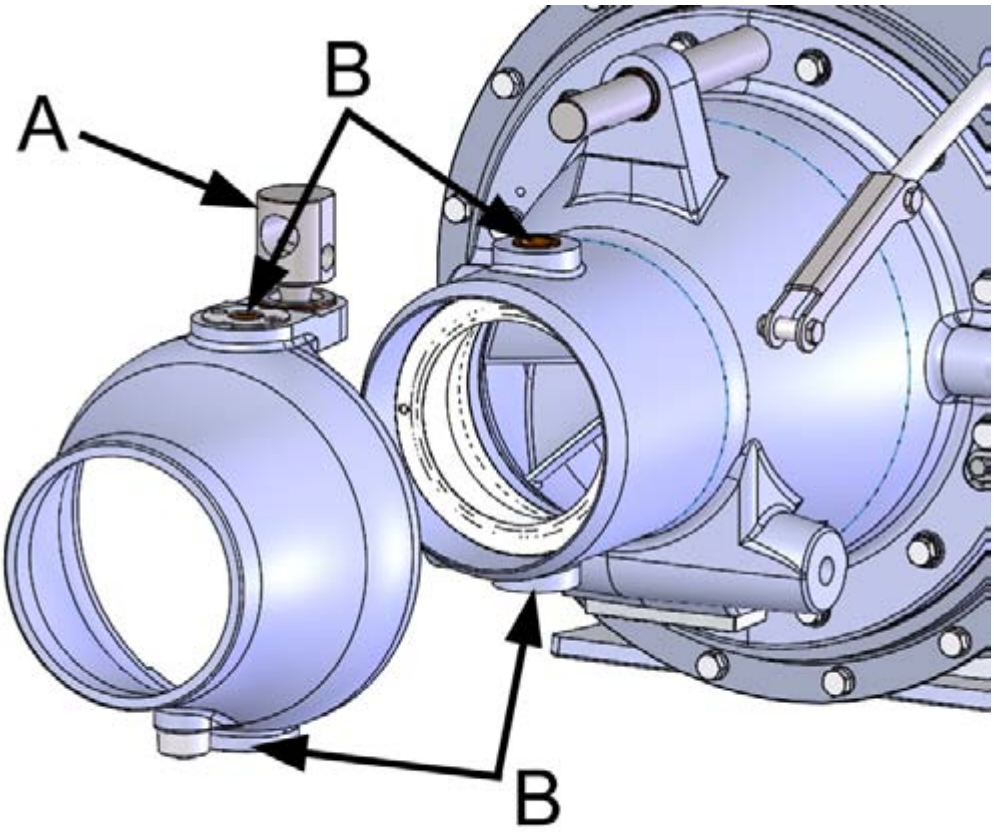


Figure 62. Installing the steering nozzle

2. Fit the spindles into place and tighten the locking nuts (2 pcs/spindle, figure 63, point B).

   The tightening torque is 25 Nm.

   Make sure that the plastic seal between the spindle and the steering nozzle is in place (figure 63, point A). Carry out the same procedure on the spindle at the bottom of the steering nozzle.

3. Push the dowel pin (figure 63, point D) through the hole on the shaft of the steering shaft and tighten it with the locking nut (figure 63, point C).

   The tightening torque is 75 Nm.

   Note that the dowel pin must be installed the right way in accordance with the figure (figure 63) and that it must be correctly wedged against the steering shaft (figure 64).

