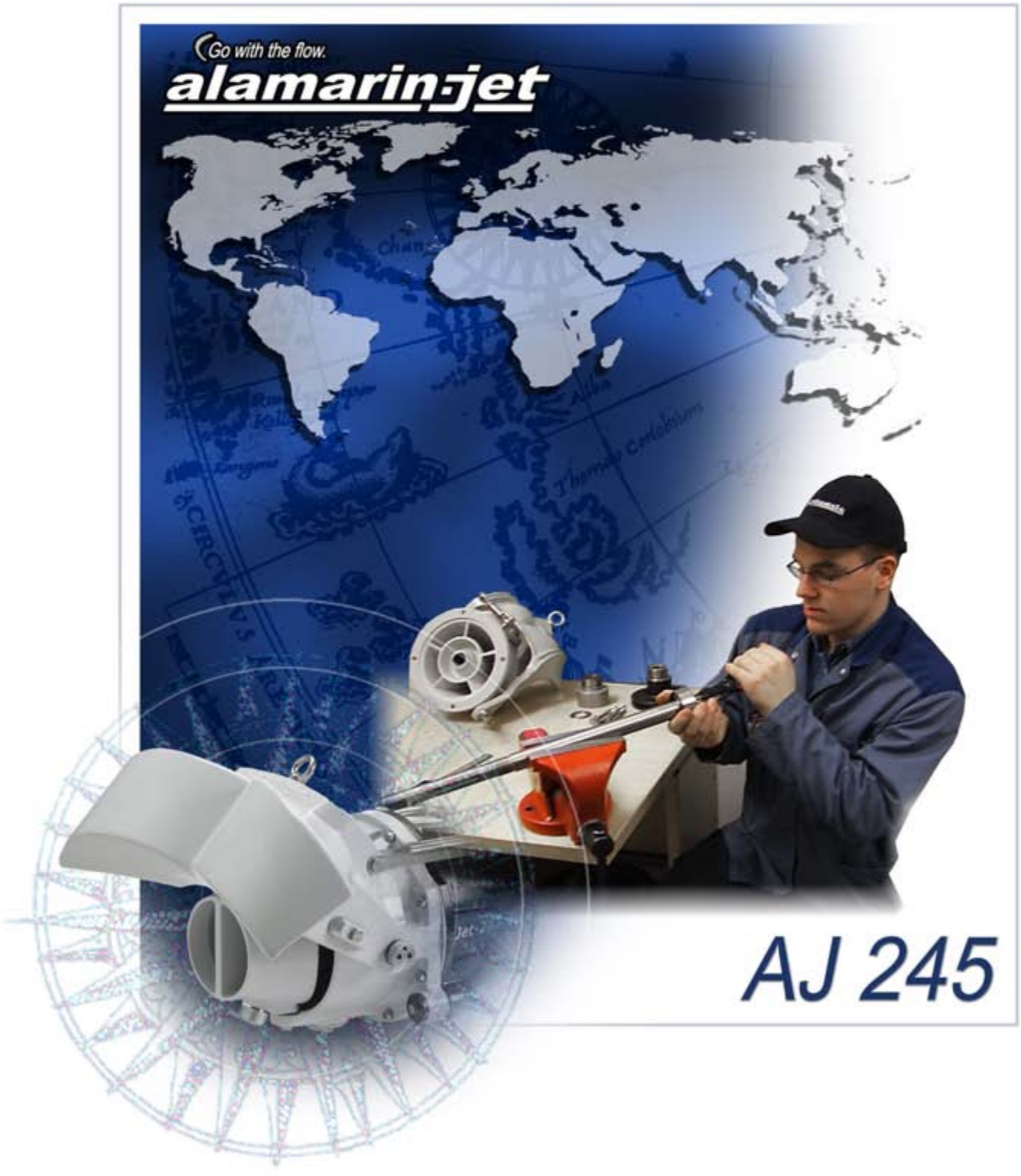
Repair manual



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WARRANTY TERMS

Warranty for the Alamarin-Jet products is 12 months from the first sea trial. However no longer than 18 months from the date of delivery from our factory.

Alamarin-Jet Warranty covers defects in Alamarin-Jet workmanship and materials for the Warranty period. Alamarin-Jet warranty terms will not cover normal part wear nor following cases with external source of issue: incorrect installation, damage caused by outside affect, vessel overloading, misuse, abnormal wear and tear, accident, improper application, improper transportation or storage, natural calamity, unsuitable water conditions, lack of maintenance or neglecting correct procedures described in Alamarin-Jet manuals.

Any Alamarin-Jet product that is serviced, repaired or altered in any way by anyone other than party certified by Alamarin-Jet will not be covered by the warranty terms. Modifying or repairing Alamarin-Jet products with any other than original Alamarin-Jet parts will lead immediate invalidation of Alamarin-Jet product warranty.

Alamarin-Jet Warranty terms excludes indirect costs: Crane rent, docking, warping, towing, assistance of yard crew and services, loss of profit, travel, hotel charges, daily allowances and waiting time, expenses of unauthorized repair work of Alamarin-Jet products, expenses caused by failure of the jet to other components inside or outside the vessel, damages to any third parties, injuries, or any other inconveniences.

In order for warranty decision, Alamarin-Jet must receive defected parts with comprehensive failure description attached and transportation charges covered by the purchaser to Alamarin-Jet for inspection. Based on given details and inspected product, Alamarin-Jet reserves rights to define whether the case is under warranty. After inspection Alamarin-Jet will provide documented description for the customer regarding the case.

In case replacement parts are needed before Alamarin-Jet has analyzed the returned parts, purchaser buys new replacement parts. After confirming potential warranty decision, Alamarin-Jet will provide credit note covering the parts under warranty. All products and parts removed or replaced under the Warranty shall become property of Alamarin-Jet.

Alamarin-Jet reserves exclusive right for Alamarin-Jet warranty terms and no other person or distributor is authorized to modify this Warranty or give any other Warranty on behalf of Alamarin-Jet.

Alamarin-Jet Oy reserves its right to change, amend, add or delete any of the Terms and Conditions without prior notice. Any disputes are to be settled according to Finnish law by arbitration in Helsinki, Finland according to the rules of the International Chamber of Commerce and in accordance with Finnish legislation of Arbitration.

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1. Introduction

This is the repair manual for Alamarin-Jet's AJ 245 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 28.

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 (figure 1, point C), connected with friction and cotter joints. The impeller generates pressure as it rotates.

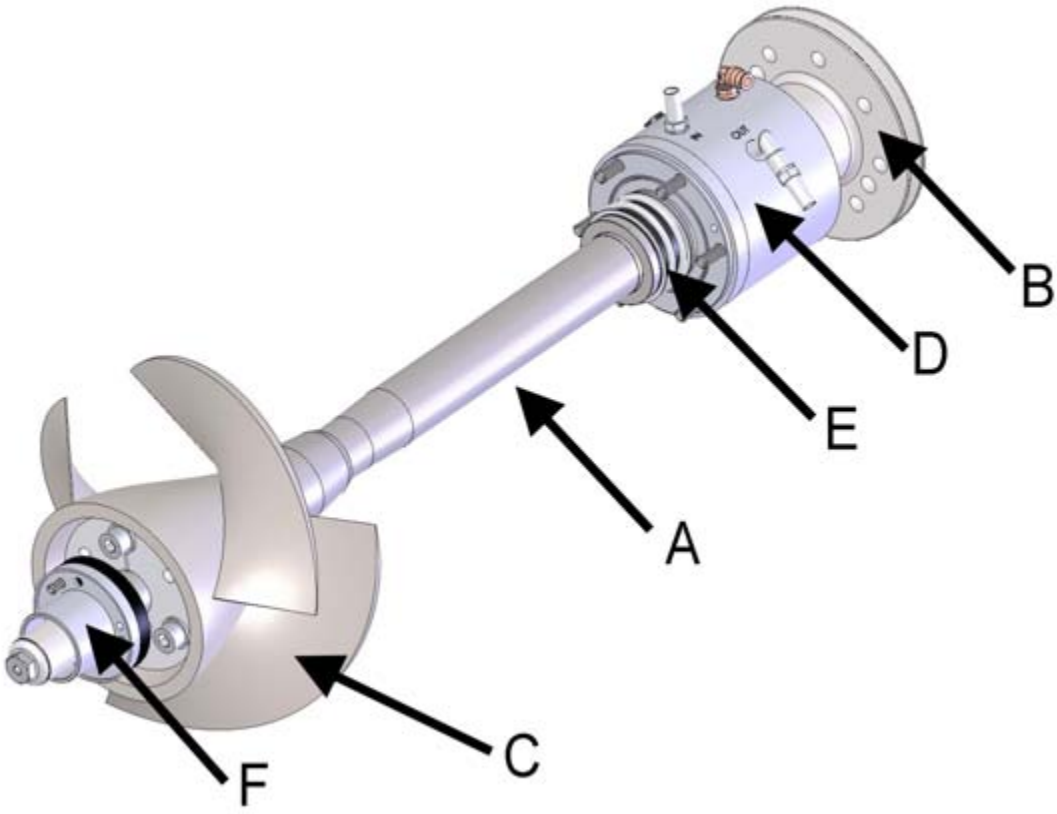

Figure 1. Main shaft and bearing

The front end has a double-cone 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. There is a needle bearing, which is lubricated from the engine room with petroleum jelly, within the housing. Alternatively, a water lubricated bearing can be used.

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 65)
- the impeller (section 3.2. *Removing the Impeller*, page 30).

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 53).

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 connectors off of the bearing housing (figure 2) 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.

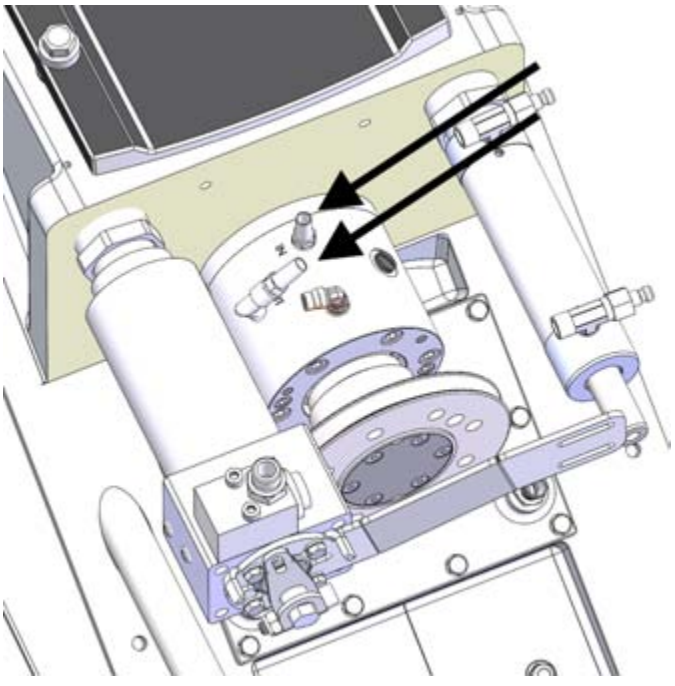

Figure 2. Lubricating oil reservoir connectors

2. Remove the drive flange.

   If you need to replace the entire bearing, including the shaft, you can leave the drive flange in place and the remove the bearing housing screws through the holes on the drive flange (figure 3, point B). However, this is not an option with older models that do not have the holes on the drive flange.

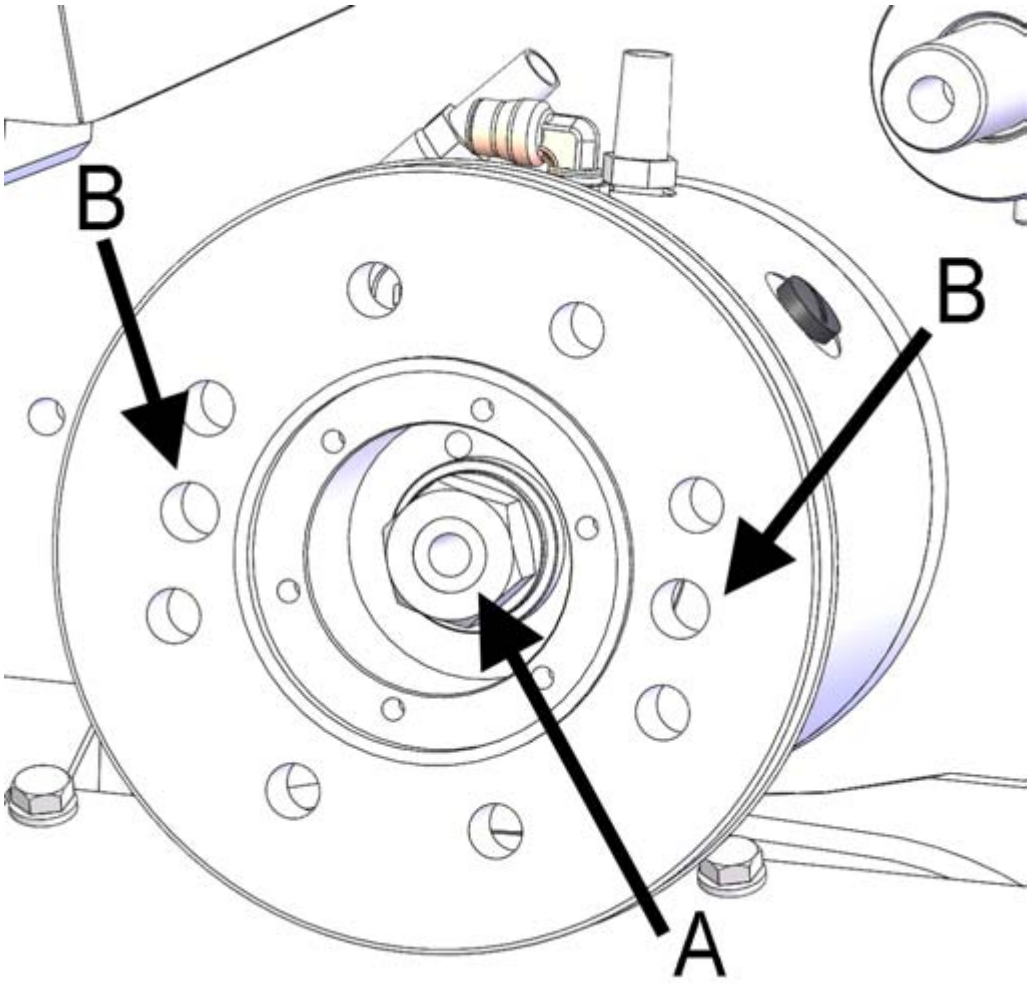

Figure 3. Drive flange fastening nut

3. Unscrew the nut (figure 3, point A) and use pliers to remove the spacer under the nut. Pull the drive flange out of the cone with a sturdy extraction tool.

   There is a special tool available that covers and protects the end of the shaft when an extraction tool is used. There is also an extraction tool available as an accessory that is specifically designed for removing the drive flange. The use of these tools is recommended in order to prevent damage to the end of the shaft. The product code of the extraction tool is 11039 while the product code of the shaft's protective sleeve is 10866.

4. Remove the key from the shaft (figure 4, point A).

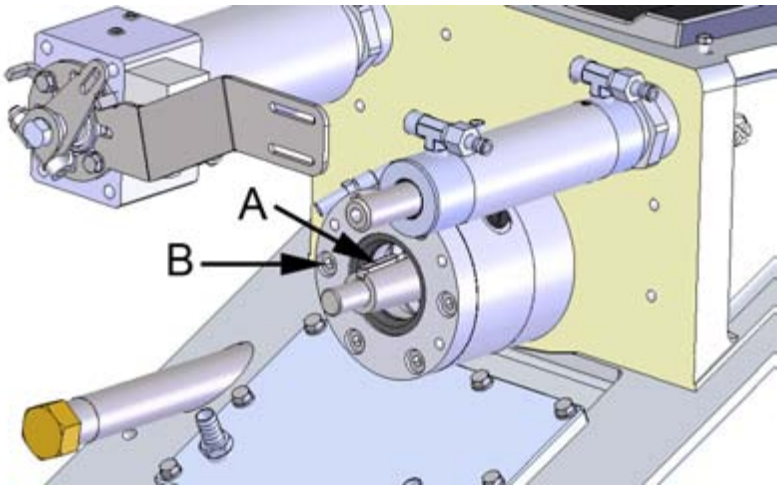

Figure 4. Removing the bearing housing

5. Open the bearing housing screws (6 pcs, figure 4, point B).

6. Remove the bearing housing seal cover (figure 5, point A from the bearing housing together with the drive flange support bearing (figure 5, point B).

7. Pull the shaft off the frame.

   Use the two M6 holes, from which the screws must first be removed (figure 4, point C). Replace the screws with longer screws or threaded rods, and tighten them until they bottom out. Tighten them evenly until the bearing housing comes loose from the frame.

   The bearing housing comes loose together with the shaft, bearings, and the mechanical seal.

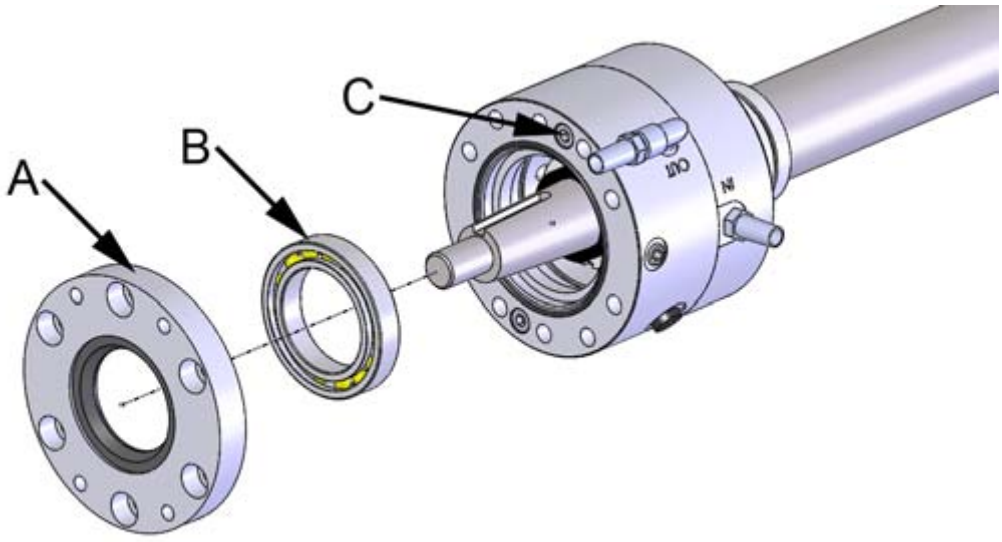

Figure 5. Bearing housing seal cover and drive flange support bearing

8. Open the bearing housing cover screws (2 pcs, figure 5, point C) and remove the bearing housing cover (figure 6, point A).

9. Remove the drive flange shaft seal (figure 6, point B) if you did not already remove it before with the drive flange.

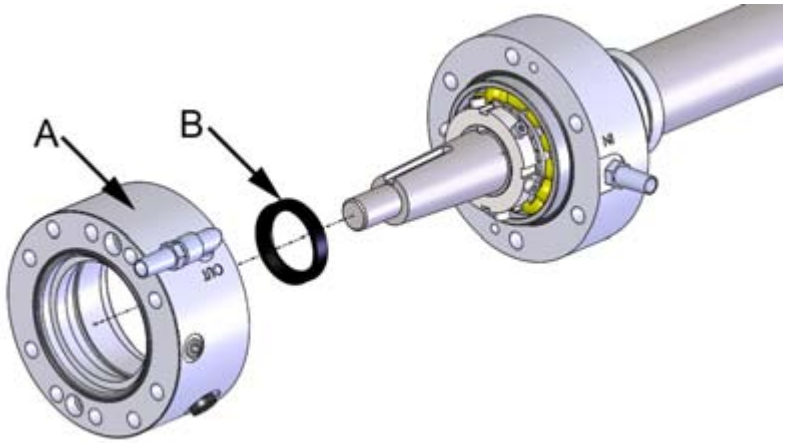

Figure 6. Bearing housing cover

10. Open the shaft nut screws (6 pcs, figure 7, point A) and turn the tooth of the lock washer (figure 7, point C) up from the shaft nut groove (figure 7, point B).

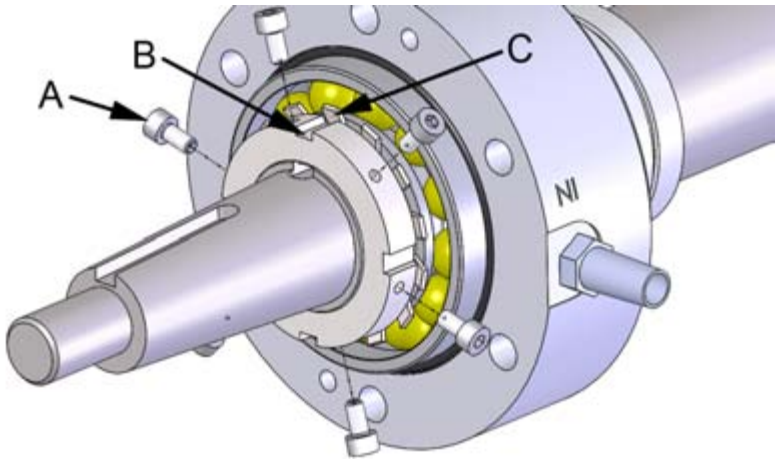

Figure 7. Shaft nut

11. Remove the shaft nut and lock washer (figure 8, points A and B).

12. Pull the bearing housing off the shaft (figure 8, point C).

    The bearing housing comes off together with the bearings and the mechanical seal’s static slip-ring (figure 10, point B).

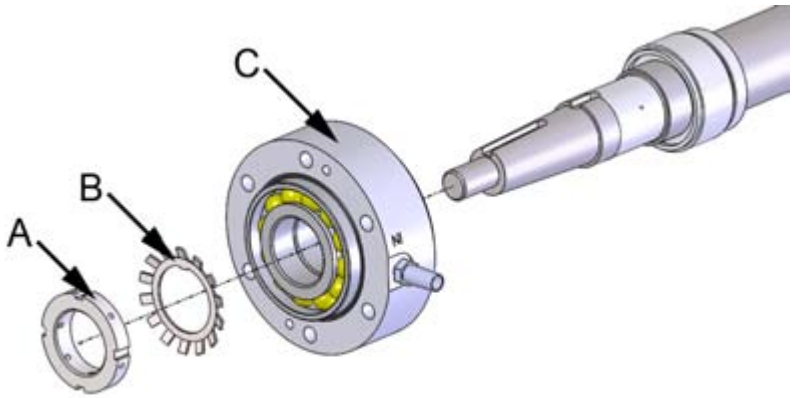

Figure 8. Removing the bearing from the shaft

13. Remove the bearings from the bearing housing by pressing them from the impeller side in accordance with figure 9 .

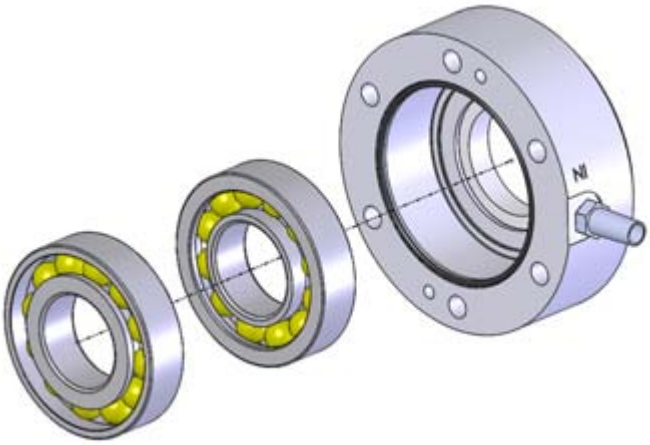

Figure 9. Removing the bearings from the bearing housing

Mechanical seal

The mechanical seal consists of several parts (figure 10).

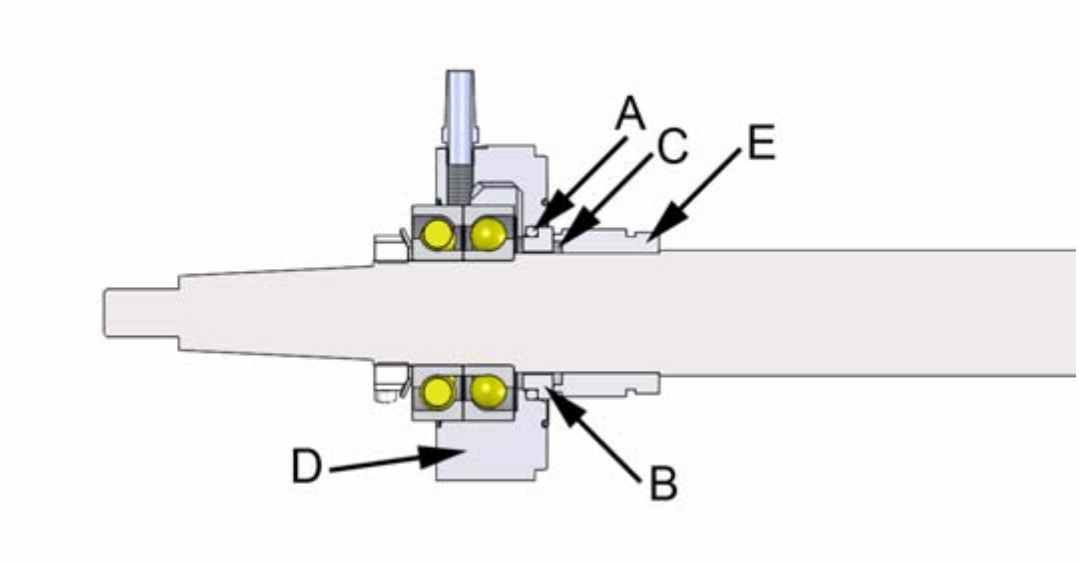

Figure 10. Cross-section of the mechanical seal

A	Static slip-ring seal
B	Static slip-ring
C	Rotating slip-ring
D	Bearing housing
E	Mechanical seal frame

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.

The frame of the mechanical seal (figure 10, points E and C) is removed by opening the set screws on its side (3 pcs, figure 10, point E) and pressing the part from the impeller side.

Parts A and B (figure 10) are removed by pushing them from the bearing side.

O-ring

An o-ring is used as sealing between the bearing housing and the jet's frame (figure 11).

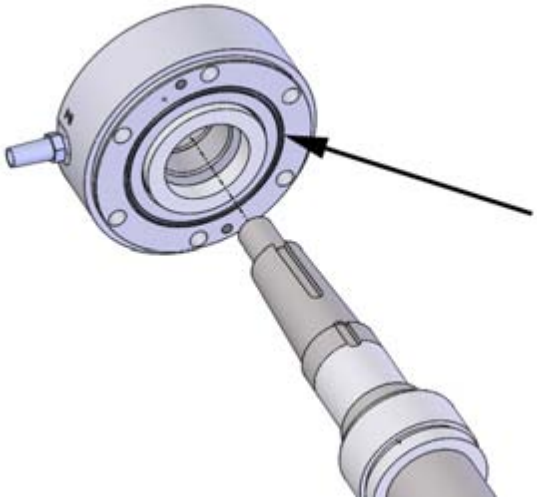

Figure 11. O-ring

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 seals

A shaft seal that seals the front end of the bearing housing is attached to the bearing housing seal cover. The seal lip rubs against the surface of the drive flange. The shaft seal (figure 12) is attached to the bearing housing seal cover. In order to replace the shaft seal, the seal cover must be removed from the bearing housing cover.

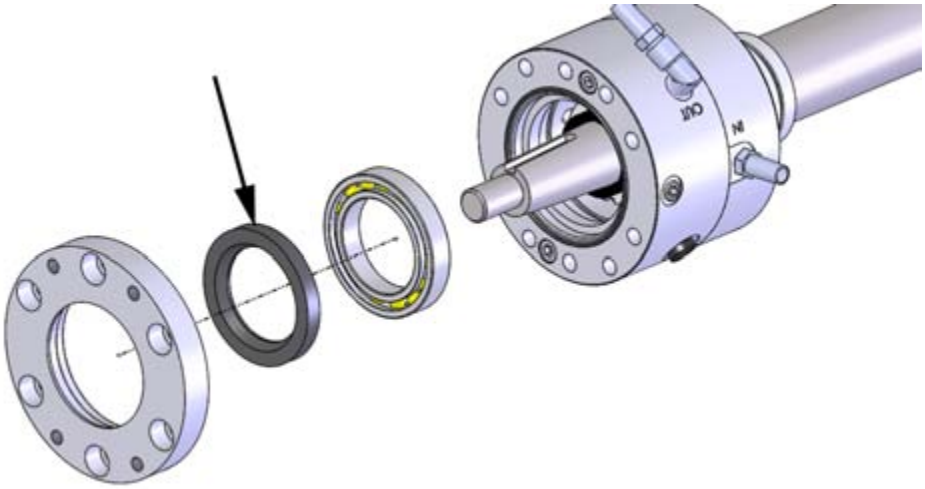

Figure 12. Shaft seal of the bearing housing

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 and the coupling flange seal should be replaced every time the bearing 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 (particularly where the shaft seal rubs against the coupling flange).

Measuring the straightness of the shaft

The straightness of the shaft is measured from three points (figure 13).

Figure 13. 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. Place the frame of the mechanical seal (figure 14, point B) against the shoulder of the shaft (figure 14, point D) and tighten the set screws (3 pcs, figure 14, point C).

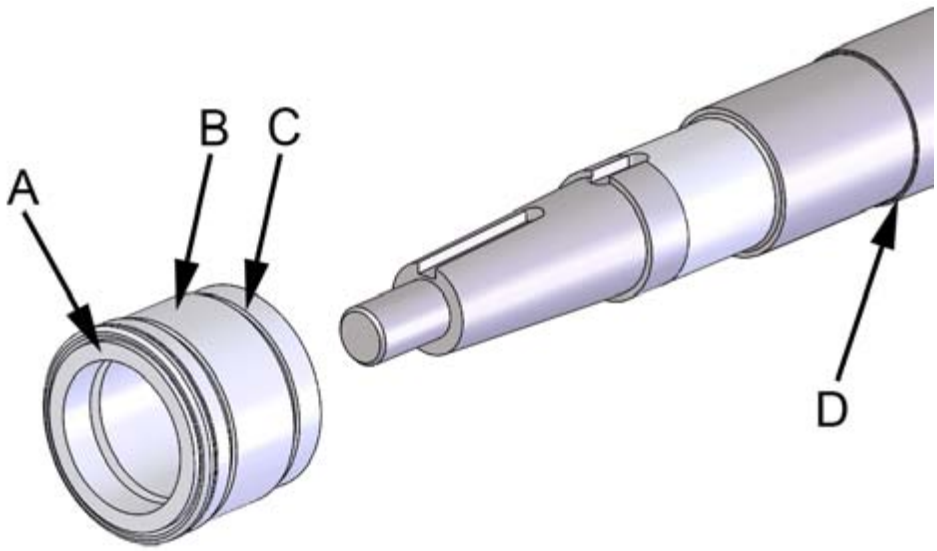

Figure 14. Installing the mechanical seal

Be careful not to damage the slip-ring (figure 14, point A) during installation. If the frame of the mechanical 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.

2. Push the static part of the mechanical seal into the bearing housing together with the seal (figure 10, points A and B).

   Figure 15 shows the static ring in its correct position.

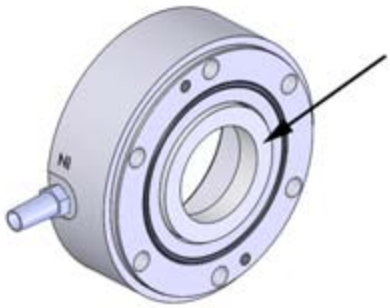

Figure 15. Static ring

3. Lubricate the inner rim of the bearing housing.

4. Push the bearing pair (figure 16, point D) into the bearing housing (figure 16, point F) and place them on to the shaft together.

Note that the bearings must be installed in the correct way (figure 17).

5. Position the lock washer on to the shaft and screw the shaft nut in place (figure 16, points A and C).

6. Tighten the shaft nut by first tightening it against the bearings by hand and then using a shaft nut wrench to tighten it enough to make one of the teeth of the lock washer connect with the groove in the nut (figure 16, point A).

7. Turn the tooth of the lock washer down into the shaft nut groove and then tighten the shaft nut screws (6 pcs, figure 16, point B).