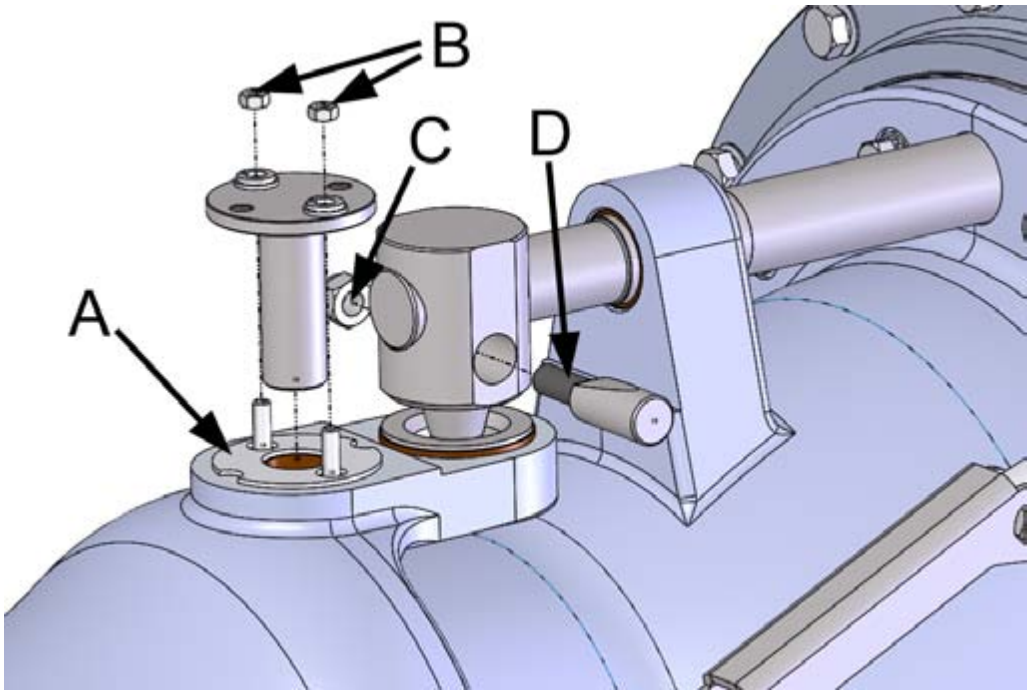


Figure 63. Installing the spindles

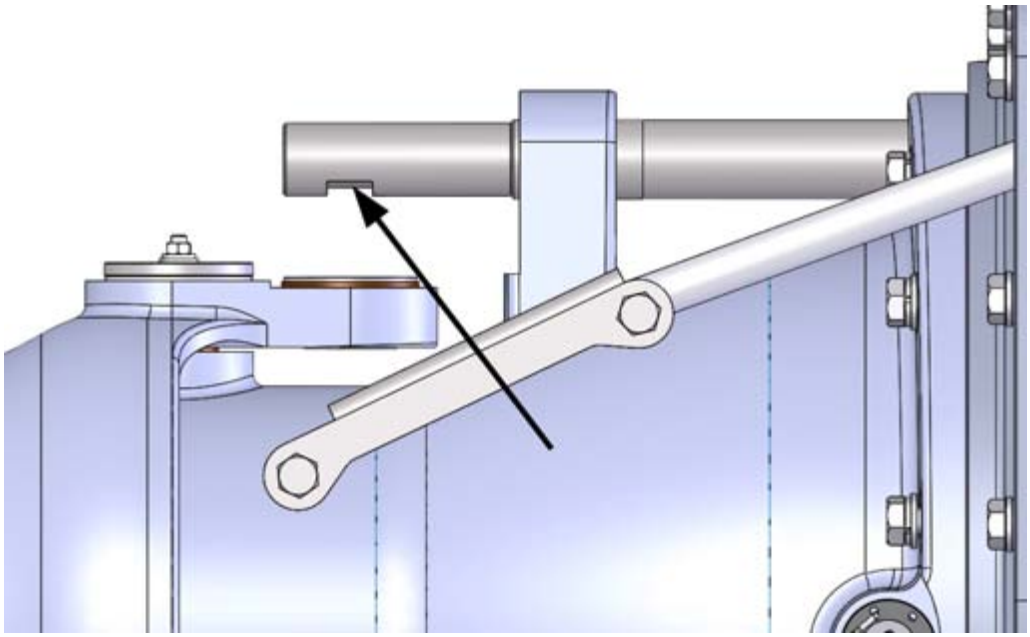


Figure 64. Correct position of the dowel pin on the steering shaft

5.2. Steering shaft

5.2.1. Removing the steering shaft

1. Open the nut of the dowel pin that locks the shaft of the steering shaft into place (figure 60, point C) and remove the dowel pin (figure 60, point B) from the shaft.

2. Remove the steering device from the front end lever (figure 65, point A).

   The type of steering device varies according to the boat manufacturer.

   The mounting point of the steering device on the lever depends on the type of the steering device (stroke length). Use a marker pen, for example, to mark the position of the control lever in relation to the shaft.