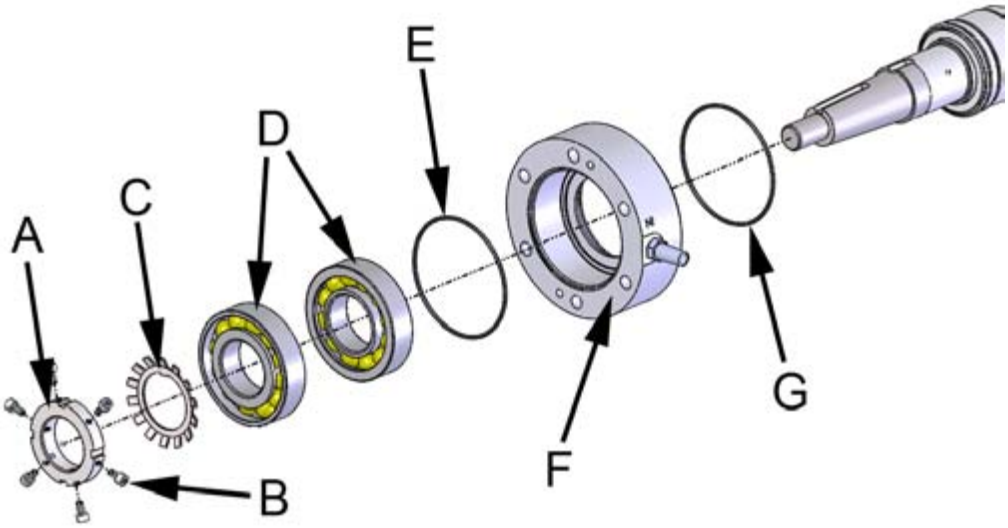

Figure 16. Pushing the bearings onto the shaft

A	Shaft nut
B	Shaft nut screw (6 pcs)
C	Lock washer
D	Bearings
E	O-ring between the bearing housing and the bearing housing cover
F	Bearing housing
G	O-ring between the bearing housing and the jet's frame

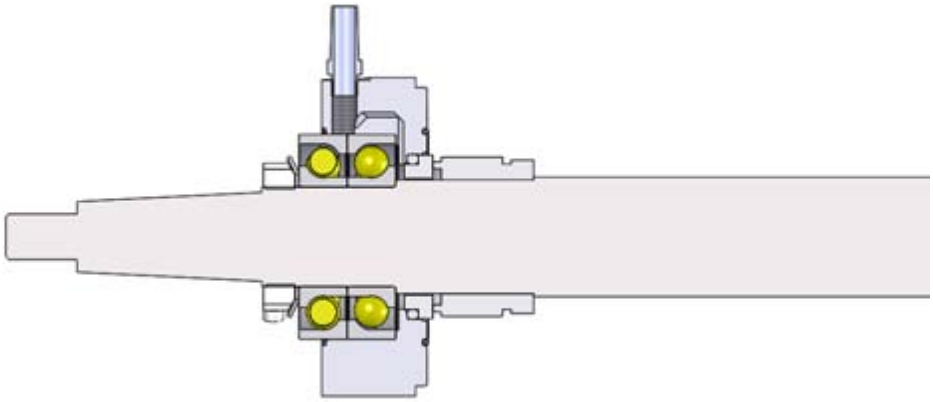

Figure 17. Bearings (cross-section)

8. Set the o-ring between the bearing housing and the jet's frame (figure 16, point G) and the o-ring between the bearing housing and the bearing housing cover (figure 16, point E) into place.
9. Push the bearing housing cover into place (figure 18, point B).

   Make sure that the screw holes are positioned correctly.
10. Fasten the bearing housing cover with two M6 screws to a tightness of 9 Nm (figure 18, point A).

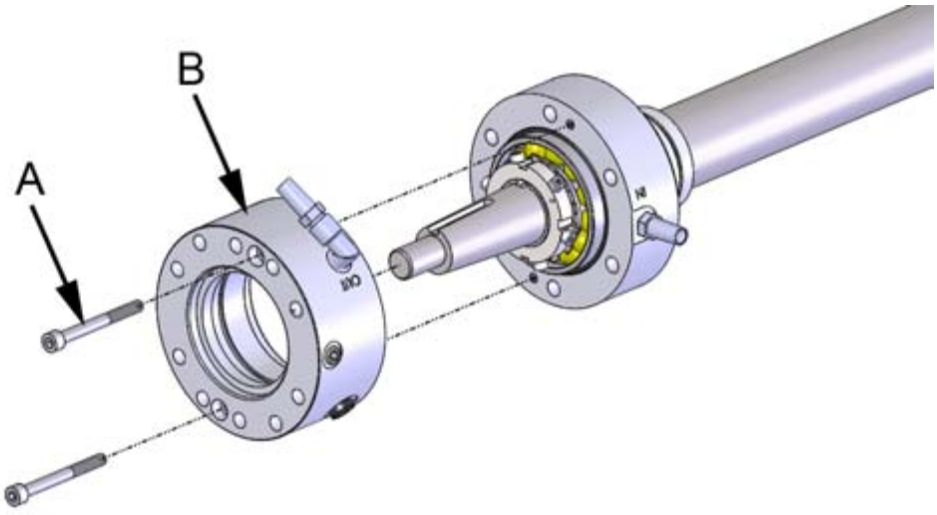

Figure 18. Installing the bearing housing cover

11. Push the shaft seal (figure 19, point B) together with the drive flange bearing (figure 19, point C) into the bearing housing cover (figure 19, point A).

    Make sure that the shaft seal is installed in the correct way (figure 20).
12. Place the o-ring that seals the gap between the seal cover and the bearing housing cover (figure 19, point D) into the groove in the seal cover.

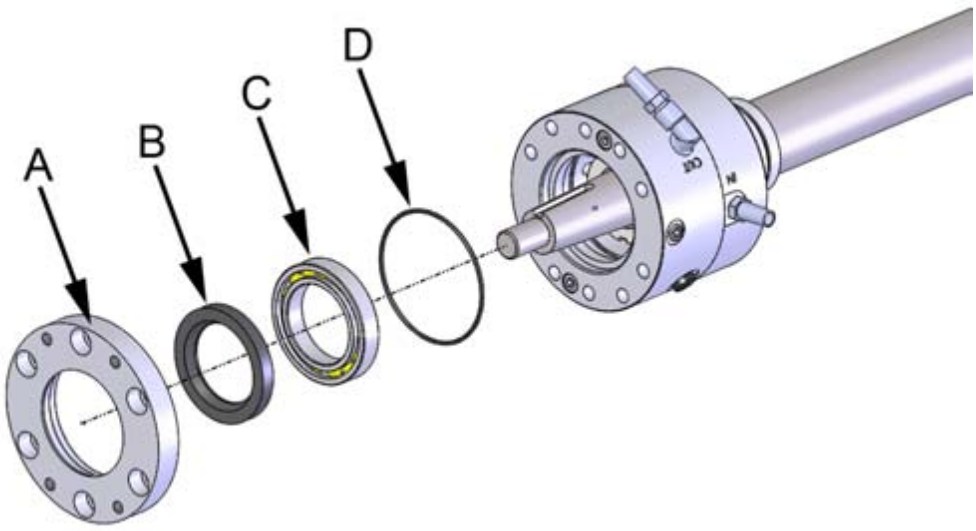

Figure 19. Assembly of the bearing housing seal cover

13. Set the assembled seal cover into place (figure 20).

    Make sure that the screw holes are positioned correctly.

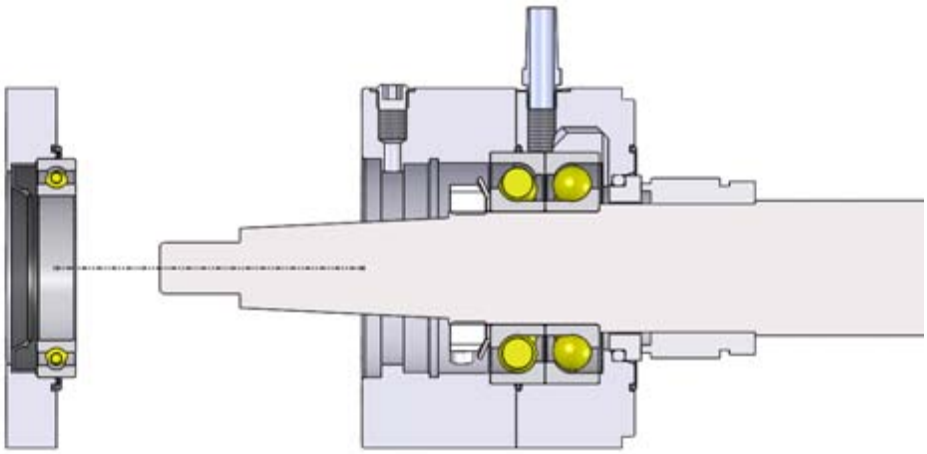

Figure 20. Installation of the assembled seal cover (cross section)

14. Replace the seal in the rear section of the drive flange.

    This seal does not necessarily wear since it is static, but when the bearing housing is opened, it is a good idea to replace it. Ensure that the seal is inserted in the correct way (figure 21).

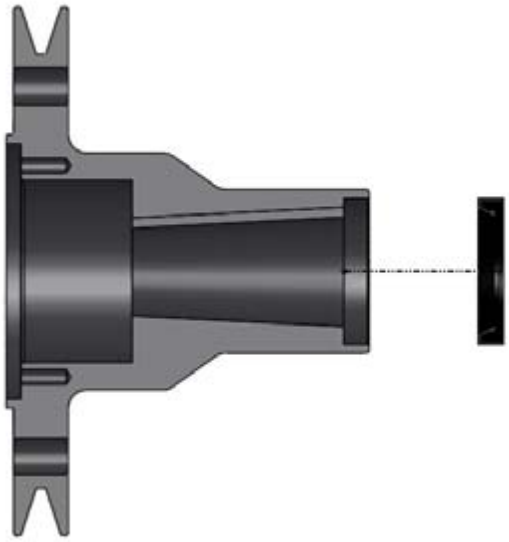

Figure 21. Installing the drive flange seal in the correct way

15. Place the bearing housing fastening screws (6 pcs, figure 22, point B) in the holes and install the drive flange.

    15.1. Place the key (figure 22, point C) in the keyway (figure 22, point D).

    15.2. Press the drive flange against the cone at the end of the shaft.

    The shaft seal in the drive flange contacts the key, but if you lift the rear edge of the drive flange slightly, it will clear the key. The tightening torque of the drive flange nut (figure 22, point A) is 100 Nm. Use a thread locking compound (such as Loctite 242).

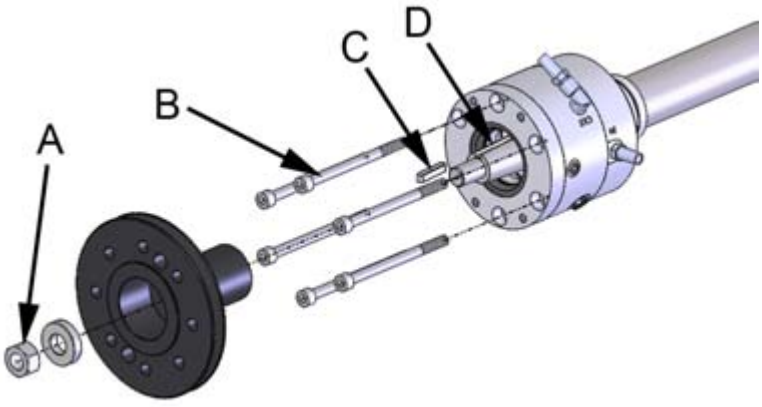

Figure 22. Installing the drive flange

It is recommended to check the tightness of the bearing housing during this phase. Attach a piece of hose turned upwards to the OUT connector (figure 23, point A) to prevent overflow. Fill the bearing housing by adding recommended oil through the IN connector (figure 23, point B). Rotate the shaft in different directions several times in order to expose the possible leak points in the

mechanical seal (figure 24, point B). Also check that the shaft seal that rubs against the surface of the drive flange is not leaking (figure 24, point A).

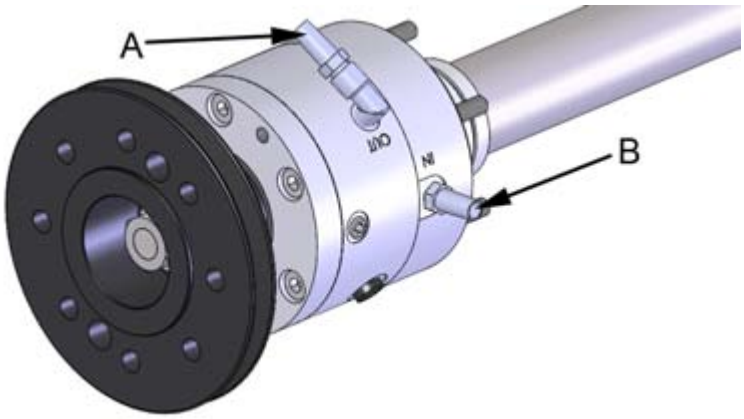

Figure 23. Bearing housing connectors

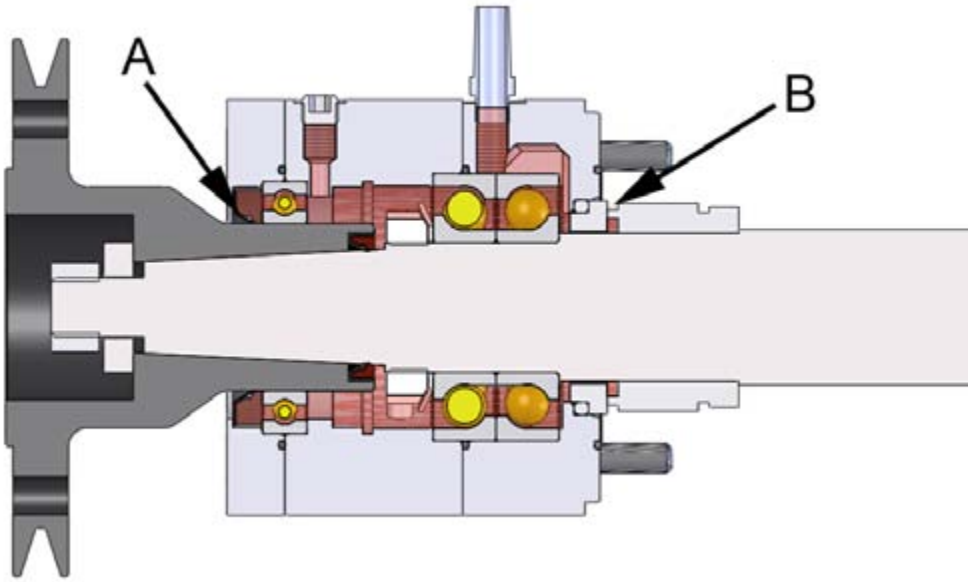

Figure 24. Lubricating the bearing housing (cross-section)

Lubricating oil is indicated in red.

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. Make sure the seal is tight by spreading sealing compound (such as Sikaflex 291i) on the shoulder (figure 25) at the o-ring.

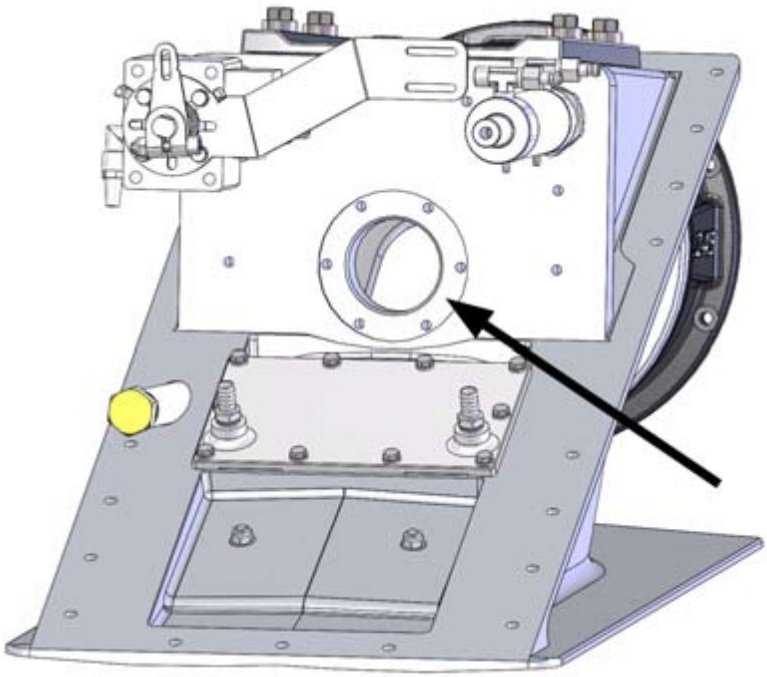

Figure 25. Shoulder

3. Push the shaft bearing into place through the hole in the jet's frame (figure 26, point A) and tighten the bearing housing fastening screws (6 pcs, figure 26, point B) through the holes in the drive flange using a long Allen wrench (figure 26, point C). Use a thread locking compound (such as Loctite 242).

   The tightening torque of the screws is 25 Nm.

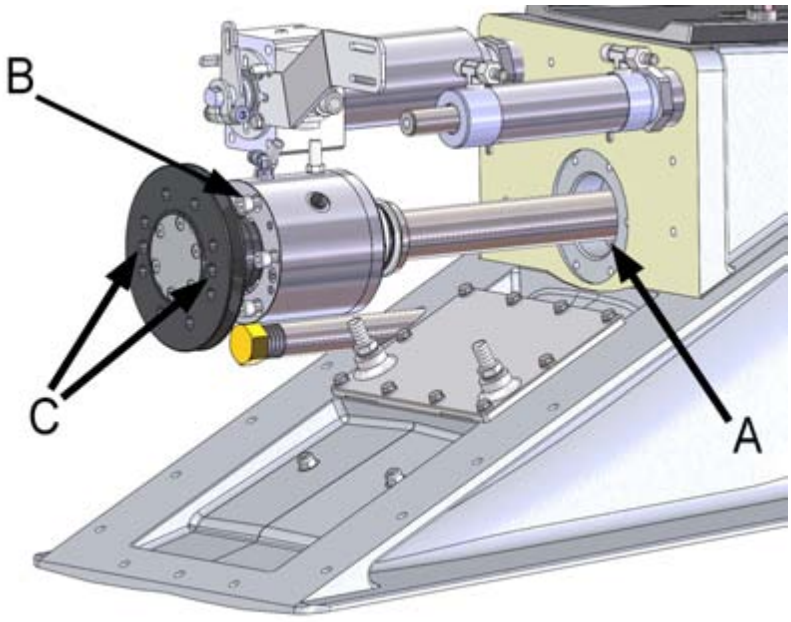

Figure 26. Attaching the bearing housing

4. Install the impeller (section 3.4. *Installing the impeller*, page 32).

5. Install the stator (section 6.3. *Installing the stator*, page 69), the steering nozzle (section 5.1.3. *Installing the steering nozzle*, page 61) and the reversing deflector (section 4.1.3. *Installing the reversing deflector*, page 41)

6. Install the hydraulic pump (section 4.3.3. *Installing the hydraulic pump*, page 56).

2.2. Rear-end bearing

2.2.1. Disassembling the rear-end bearing

Disassembling a grease-lubricated rear end bearing:

1. Remove the stator (section 6.1. *Removing the stator*, page 65).

2. The rear bearing housing is attached to the stator with three screws (figure 27). Undo the screws and remove the plastic cover.

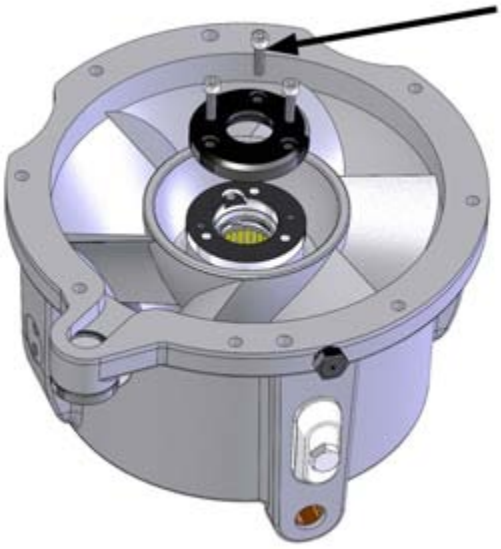

Figure 27. Rear bearing housing screws

3. Screw one or, if necessary, two of the fastening screws into the threaded holes in the bearing housing flange.

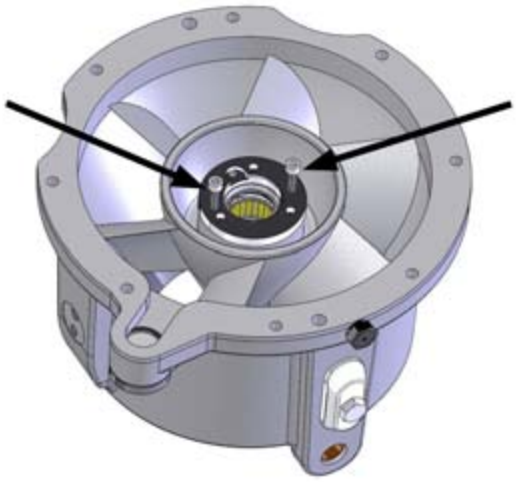

Figure 28. Detaching the rear bearing housing from the stator

4. Tighten the screws carefully until the bearing housing comes loose.
5. Pull the bearing housing off the stator.

Disassembling a water-lubricated rear end bearing:

1. Remove the stator (section 6.1. *Removing the stator,* page 65).
2. The water-lubricated bearing is pressed inside the stator. Use an extraction tool to remove the water-lubricated bearing (figure 29).

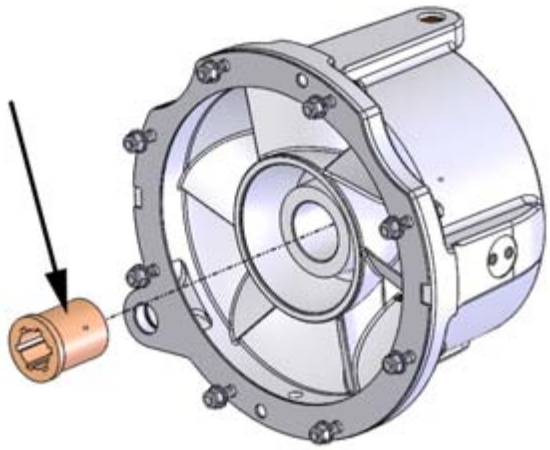

Figure 29. Disassembling a water-lubricated rear end bearing

NOTE!

A water-lubricated rear end bearing cannot be removed without damaging it. As such, a removed water-lubricated rear end bearing must always be replaced with a new one, and never re-used.

2.2.2. Repairing the rear end bearings

A water-lubricated rear end bearing cannot be repaired. This section pertains to the water-lubricated bearing only in regard to the removal of the shaft sleeve.

Repair operations on the rear bearings are limited to replacing worn parts. The wearing parts include the bearing, seals, and shaft sleeves, which are replaced as necessary. The wearing speed varies according to the load on the jet.

CAUTION!

If the seals are worn, they may allow water to flow into the bearing housing, in turn weakening the lubrication of the bearing and shortening its operating life.

However, it is normal for a small amount of water to leak into the bearing housing during operation, even if the seals are intact. This can be observed as a change in lubricant colour, and it does not affect the operating life of the bearings, as long as the instructed lubrication intervals are followed.

Please note that the greatest permissible radial clearance in the rear bearings is 0.1 mm.

Seals

NOTE!

A removed sealing must always be replaced with a new one, never reinstalled.

Replacing the seals:

1. Remove the seals with a screwdriver, for example (figure 30).

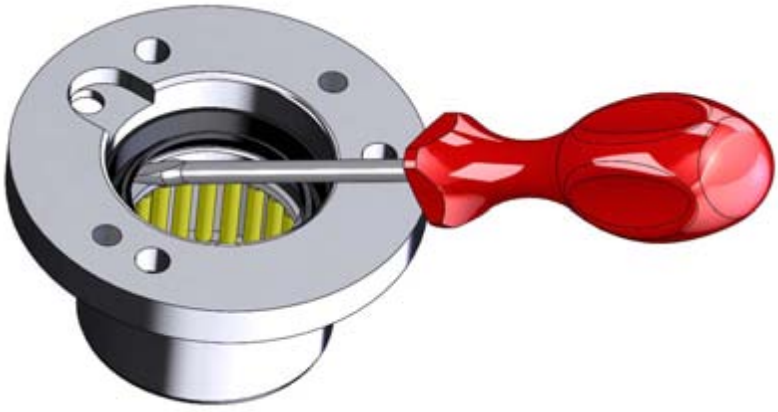

Figure 30. Removing the rear bearing seals

The second seal is attached to the plastic cover.

2. Replace the old seals with new ones.

Bearing

Replacing the bearing:

1. Push the bearing out of the housing from the front side.

   There are holes on the housing race (figure 31) to allow pushing the bearing with a mandrel, for example.

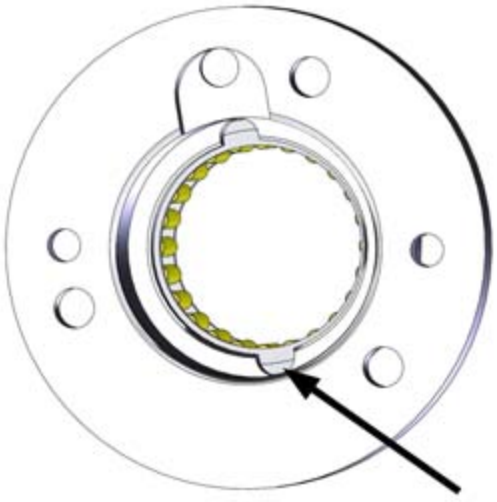

Figure 31. Recess allowing for easy removal of the bearing

Shaft sleeves

Grease-lubricated rear end bearing

There is a sleeve at the rear end of the shaft. The sleeve consists of two parts: the short (figure 32, point A) and long sleeves (figure 32, point C). A worn sleeve can be replaced. At the end of the shaft there is a locking plate (figure 32, point B) that presses the sleeves into place.

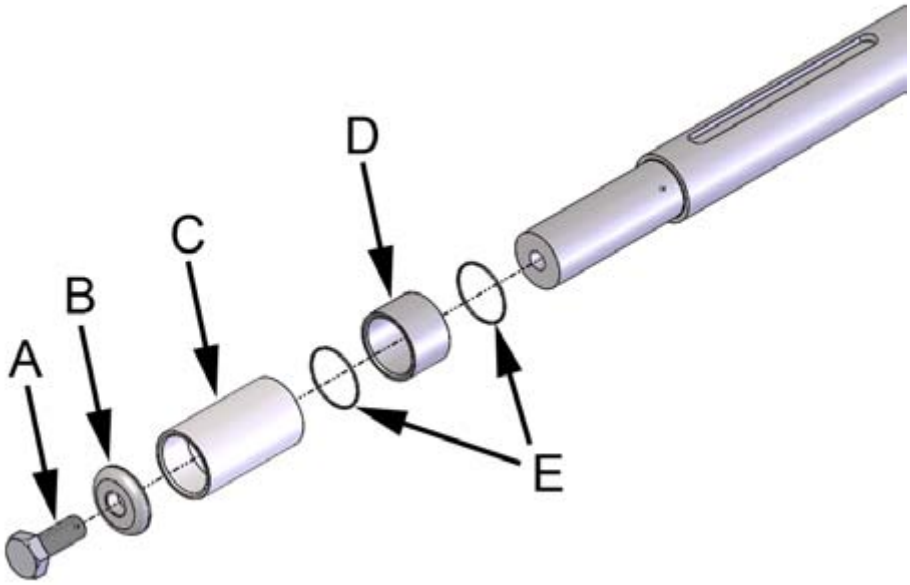

Figure 32. The shaft sleeves of a grease-lubricated rear end bearing

Removing the shaft sleeves (grease-lubricated rear end bearing):

Unscrew the screw located at the end of the shaft (figure 32, point A) and pull the sleeves off the shaft.

Please note that there are o-rings between the sleeves (figure 32, point E).

Water-lubricated rear end bearing

There is a sleeve at the rear end of the shaft (figure 33, point C). A worn sleeve can be replaced. At the end of the shaft there is a locking plate (figure 33, point B) that presses the sleeve into place.

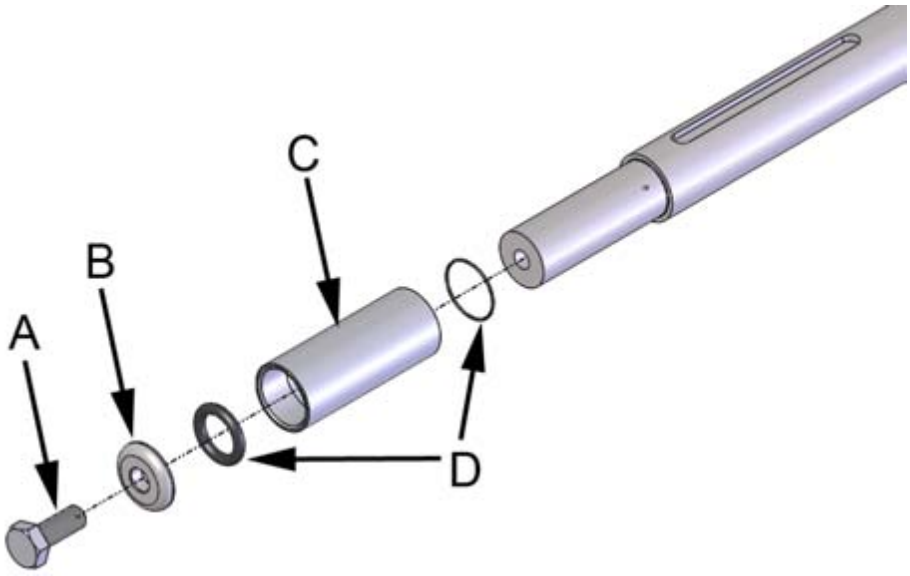

Figure 33. The shaft sleeve of a water-lubricated rear end bearing

Removing the shaft sleeve (water-lubricated rear end bearing):

Unscrew the screw located at the end of the shaft (figure 33, point A) and pull the sleeve off the shaft.

Please note that there are o-rings between the parts (figure 33, point D).

2.2.3. Assembling the rear end bearing

Assembling a grease-lubricated rear bearing

1. Push the bearing into the bearing housing from the back (figure 34).

   Use a bearing retaining compound to ensure that the bearing stays in place (such as Loctite 648 or similar).

Figure 34. Assembly of the rear bearing

2. Push the seal into place from the front of the bearing housing.

   The second seal is attached to the plastic cover. Ensure that the seals are inserted in the correct way (figure 35).

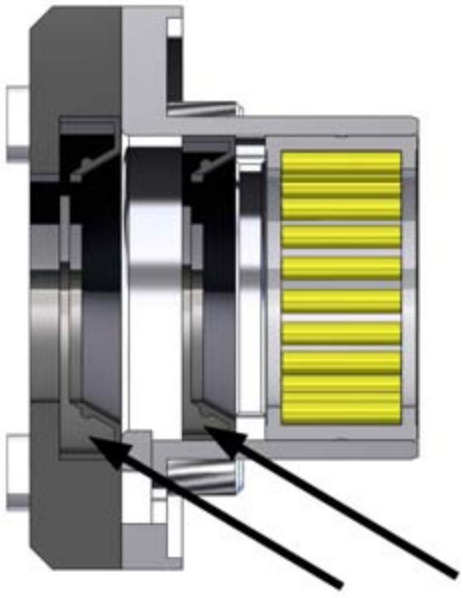

Figure 35. Installation direction of the seals

2.2.4. Installing the rear end bearing

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

Installing a grease-lubricated rear end bearing:

1. Spread adhesive sealing compound on to the area indicated in figure 36 .

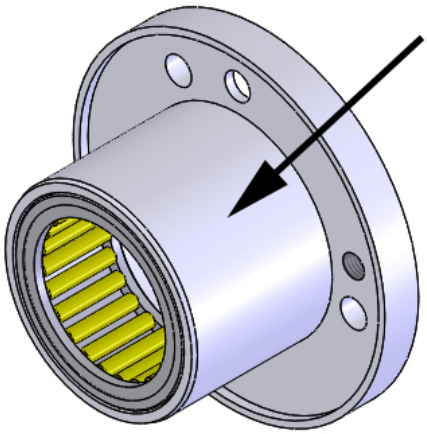

Figure 36. Spreading area of the adhesive compound

2. Clean the rear end bearing lubrication channel located on the stator (figure 37, point E) of old grease.

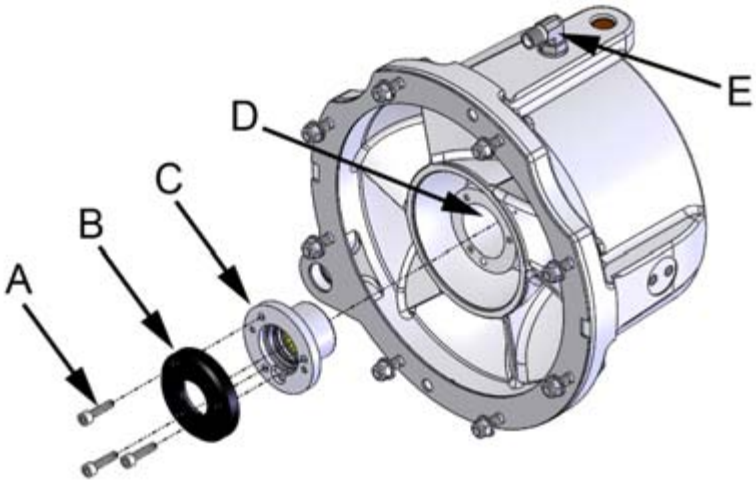

Figure 37. Installing the bearing housing cover

3. Push the bearing housing (figure 37, point C) into the stator hole (figure 37, point D) in the correct position so that the holes of the three fastening screws (figure 37, point A) are aligned. This is when the housing is in the correct position.
4. Install the cover (figure 37, point B) in place and tighten the fastening screws.

Apply thread locking compound (such as Loctite 242) to the screws. The tightening torque of the screws is 10 Nm.

5. Remove excess adhesive compound from the hole (figure 37, point D).

6. Install the sleeves at the end of the shaft onto the shaft together with the o-rings.

   The correct installation sequence is illustrated in figure 38.

   Use thread locking compound (such as Loctite 243) on the fastening screw in order to prevent any unintentional loosening of the screw.