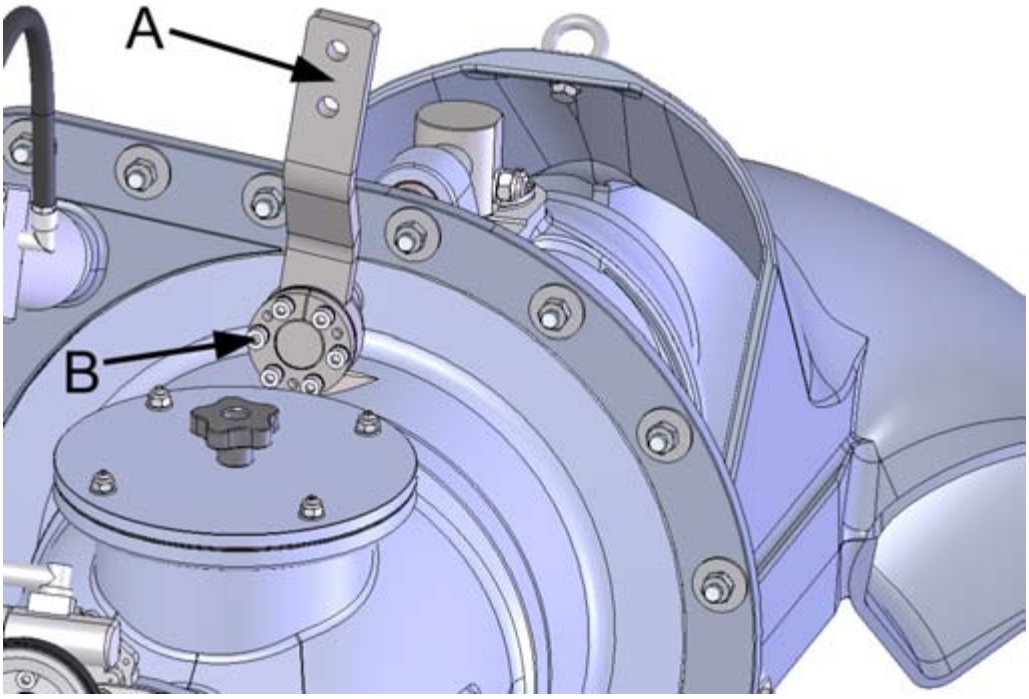


Figure 65. Removing the steering device

3. Loosen the screws of the lever fastening sleeve (6 pcs, figure 65, point B).

4. Remove at least two screws and insert them into the threaded holes (figure 66).

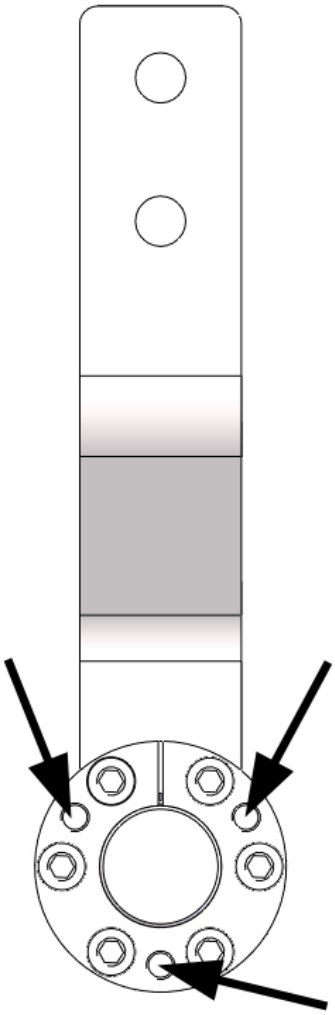


Figure 66. Threaded holes

5. Tighten the screws until the cone sleeve opens.
6. Pull the steering lever off the shaft.
7. Remove the steering shaft by pulling it out (figure 67).

   It is advisable to apply some petroleum jelly onto the shaft before removal. This will make it easier to remove.

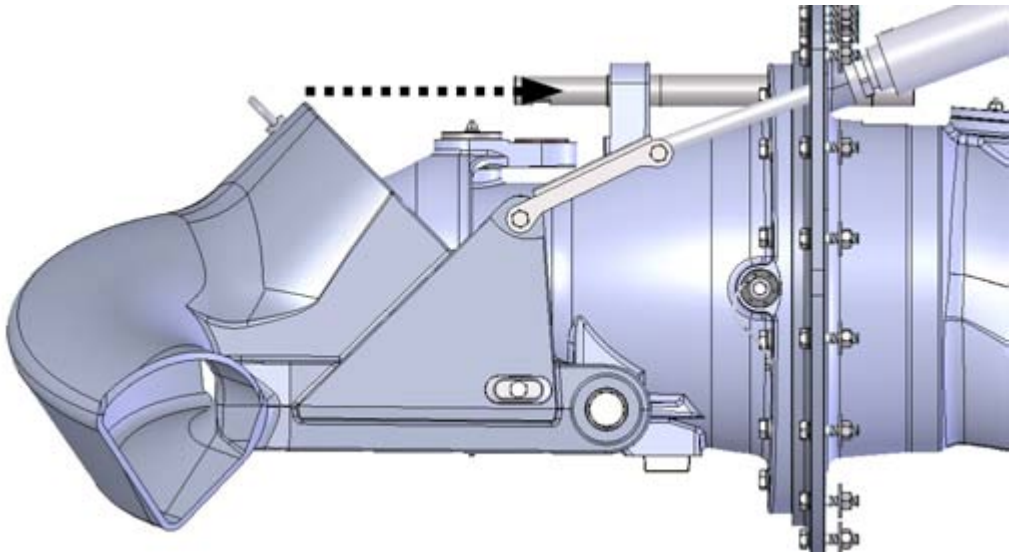


Figure 67. Removing the steering shaft

5.2.2. Repairing the steering shaft

Replaceable parts in the steering shaft include worn bushings (figure 68) and the o-ring in the front end.