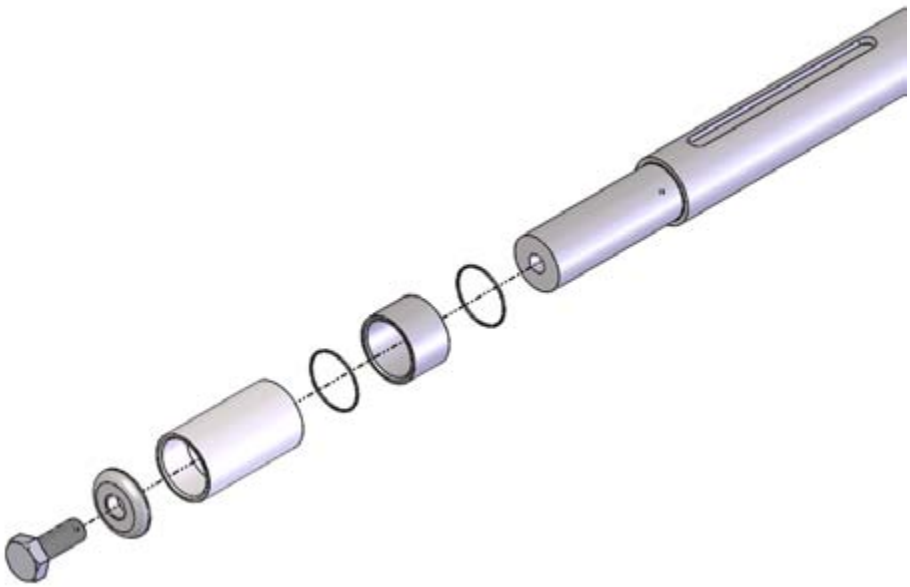

Figure 38. Installation sequence of the sleeves

7. Install the stator (section 6.3. *Installing the stator*, page 69).

Installing a water-lubricated rear end bearing:

1. Spread waterproof grease in the area around the bearing indicated in figure 39 .

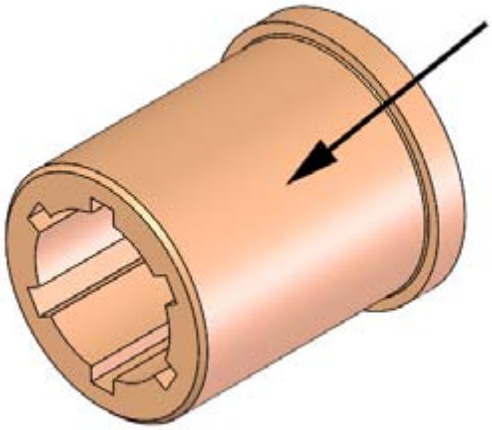

Figure 39. Spreading area of the waterproof grease

2. Place the water-lubricated bearing in the hole on the stator (figure 40, point B).

3. Carefully push the water-lubricated bearing into the stator hole using a hydraulic press, for example.

   Use as much of the bearing’s outfacing surface area for pushing as possible (figure 40, point A).

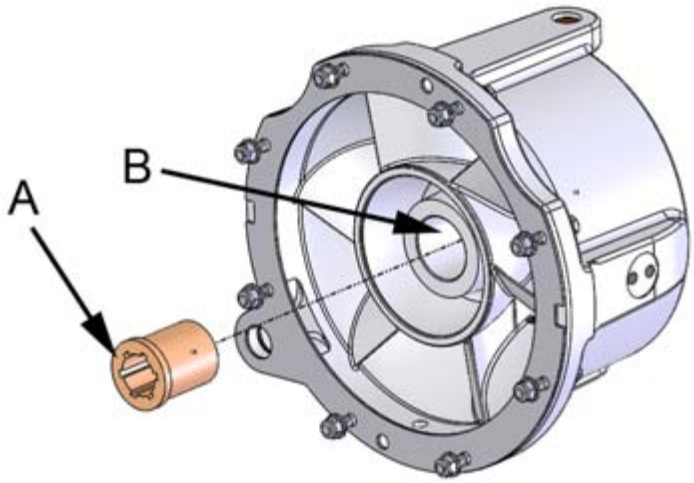

Figure 40. Installing the water-lubricated bearing

4. Remove excess waterproof grease from the hole (figure 40, point B).

5. Install the sleeve at the end of the shaft onto the shaft together with the o-rings.

   The correct installation sequence is illustrated in figure 41.

   Use thread locking compound (such as Loctite 243) on the fastening screw in order to prevent any unintentional loosening of the screw.

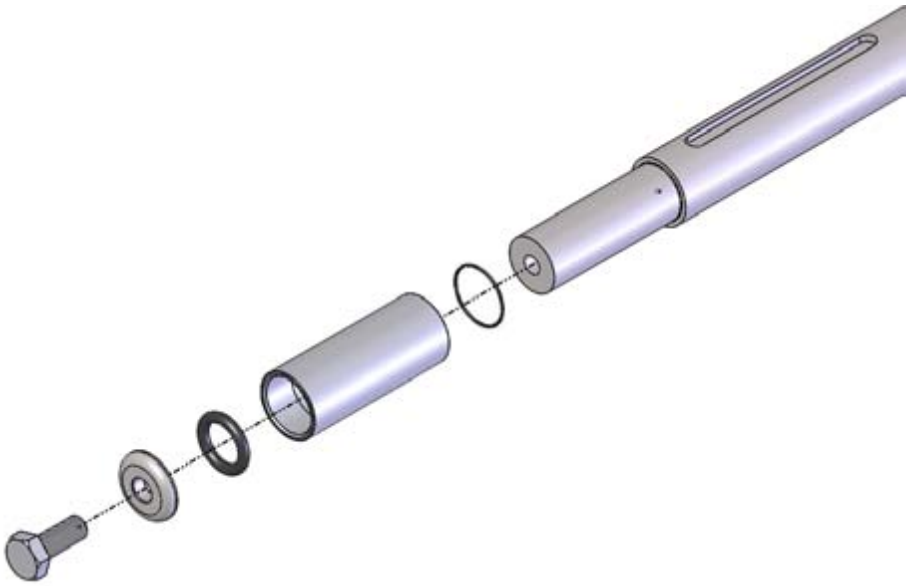

Figure 41. Installation sequence of the sleeves

6. Install the stator (section 6.3. *Installing the stator*, page 69).

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 42, 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.

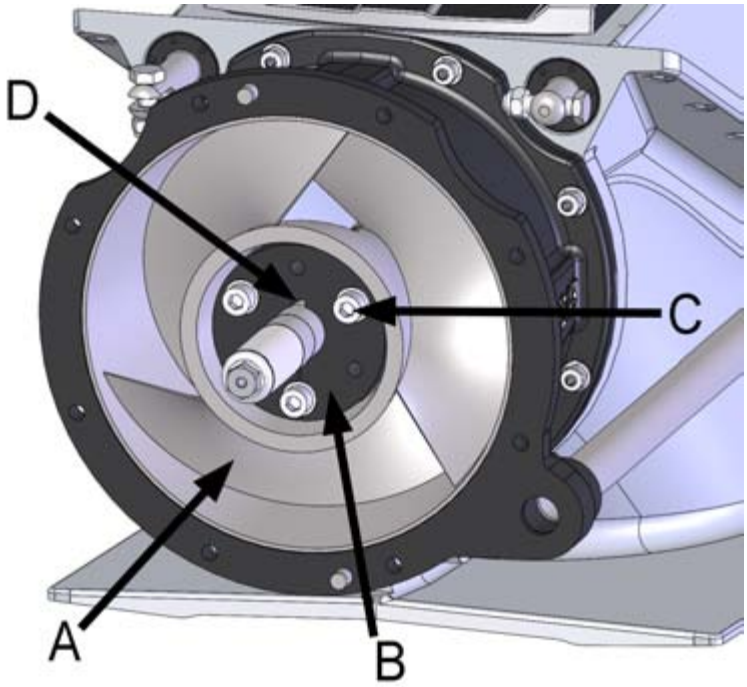

Figure 42. Impeller

The impeller is attached to the shaft using a plastic cone (figure 42, point B), tightened between the impeller and shaft using three screws (figure 42, point C). The torque is transmitted to the shaft using a key (figure 42, point D).

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 rings of various thicknesses (figure 43, 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. A plastic insulating ring must always be present in front of the impeller (figure 43, point B). The ring galvanically insulates the impeller from the shaft.

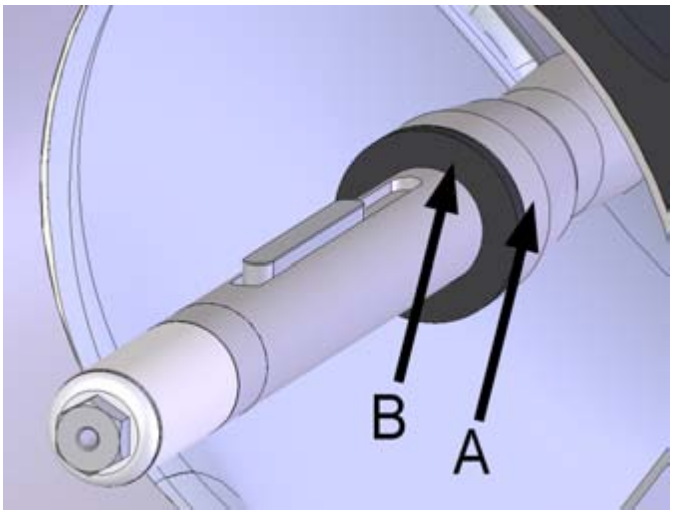

Figure 43. Impeller rings

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 245 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 44). The type of the impeller must be declared, for example, when ordering a new impeller. The format of the type marking is "245-X/N+T.

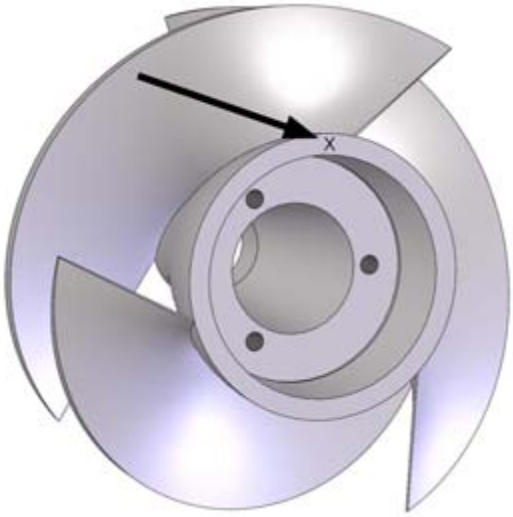

Figure 44. Impeller type marking

3.2. Removing the Impeller

Before removing the impeller, remove the stator (section 6.1. *Removing the stator*, page 65).

Removing the impeller:

1. Open the impeller fastening cone screws (3 pcs, figure 42, point C).
2. Insert one of the screws into the threaded hole (figure 45) and tighten until the cone comes loose.

   If the cone is stuck, insert and tighten a screw in another threaded hole.

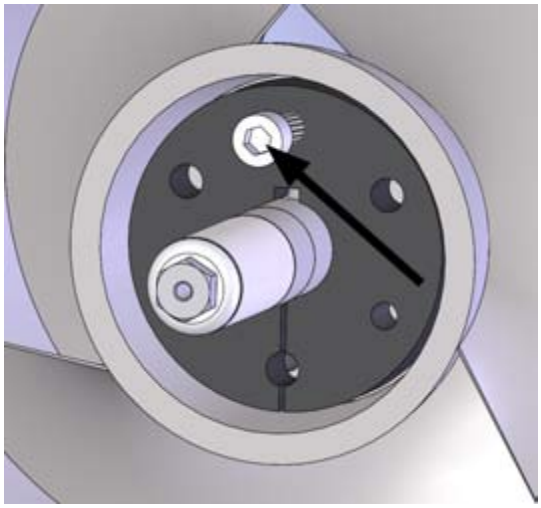

Figure 45. Removing the Impeller

3. Pull the impeller off of the shaft and remove the key from the keyway.

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 impeller is manufactured from acid-proof steel 1.4460 (AISI329).

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 46).

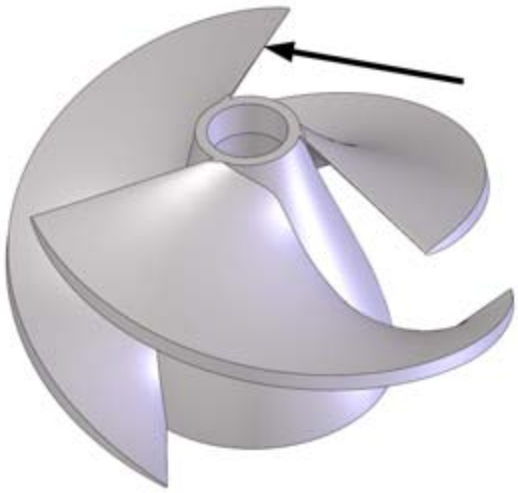

Figure 46. Front edge

Repairing bent blades

Bends in the blades can be carefully tapped back into their original shape with a hammer.

3.4. Installing the impeller

New and repaired impellers are fitted in the same way.

Installing the impeller:

1. Attach the plastic fastening cone to the impeller hub and tighten the screws so that they are finger-tight.

   Note that the place of the keyway is marked on the impeller hub (figure 47).

Figure 47. Position of the keyway

The thrust caused by the impeller is transmitted through the adjuster sleeve to the shaft (figure 48, point A). The sleeve consists of rings of different thickness. The length of the sleeve can be adjusted in 0.5 mm (approx. 0.02") increments by changing the number of the rings. This way the impeller gap on the outer race becomes fit.

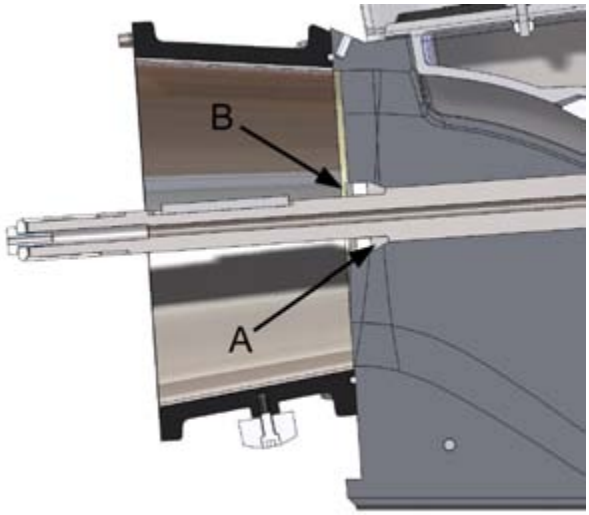

Figure 48. Adjuster sleeve

2. Find the right adjuster sleeve length by testing.

3. Push the sleeve and the plastic insulating ring (figure 48, point B) on to the shaft. The insulating ring sits against the impeller.

4. Place the impeller into the tunnel.

   At this point the screws of the plastic mounting cone must be finger-tight.

5. Measure the gap on the impeller outer race.

   The optimal gap is 0.4–0.8 mm.

   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 tunnel.

CAUTION!

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

6. Once you have found the right adjuster sleeve length, place the key in the shaft keyway (figure 49) and push the impeller on to the shaft against the adjuster sleeve.

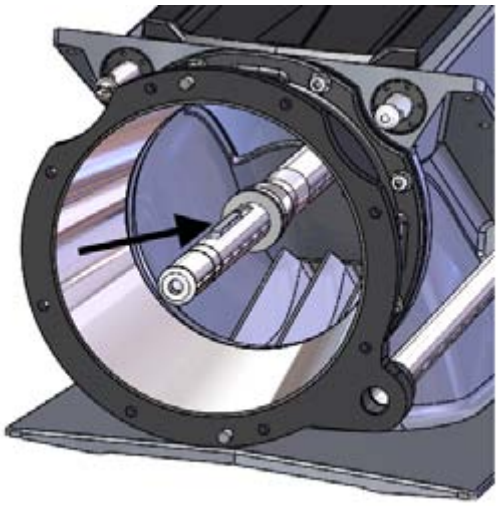

Figure 49. Keyway

7. Tighten the impeller fastening screws evenly in a crosswise sequence.

   The tightening torque is 20 Nm.

   While tightening, the impeller moves back a bit and a small gap develops on the front. The gap will disappear when the impeller is being loaded.

8. Install the stator and the steering nozzle in place in reverse order to that when removing (section 3.2. *Removing the Impeller*, page 30).

   The torque to be used is the tightening torque for M10 bolts.

3.5. Impeller cone

The impeller spins inside a tunnel with an aluminium exterior surface (figure 50, point A) and an inner cone made of acid-proof steel (figure 50, point B). The inner cone is not an actual wearing part as the cone shape enables the impeller to be adjusted more deeply, in order to maintain a small clearance. However, if the inner cone is damaged, the entire impeller tunnel can be replaced.

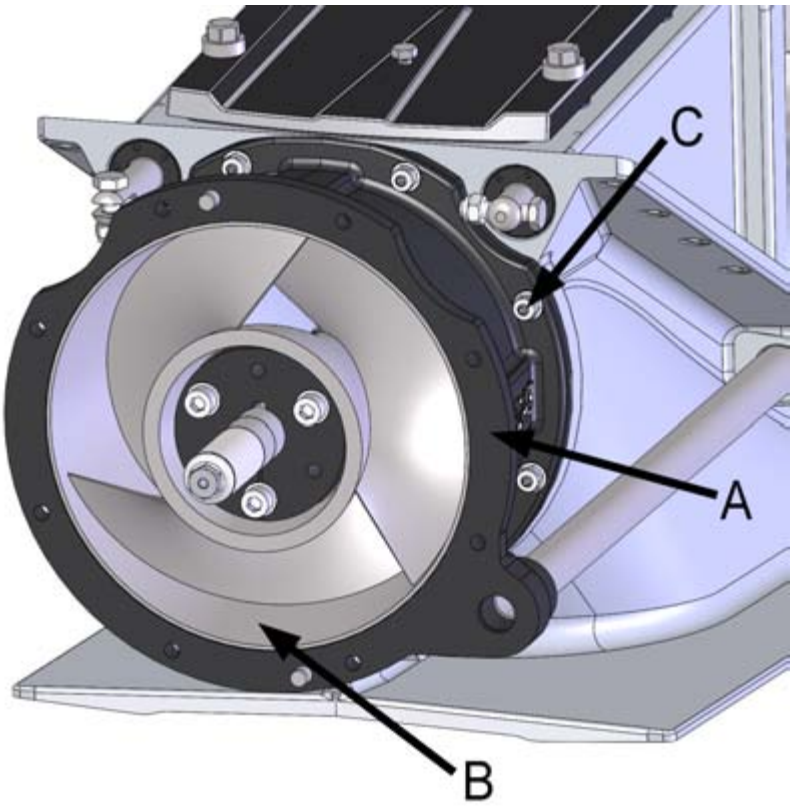

Figure 50. Impeller cone

Removing the impeller tunnel

Before removing the impeller tunnel, detach the stator (section 6.1. *Removing the stator*, page 65) and the the impeller (section 3.2. *Removing the Impeller*, page 30).