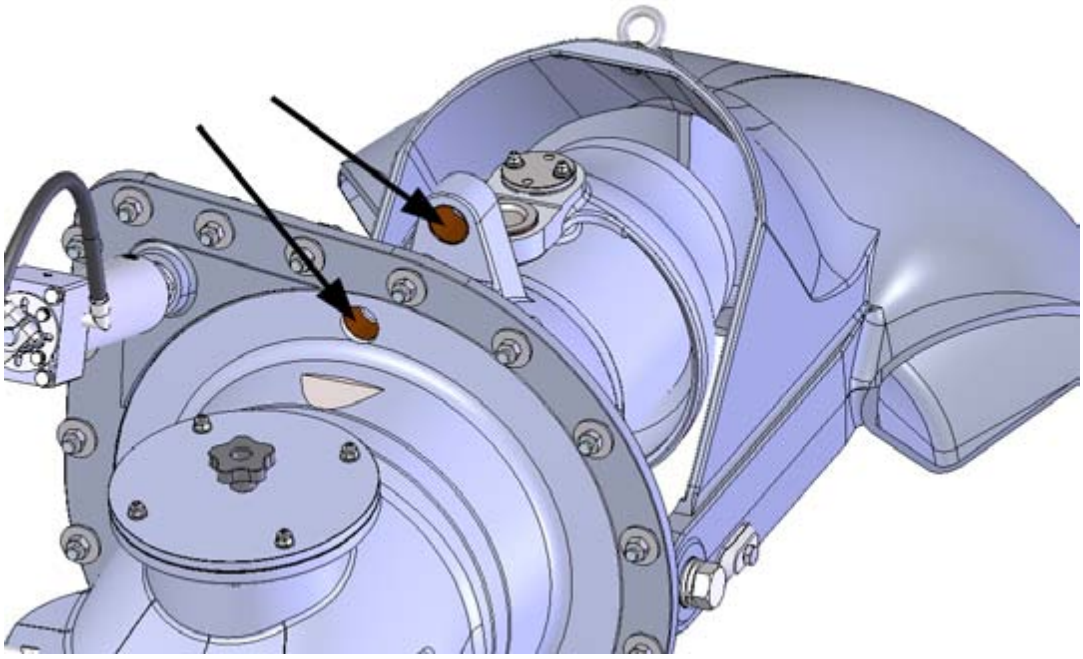


Figure 68. Bushings and bearings

Replacing the rear end bushing:

1. Remove the old rear bushing by pushing it from the hole with a suitable mandrel (figure 69).

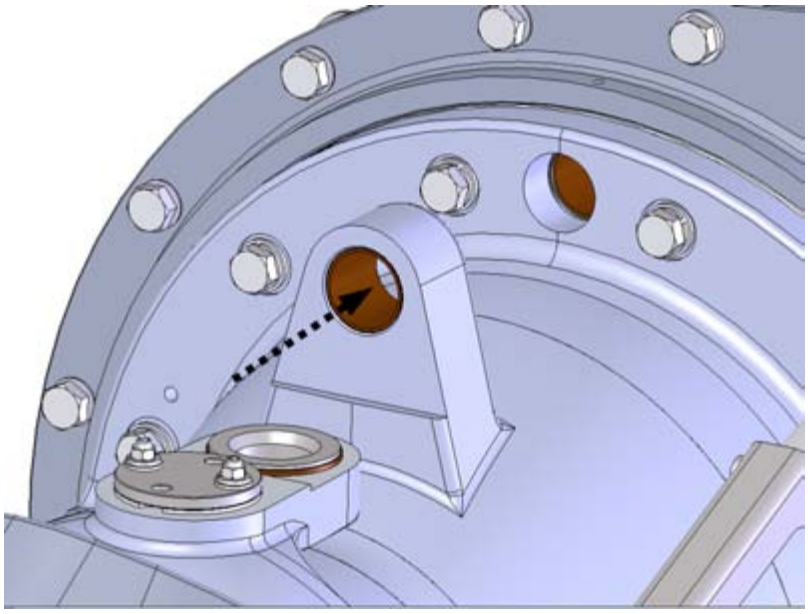


Figure 69. Removing the rear end bushing

2. Install the new bearing.

Replacing the front end bushing and sealing ring:

1. Remove the stator (section 6.1. *Removing the stator*, page 63).
2. Remove the old front bushing by pushing it from the hole with a suitable mandrel (figure 70). While doing so, remove the o-ring from its groove (figure 70, point A).

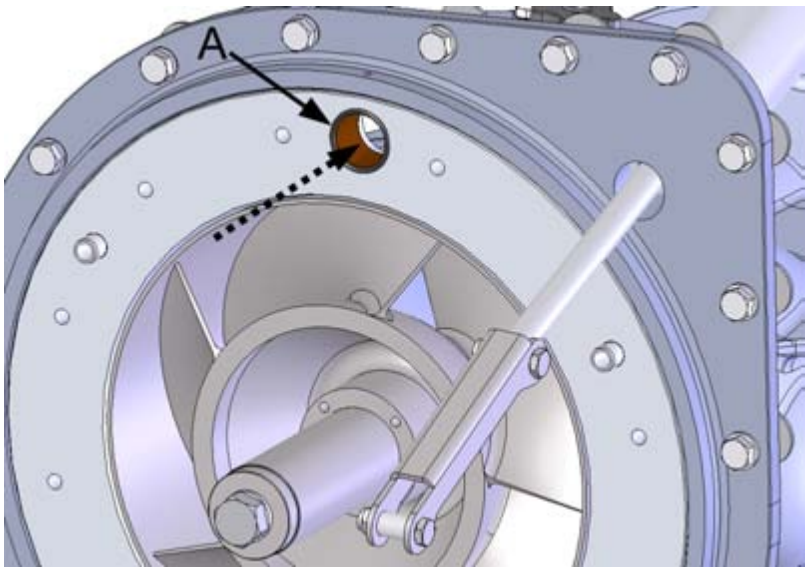


Figure 70. Removing the front end bushing and o-ring

3. Install the new bearing.
4. Install the steering shaft (section 5.2.3. *Installing the steering shaft*, page 60).
5. Install the new o-ring (figure 71) onto the shaft.