1. Open the connection to the raw water line at the pipe end on the engine room side (figure 51, point A).
2. Screw the raw water pipe to disconnect it from the rear end (figure 51, point B). However, you can leave it attached to the frame.

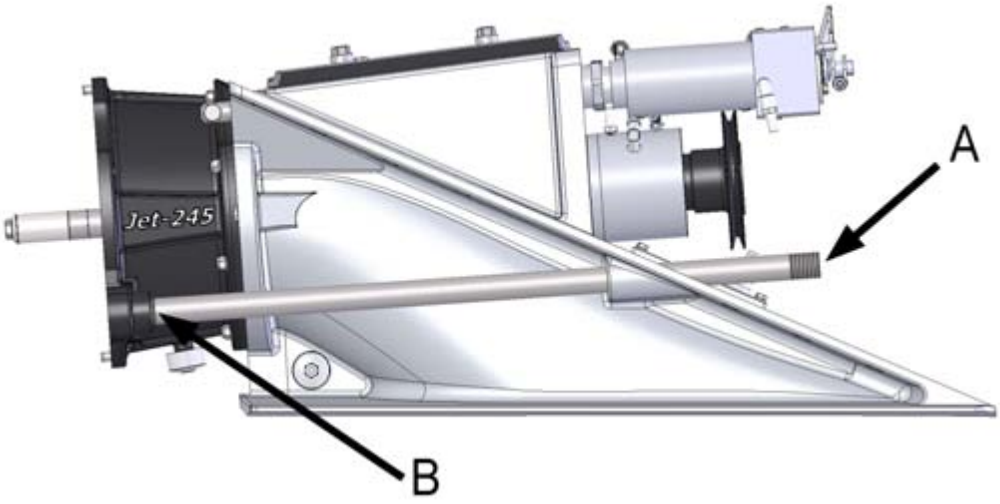

Figure 51. Raw water line

3. Open the tunnel locking nuts (8 pcs, figure 50, point C).

4. Pull the tunnel off the frame.

   You can assist the detachment by inserting a blunt wedge in the holes included for this purpose (figure 52).

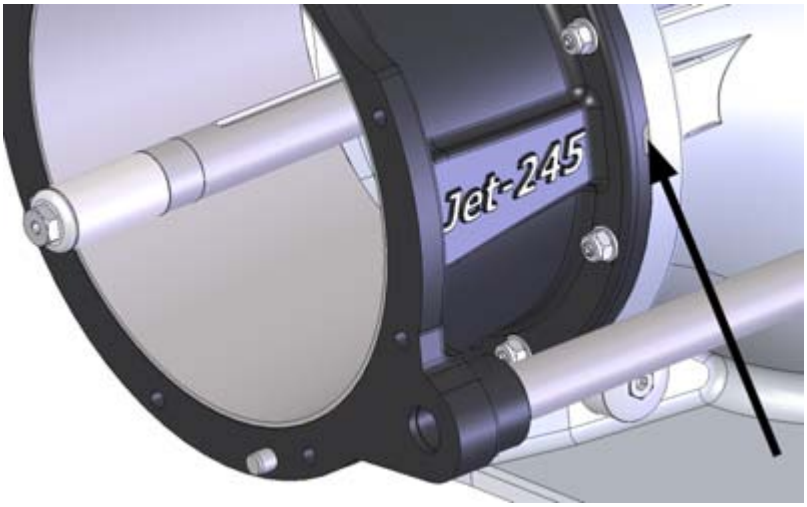

Figure 52. Removing the impeller tunnel from the frame

Installing the impeller tunnel

1. Ensure that the o-ring between the impeller tunnel and frame is in place. Apply waterproof petroleum jelly onto the connecting surface (such as Shell Gadus S2 V220AC or similar) (figure 53, point A).

2. Ensure that the set screws (8 pcs) are in their correct places in the frame. If they have come loose, they must be reinstalled with thread locking compound (such as Loctite 242) (figure 53, point B).

3. Ensure that the dowel pins of the impeller tunnel are in place (figure 53, point C).

4. Press the impeller tunnel into place.

5. Tighten the nuts and the washers (8 pcs) into place to a torque of 25 Nm.

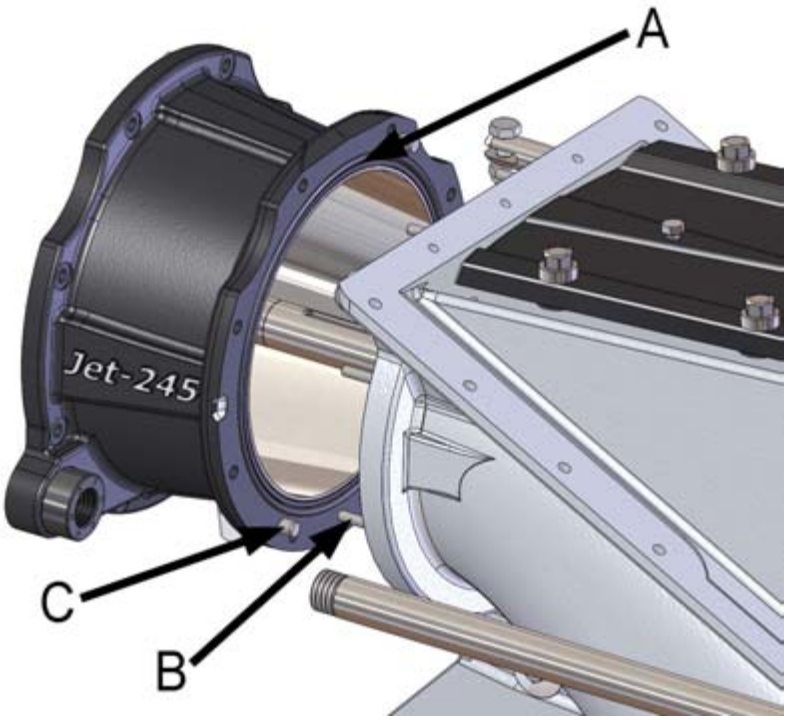

Figure 53. Installing the impeller tunnel

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 54, 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 54, point B). A cable runs from the handle in the cabin to the operating lever of the cylinder (figure 54, point C). The hydraulic cylinder receives its power from a pump integrated in the jet (figure 54, point D), rotated from the coupling flange with a V belt.

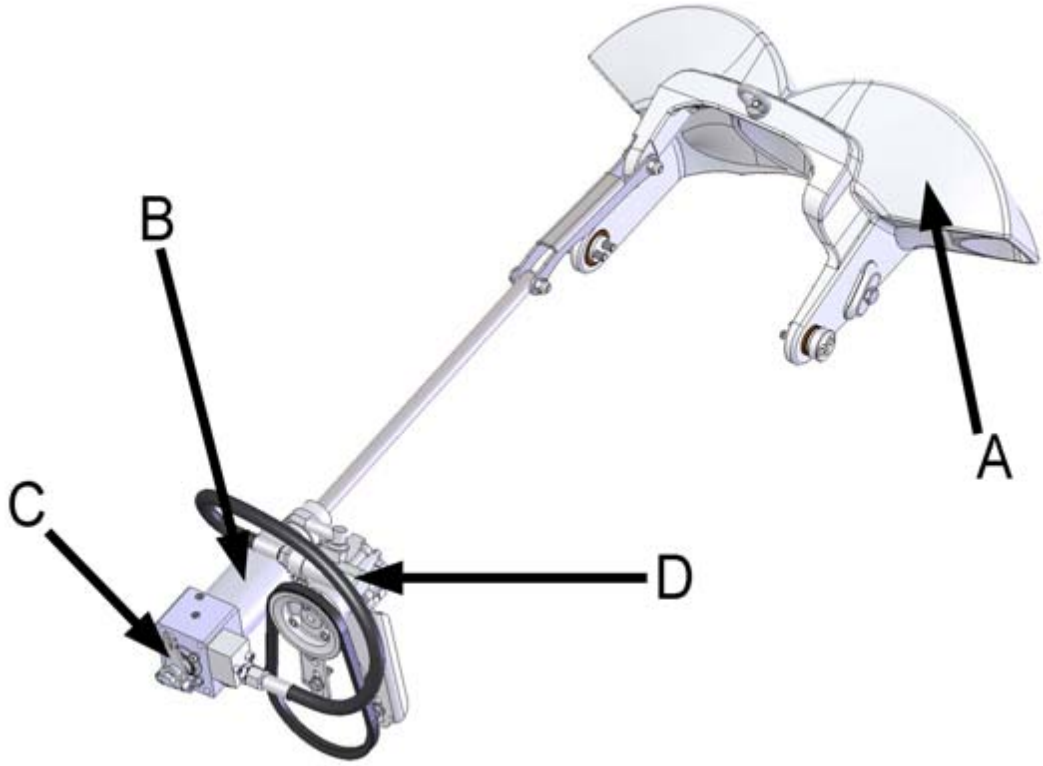

Figure 54. Reversing deflector and operating hydraulics

4.1. Reversing deflector

4.1.1. Removing the reversing deflector

Removing the reversing deflector:

1. Open the knee bolt of the connecting rod between the hydraulic cylinder and the reversing deflector (figure 55, point A).

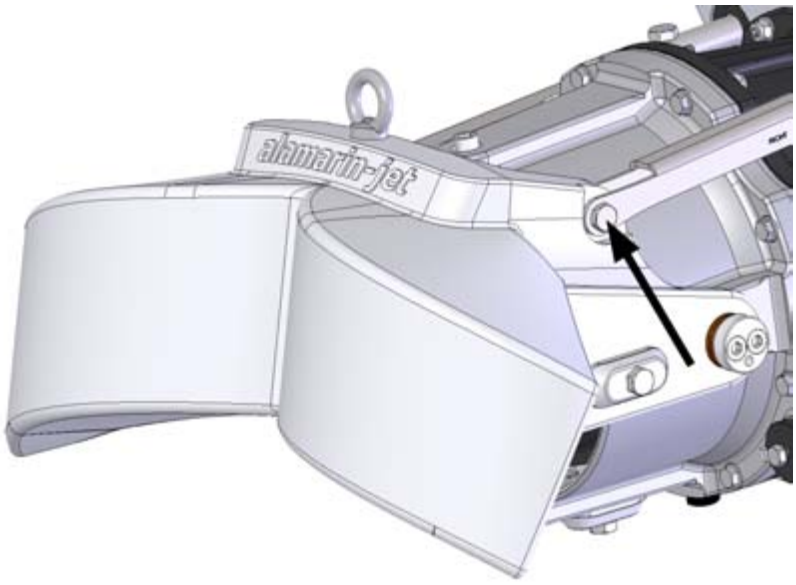

Figure 55. Removing the reversing deflector

2. Open the four joint peg screws (2 pcs, figure 56).

WARNING!

Be careful not to drop the deflector.

The deflector weighs approximately 10 kg.

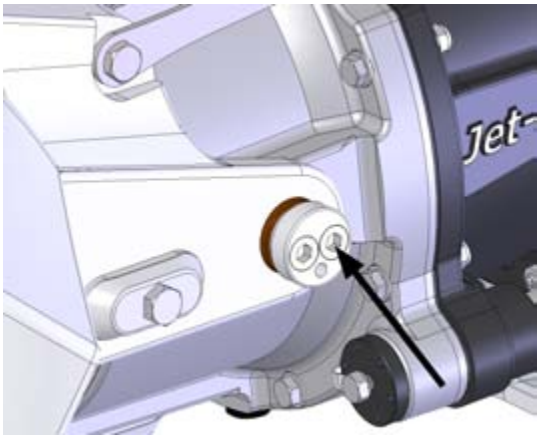

Figure 56. Joint peg screws

3. If you must replace the plastic bearings on the joint pegs, they can be removed with a suitable mandrel.

   The plastic bearings are pushed to their place and can be removed by pushing (figure 57).

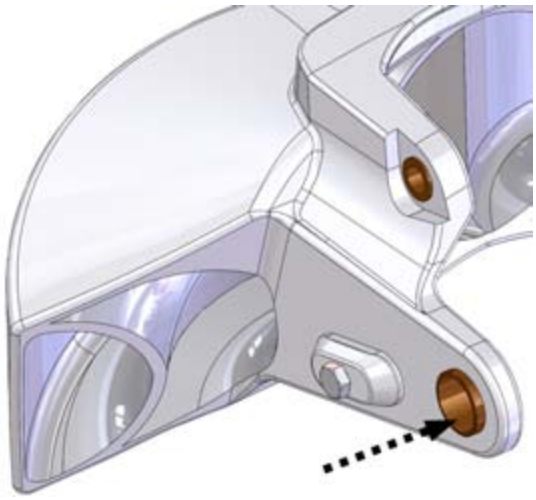

Figure 57. Removing the plastic bearings

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 joint pegs expands too much, the bearings must be replaced. The greatest permissible radial clearance is +1 mm. The articulation bearing of the hydraulic cylinder connecting rod 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

Installing the reversing deflector:

1. Push the plastic bearings of the joint peg and the hydraulic cylinder connecting rod into their places.

   Take note particularly of the direction of the joint peg bearing flange (figure 58).

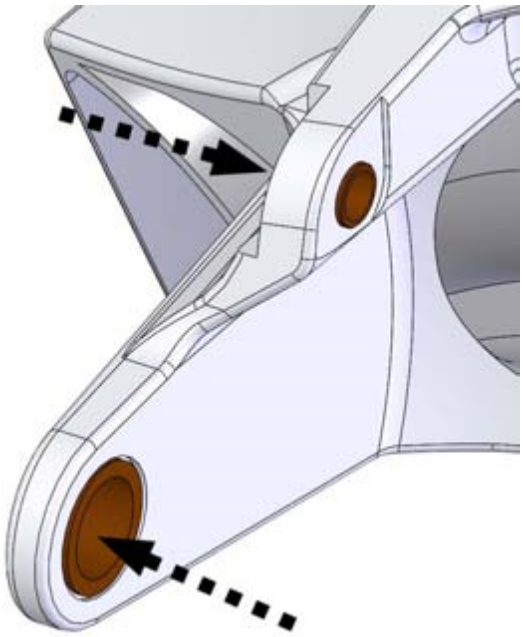

Figure 58. Direction of the plastic bearing flange

2. Lift the reversing deflector in place and push the joint pegs in the holes.
3. Tighten the fastening screws (2 on each side) (figure 59).

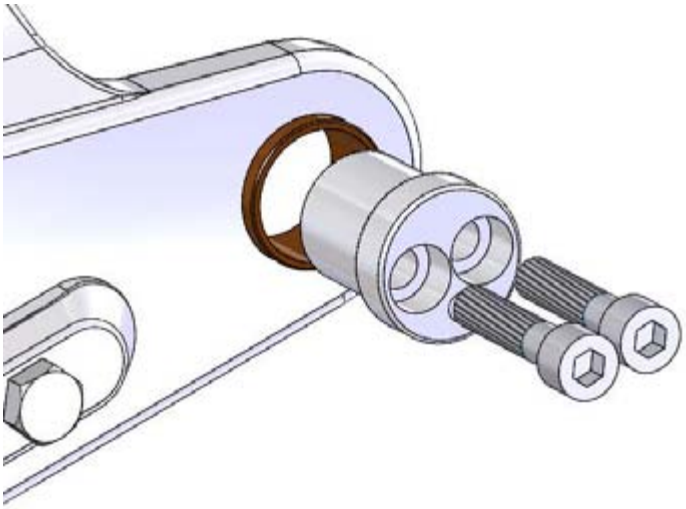

Figure 59. Attaching the joint pegs

4. Attach the knee bolt of the hydraulic cylinder connecting rod (figure 55, point A).

   Please note that there must be a sleeve in the reversing deflector's hole.

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 60, point A) from the control lever.

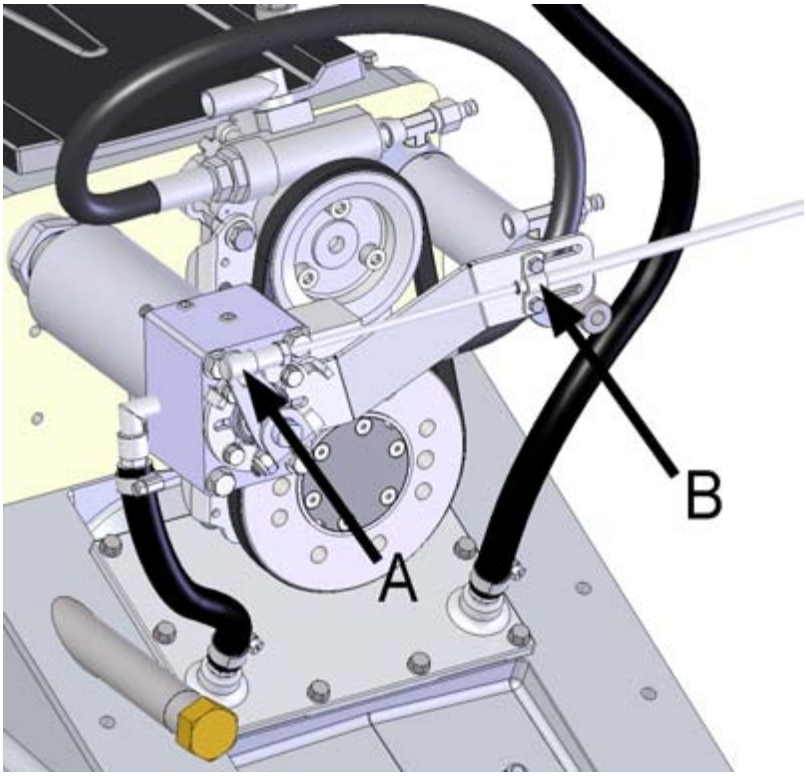

Figure 60. Removing the cable

   1.2. Remove the saddle mounting from the cable clamp (figure60, point B).

2. Remove the cylinder pressure hose (figure 61, point A) and return hose (figure 61, point B) from the valve and drain the oil into a container.

   Alternatively, you can plug the ends of the hoses.

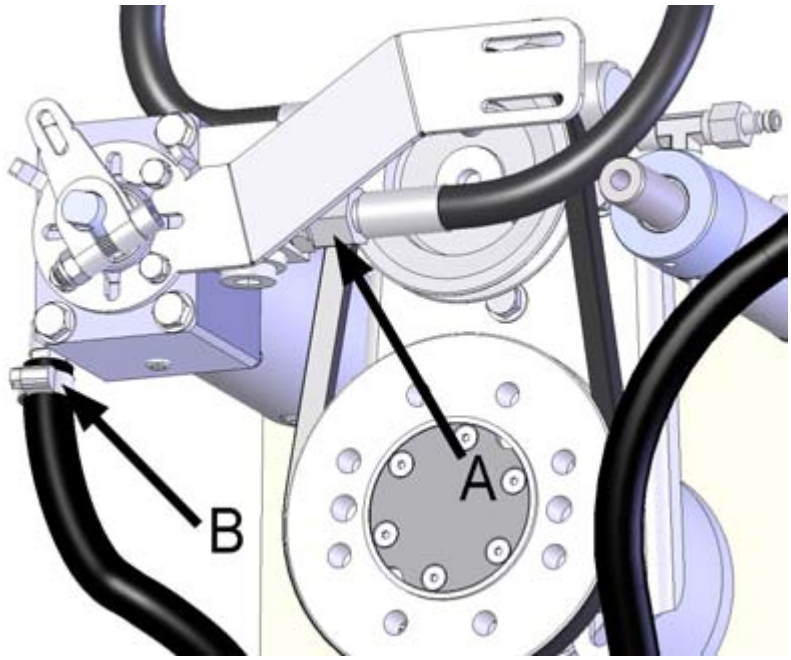

Figure 61. Removing the hoses

3. Open the knee bolt of the connecting rod between the hydraulic cylinder and the reversing deflector (figure 62, point A).

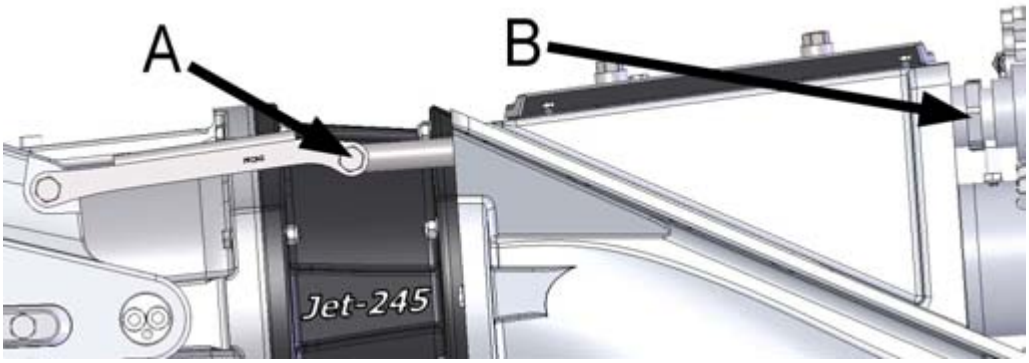

Figure 62. Removing the cylinder

4. Open the fastening nut of the hydraulic cylinder (figure 62, point B).

   If the opening is not possible with conventional tools, you can use special tools 10718.

5. Unscrew the cylinder from the jet's body towards the engine room.

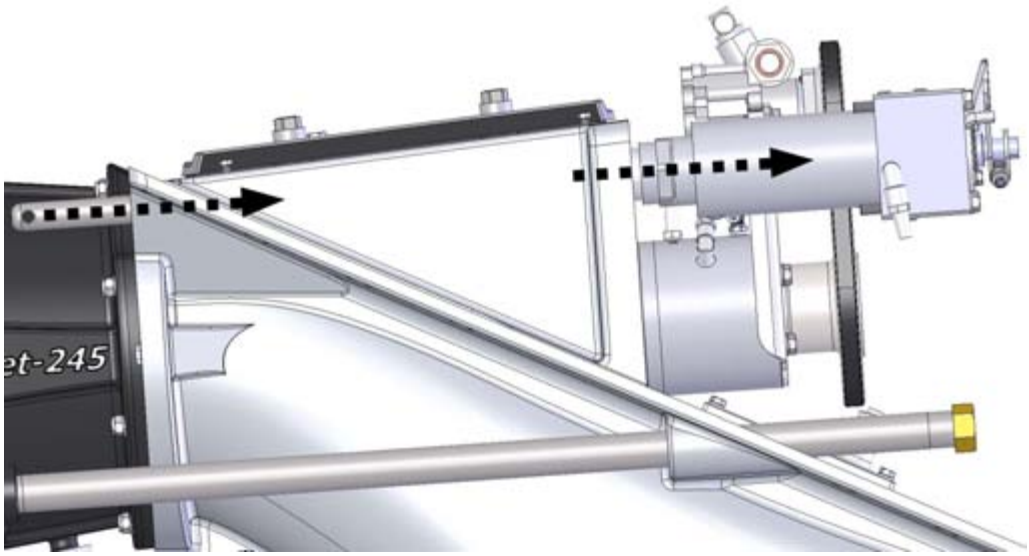

Figure 63. Pushing the cylinder

4.2.2. Repairing the cylinder

Worn or damaged parts of the cylinder can be replaced.

The code for the seal 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.

The cylinder rear end seal (figure 64, point A) is a wearing part and must be replaced regularly. The replacement can be performed with the cylinder in place.

The seal sleeve must be replaced as an assembly as disconnecting the seal damages the seal groove. The sleeve is also subjected to wear when the cylinder is operated.

The code for the seal sleeve kit is P9909.

Replacing the cylinder rear end seal:

1. Open the cylinder's connecting rod screw if the cylinder is closed (figure 64, point B).

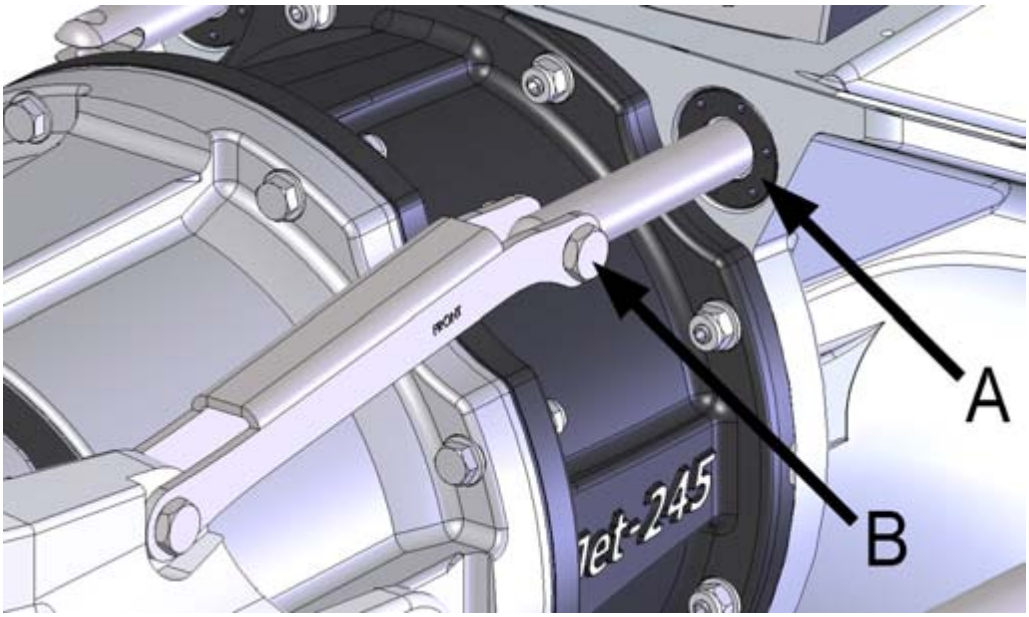

Figure 64. Cylinder rear end seal

2. Unscrew the seal sleeve using the holes in the sleeve.
3. Install the new sleeve using sealing compound (such as Sikaflex 291i).
4. Attach the cylinder's connecting rod screw if the cylinder is installed in place (figure 64, point B).

4.2.3. Installing the cylinder

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

1. Clean the cylinder attachment hole and thread in the body (figure 65, point A).
2. Screw the locking nut on the thread onto the end of the cylinder in the correct position (figure 65, point B).
3. Screw the cylinder onto the threads in the body. It is a good idea to apply lubricant on the thread (figure 65, point C).

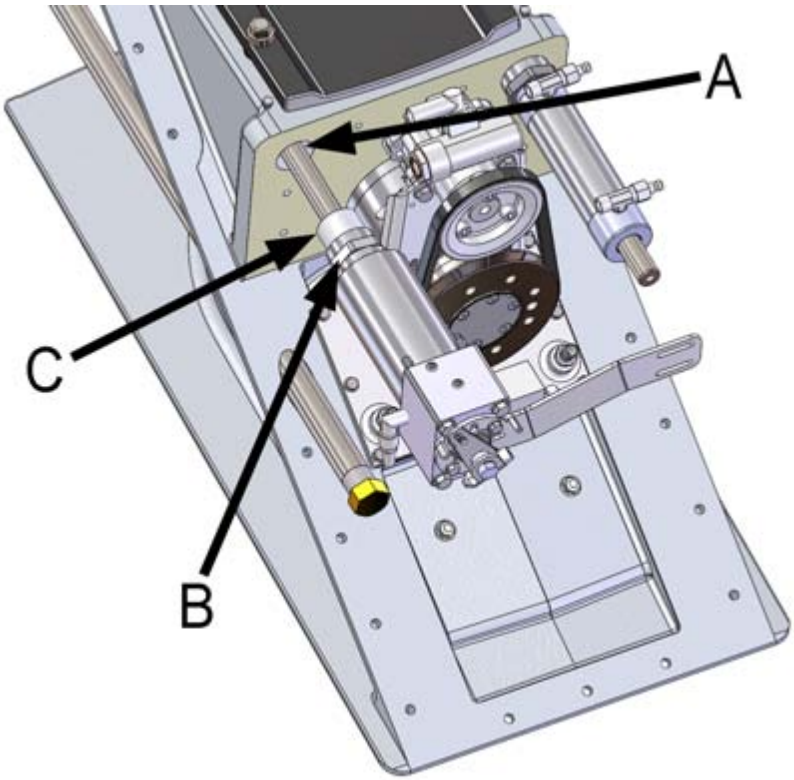

Figure 65. Installing the cylinder

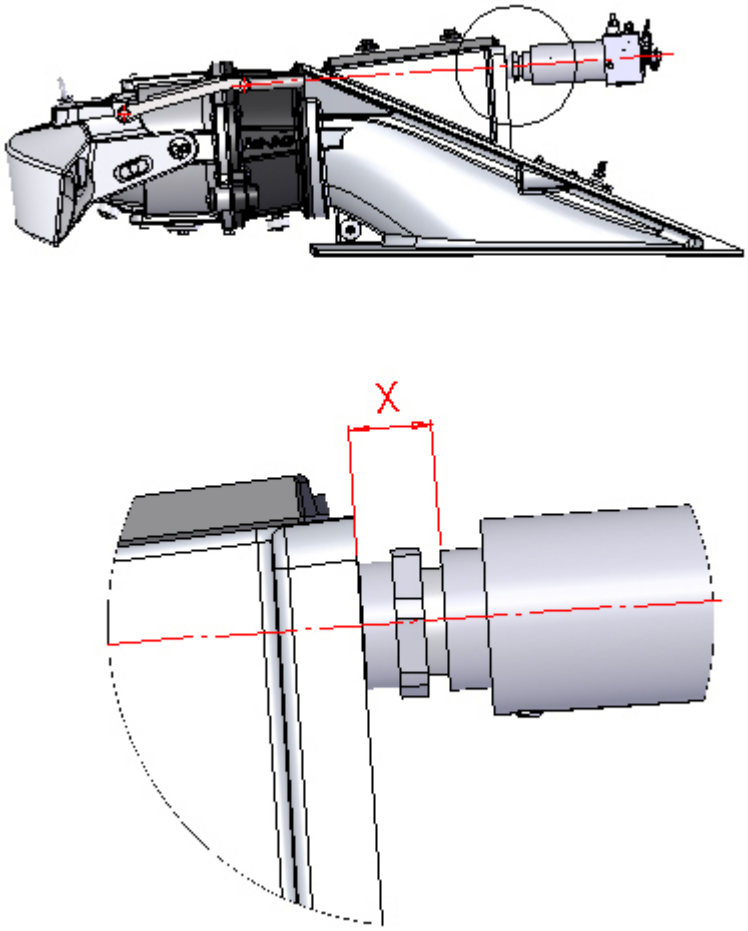

Figure 66. Cylinder dimensions

4. When the correct measurement X ~31 mm is met (figure 66), apply some sealing compound (such as Sikaflex 291i) on the thread, and tighten the nut. You can turn the cylinder slightly if you want the cable clamp to point directly in the cable's direction of entry (figure 67).

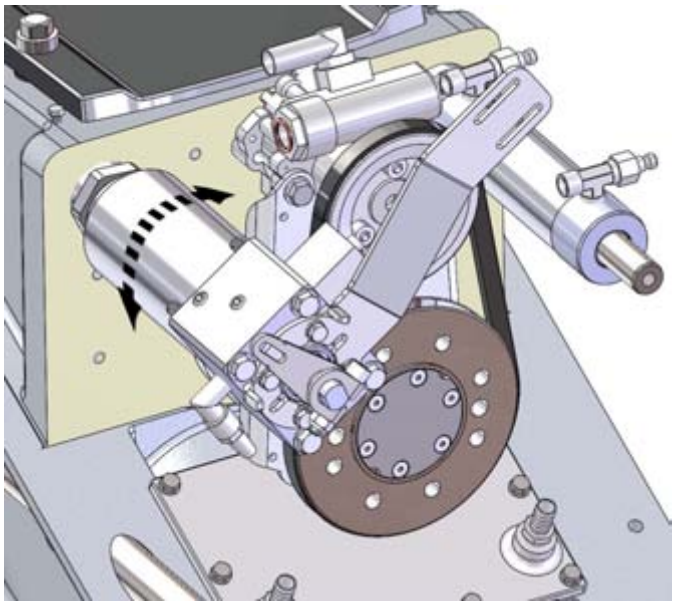

Figure 67. Adjusting the cylinder's position

If the nut cannot be tightened with a normal wrench, special tool 10718 is available.

5. Install the rod between the cylinder and the deflector.

   Check the correct alignment of the rod (figure 68).

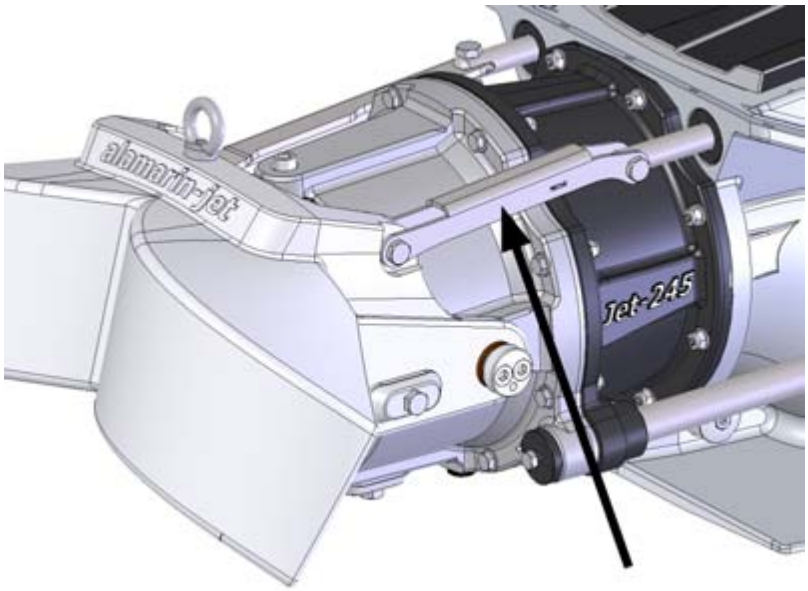

Figure 68. Installing the cylinder's connecting rod

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 69). Every now and then, move the hydraulic cylinder's operating lever back and forth (figure 70, point A) so that the cylinder fills with oil.