It is advisable to apply some waterproof petroleum jelly onto the o-ring.

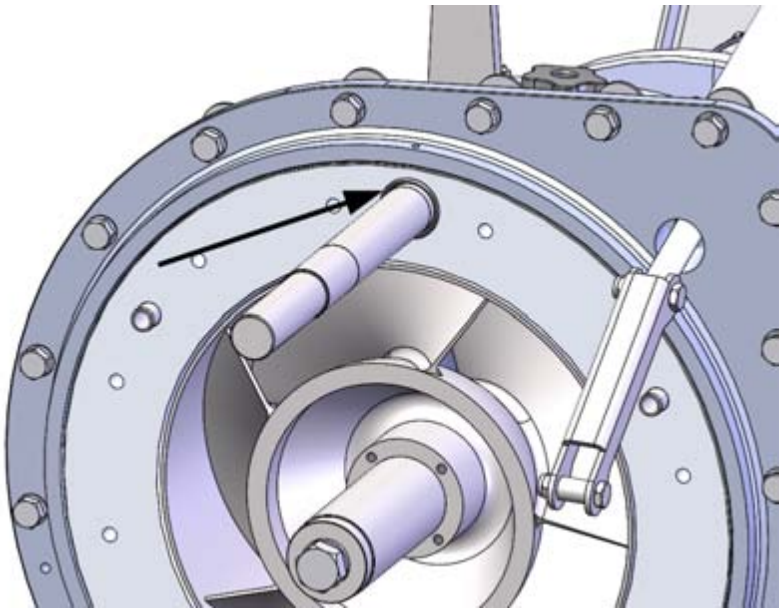


Figure 71. O-ring

6. Install the stator (section 6.3. *Installing the stator*, page 67).

5.2.3. Installing the steering shaft

Installing the steering shaft:

1. Push the steering shaft through the holes from the front (figure 72).

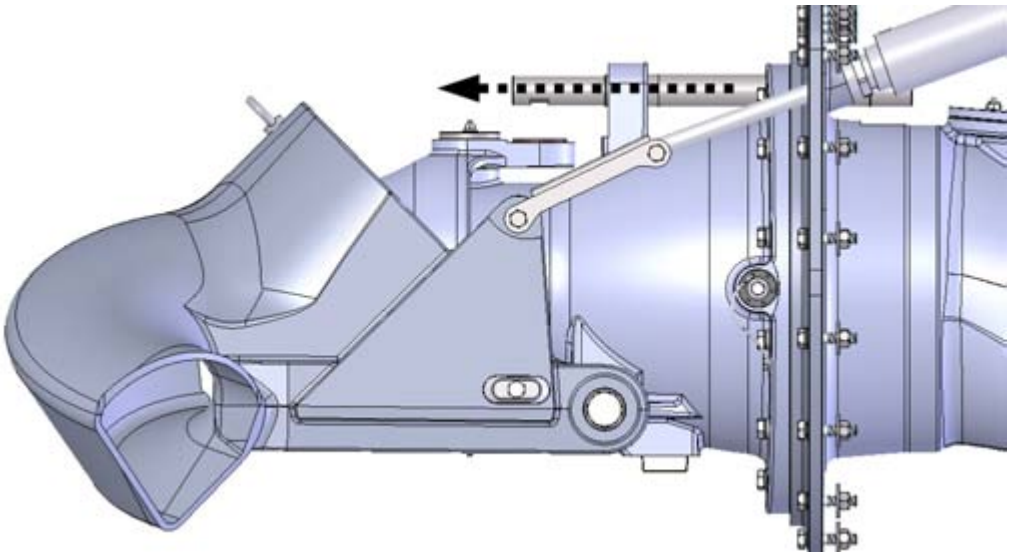


Figure 72. Installing the steering shaft

2. Clean the shaft of any excess grease.

3. Push the steering lever on the shaft along with the cone sleeve.

   Make sure that the lever is in the same position it was in before it was removed (section 5.2.1. *Removing the steering shaft*, page 55).

4. Tighten the screws of the cone sleeve, and make them finger-tight.

   This way the lever can slide on the shaft and you can find the correct position for it.

5. Once you have found the correct position for the lever, tighten the lever on to the shaft with the cone sleeve.

   Tighten the cone sleeve screws evenly by tightening each screw in turn by several revolutions of the tightening ring while making sure that each screw is tightening the cone sleeve evenly. Do not over-tighten the cone sleeve or the cone will stretch the outer ring of the lever. An excessively tightened cone will collapse and lose its grip.

6. Attach the operating device.

   Please be sure to attach it in the same hole from which it was removed.

6. Stator

6.1. Removing the stator

The stator and steering nozzle can be removed at the same time. If necessary, the steering nozzle can then be removed from the stator. The reversing deflector cylinder should preferably be placed in a position where it won't impede the removal of the stator.

Removing the stator:

1. Remove the reversing deflector (section 4.1.1. *Removing the reversing deflector*, page 31).

2. Remove the shaft of the steering nozzle (section 5.1.1. *Removing the steering nozzle*, page 51, step 1).

3. Open the stator fastening screws (12 pcs, figure 73).

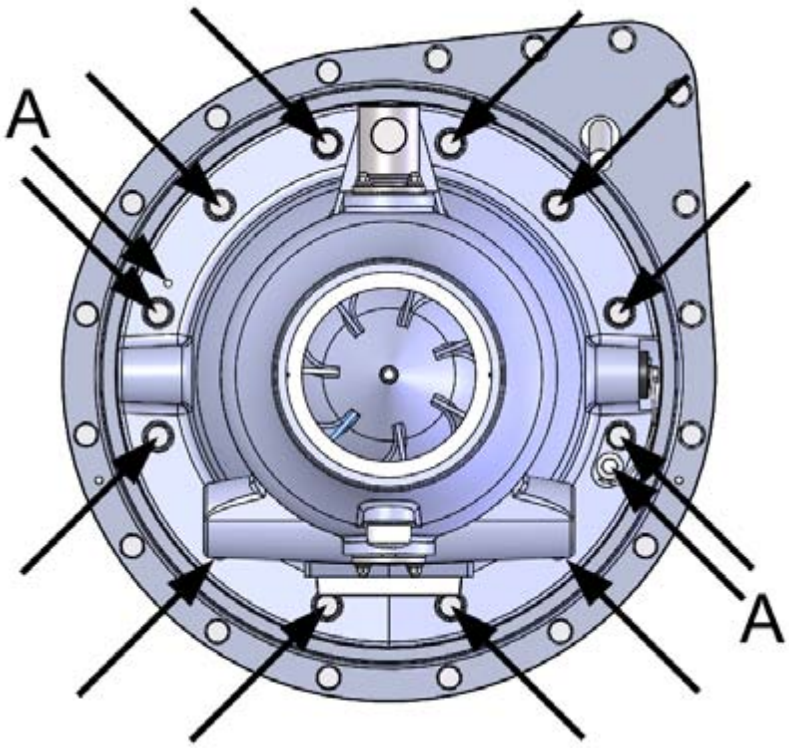


Figure 73. Stator fastening screws

4. Remove the stator from the frame.

   Make use of the stator extraction holes (2 pcs, figure 73, point A). The second extraction hole is located under the stator anode lead.

   You can also use a flathead screwdriver to help remove the stator. Push it between the frame and the stator and carefully crank the stator loose (figure 74).

CAUTION!

Be careful.

Careless use of a screwdriver may damage painted surfaces.

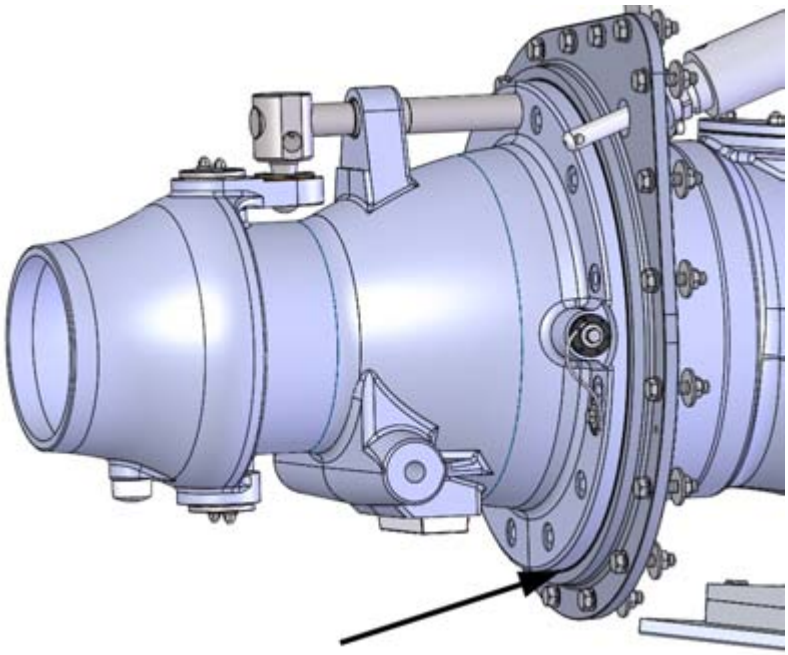


Figure 74. Removing the stator

5. Remove the steering nozzle from the stator if so required by the repair operation (section 5.1.1. *Removing the steering nozzle*, page 51, steps 2 and 3).

6.2. Repairing the stator

Replaceable parts in the stator include:

- the o-ring (figure 75, point A).
- the choker (figure 75, point B).
- the zinc anodes (figure 75, point C, 2 pcs).

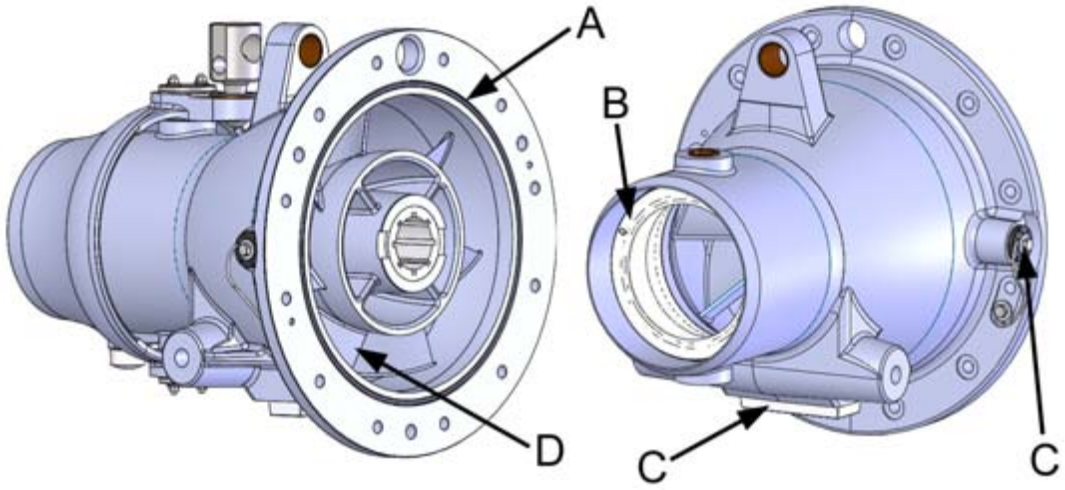


Figure 75. Stator o-ring and choker

The stator is cast aluminium (AlSi7Mg), and minor breakages can be repaired by welding. The filler metal for the welding is AlMg5.

Typically the tips of the blades suffer most damages in the stator (figure 75, point D). These kinds of damage can be prevented by repair painting any minor damage.

If the steering nozzle pivots show breakages, the part must be replaced, not repaired.

NOTE!

Bare aluminium areas must be painted when welding the stator. Use paints suitable for aluminium. Check the correct paint type from the paint supplier.

O-rings

Leaking o-rings must be replaced.

Replacing the o-rings:

1. Remove the old o-ring (figure 75, point A).
2. Install the new o-ring.

   Apply some petroleum jelly onto the o-ring. This will prevent damage to the o-ring during the installation of the stator.

Choker

The choker must be replaced if it is damaged.

Replacing the choker:

1. Remove the choker.

   Make use of the extraction holes on the choker (figure 76, 2 pcs).

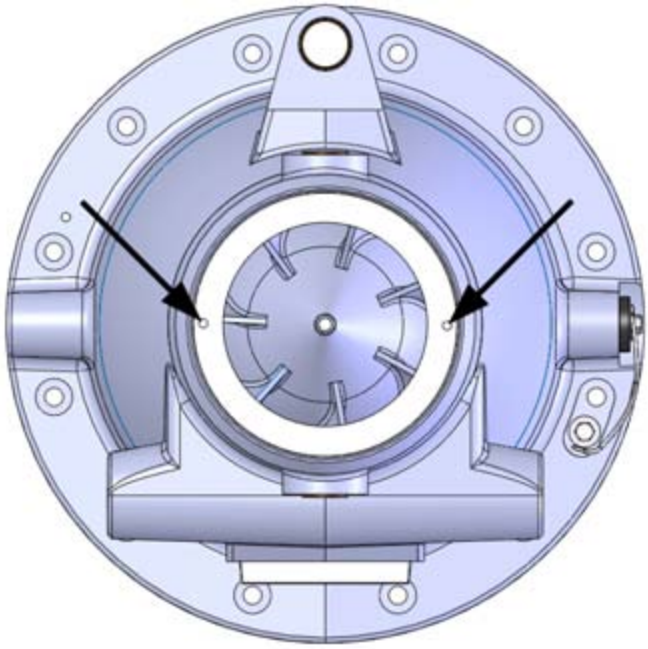


Figure 76. Removing the choker

2. Fit the new choker into place.

   The choker is ultimately attached to the stator with the steering nozzle spindles, so make sure that the holes are aligned during installation (figure 77).

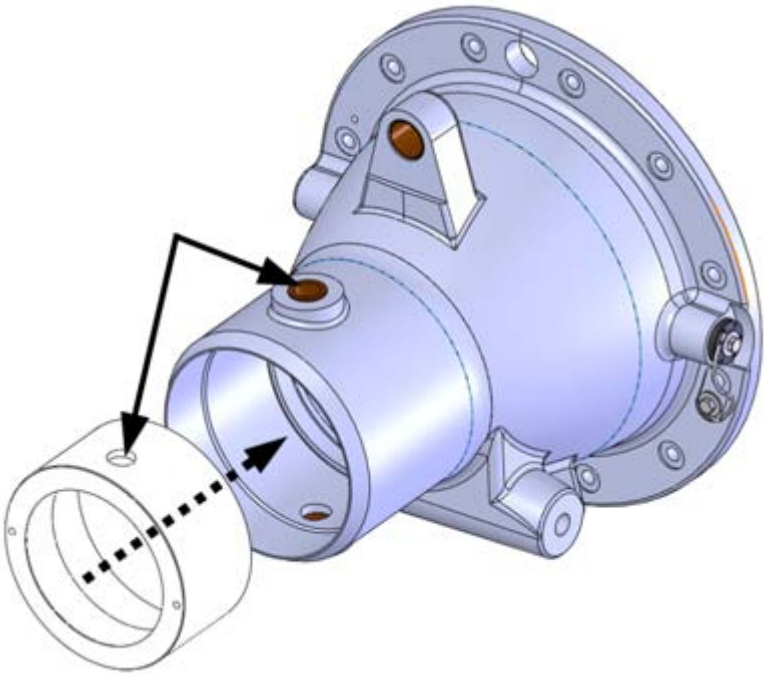


Figure 77. Installing the choker

6.3. Installing the stator

1. Push the stator into place with the end of the shaft in the rear bearing housing and the steering shaft pushing through the bushing on the stator (figure 78).

   The stator is centred with the pins in the frame of the jet (figure 78, point A, 3 pcs). Make sure that the steering shaft o-ring is undamaged and in place (figure 78, point B). Apply some petroleum jelly onto the surface of the o-ring.

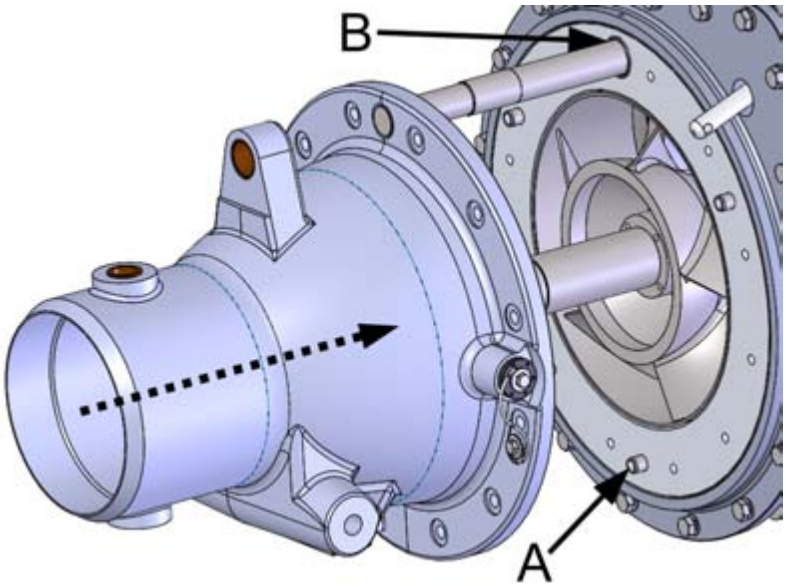


Figure 78. Installing the stator

2. Tighten the stator fastening screws evenly.

   The tightening torque is 75 Nm.

3. Install the steering nozzle if you removed it from the stator earlier (section 5.1.3. *Installing the steering nozzle*, page 53).

Appendix 1. Grease recommendations

The grease used for lubricating the propulsion unit bearing must meet the following requirements:

- lithium soap and a thickener with EP additives
- mineral oil as a base oil
- NLGI class 2
- operating temperature range -25 to 130°C (-13–266 °F)
- continuous operating temperature min. 75 °C (167 °F)

Recommended grease brands:

- Würth Multi-Purpose Grease III
- FAG Multi2
- FAG Load 220
- Mobil XHP 222
- Neste Allrex EP2
- Shell Retinax Grease EP2

A grease that has equivalent properties to those mentioned above can also be used for lubrication.

Appendix 2. Oil recommendations

The operating hydraulic system of the reversing deflector and the lubrication of the front bearing are designed to use oil that is specifically intended for automatic transmission systems. The oil must meet the following requirements:

Kinematic viscosity 40℃	33-36 mm^2/s
Kinematic viscosity 100°C	7.1-7.7 mm^2/s
Viscosity index	min. 170
Density 15°C	0.835–0.890 g/cm^3
Pour point	max. -42 ℃
Flashpoint	min. 180 ℃

Recommended oil brands:

- Mobil ATF 320
- FormulaShell ATF DEXRON III
- Neste ATF-X
- BP Autran DX III

Appendix 3. Tightening torques

Use the tightening torques from the table 2 when tightening the propulsion unit screws. The strength grade of an acid-proof A4-80 screw is equivalent to a class 8.8 screw.

Table 2. Tightening torques of the screws

	Strength grade		
	8.8	10.9	12.9
Thread	Tightening torque (Nm) (*)		
M5	5.5 (4)	8.1 (6)	9.5 (7)
M6	9.6 (7)	14 (10)	16 (12)
M8	23 (17)	34 (25)	40 (30)
M10	46 (34)	67 (49)	79 (58)
M12	79 (58)	115 (85)	135 (100)
M16	145 (107)	215 (159)	250 (184)

(*) The tightening torque in pound-feet (approximate value) is marked in the table in parentheses after the corresponding value in Nm.

A suitable thread locking compound that is good for all purposes is one of medium strength, for example. Loctite 242 or similar.