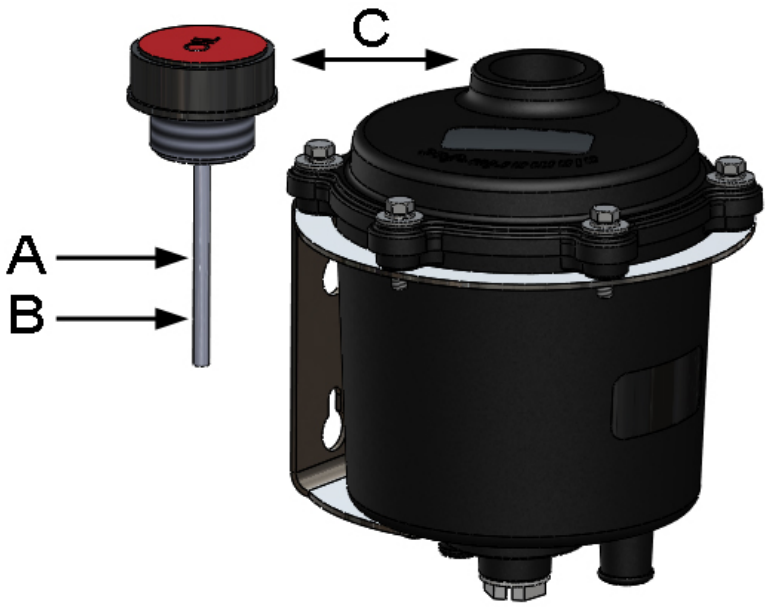

Figure 69. Checking the oil level

A	Maximum level
B	Minimum level
C	Cap

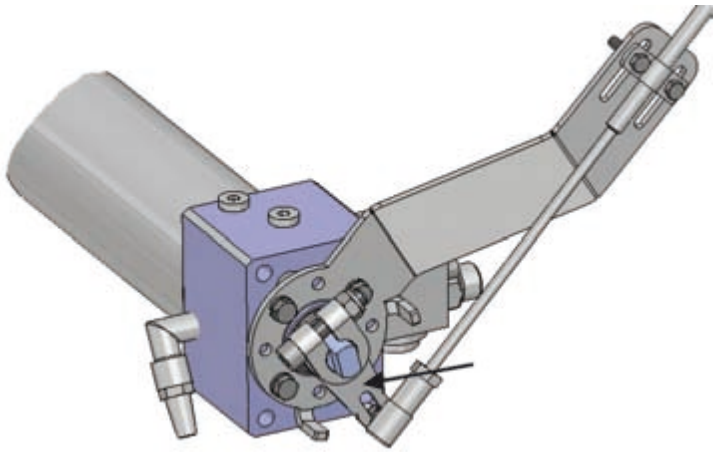

Figure 70. Operating lever

Adjusting the cylinder:

1. Detach the control cable from the end of the cylinder operating lever (figure 71, point A).

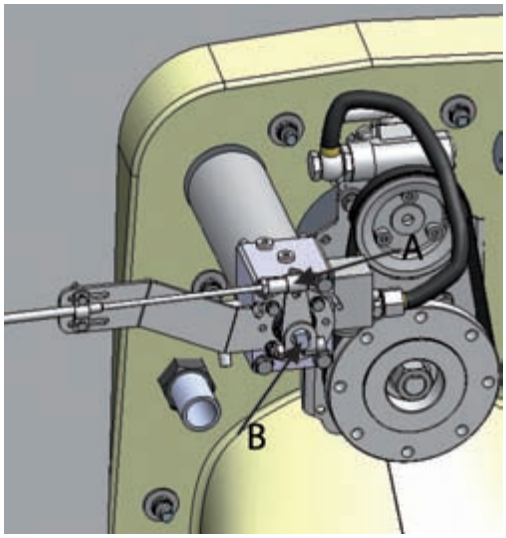

Figure 71. Removing the control cable

2. Loosen the operating lever screw (figure 71, point B) but do not pull the lever off the shaft yet.

3. Place the lever against the limiter on the shaft (figure 72, point A).

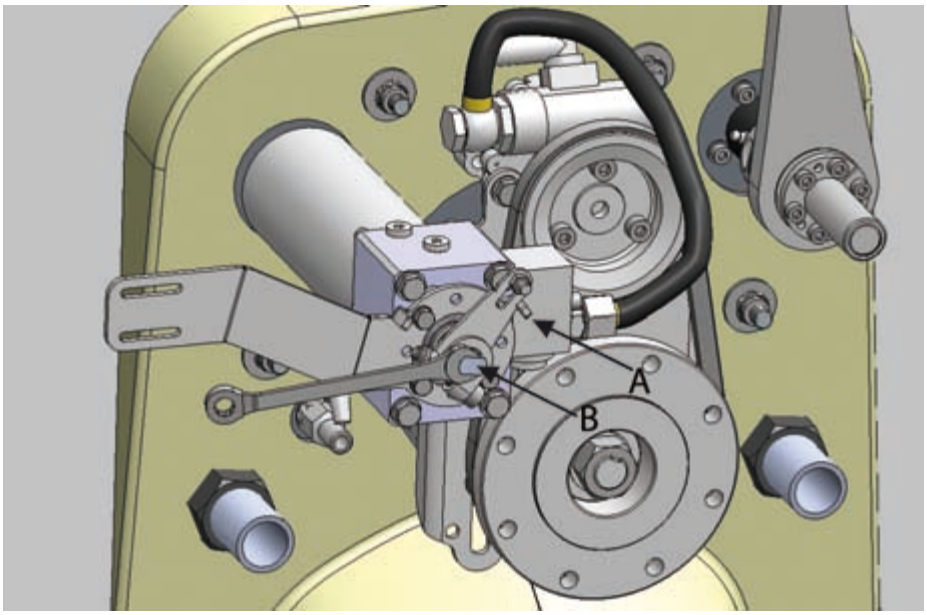

Figure 72. Operating shaft and limiter

4. Turn on the engine and put it into gear.
5. Using a wrench, turn the operating shaft (figure 72, point B) 13 mm (0.4") clockwise so that the reversing deflector is down, 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 71, 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 73). In the down position, the top of the reversing deflector nearly touches the steering nozzle (figure 74).

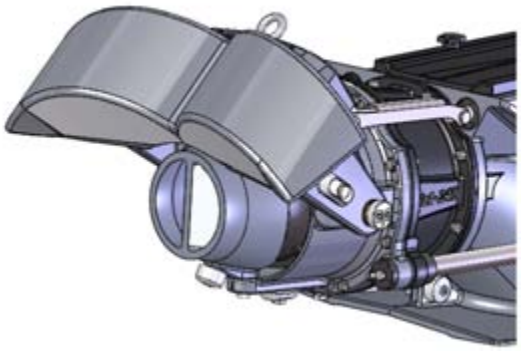

Figure 73. Deflector in the up position

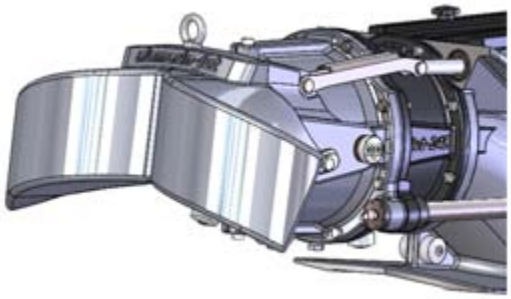

Figure 74. Deflector in the down position

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 75, point A) and suction hose (figure 75, point B) and drain the oil into a container.

   Alternatively, you can plug the ends of the hoses.

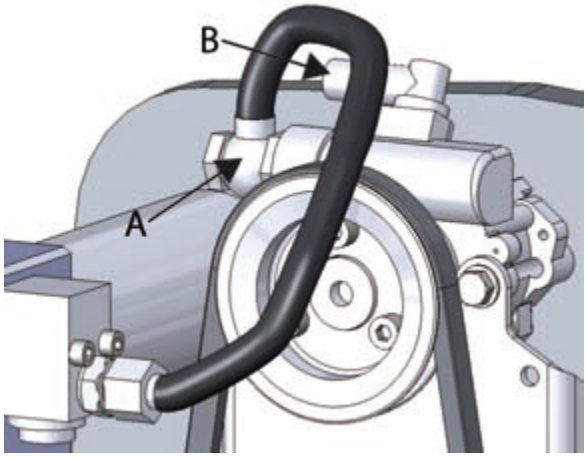

Figure 75. Hoses of the hydraulic pump

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

   The rack is attached to the front surface of the bearing housing with four screws, two on each side of the pump (figure 76).

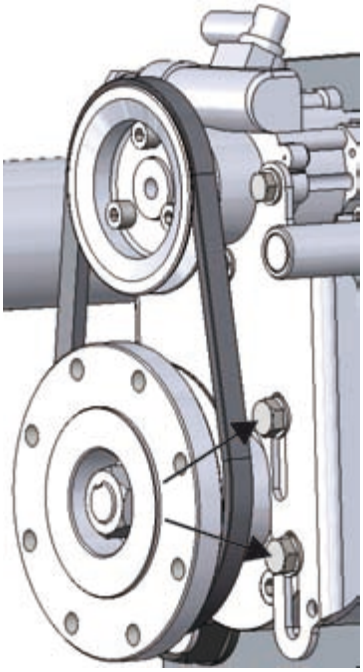

Figure 76. Hydraulic pump rack fastening screws

3. Remove the hydraulic pump from the rack by opening its three fastening screws (figure 77).

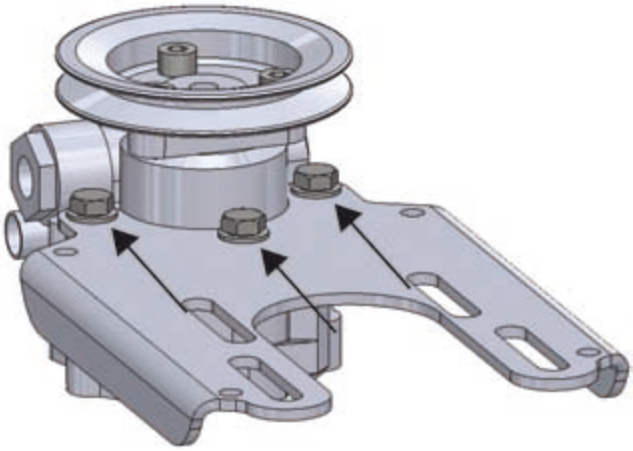

Figure 77. Hydraulic pump fastening screws

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 rack.

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 rack.

Replacing the belt pulley:

1. Loosen the fastening screws of the hydraulic pump rack (figure 76).

2. Open the three screws that attach the belt pulley to the rack (3 pcs, figure 78).

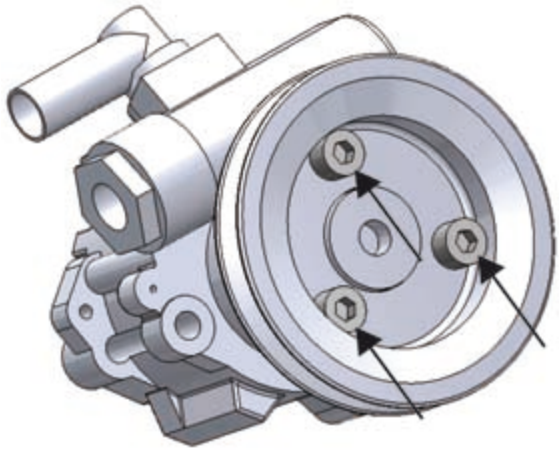

Figure 78. Belt pulley fastening screws

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 79)

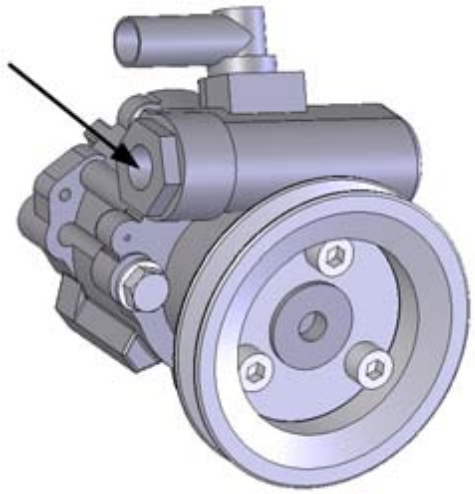

Figure 79. Hydraulic pump pressure relief valve

3. Lift out the pressure relief valve (figure 80) and clean it of any debris and impurities.

Figure 80. 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 rack using fastening screws (figure 77).

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

2. Set the rack against the front surface of the bearing housing and tighten the fastening screws (figure 76) loosely.

Use thread locking compound.

3. Set the belt in its place and lift the rack until the belt tightens.
4. Tighten the rack fastening screws at the same time.

   The tightening torque is 25 Nm.

5. Install the pressure hose (figure 75, point A) and return hose (figure 75, 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 81)

Figure 81. 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 82).

Figure 82. 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 83, point A). The cover must also be positioned correctly so that the spring is in line with its support (figure 83, point B).

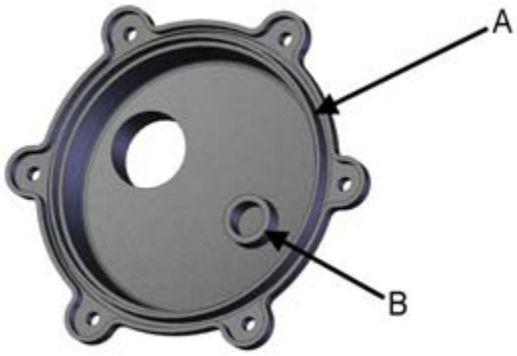

Figure 83. Oil reservoir cover

4. Reattach the six cover screws (figure 81).

5. Steering nozzle and actuating cylinder

The steering nozzle (figure 84, point A) is used to turn the direction of the water from the jet, causing the boat to turn. The steering nozzle is turned with a hydraulic cylinder (figure 84, point B).

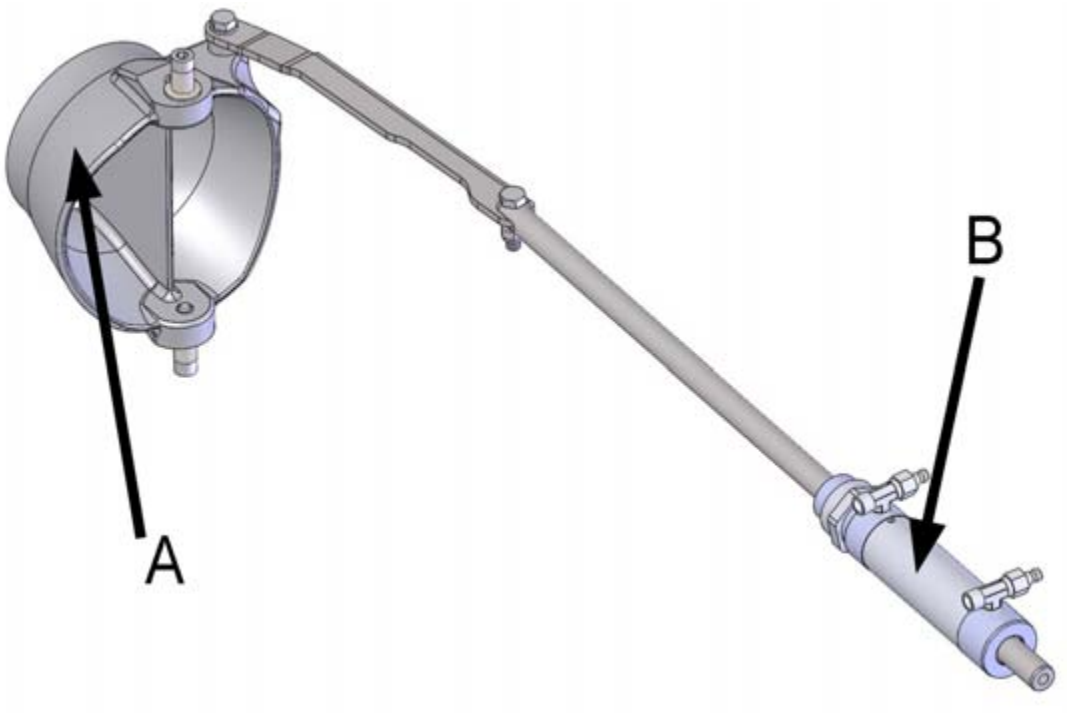

Figure 84. Steering nozzle and actuating cylinder

5.1. Steering nozzle

The steering nozzle can also be removed when the boat is in water, but it is easier if the boat is out of the water.

5.1.1. Removing the steering nozzle

1. Open the connection of the reversing deflector connecting rod (figure 85) and lower the deflector.

   Please note that the steering nozzle must be straight when the deflector is lowered.

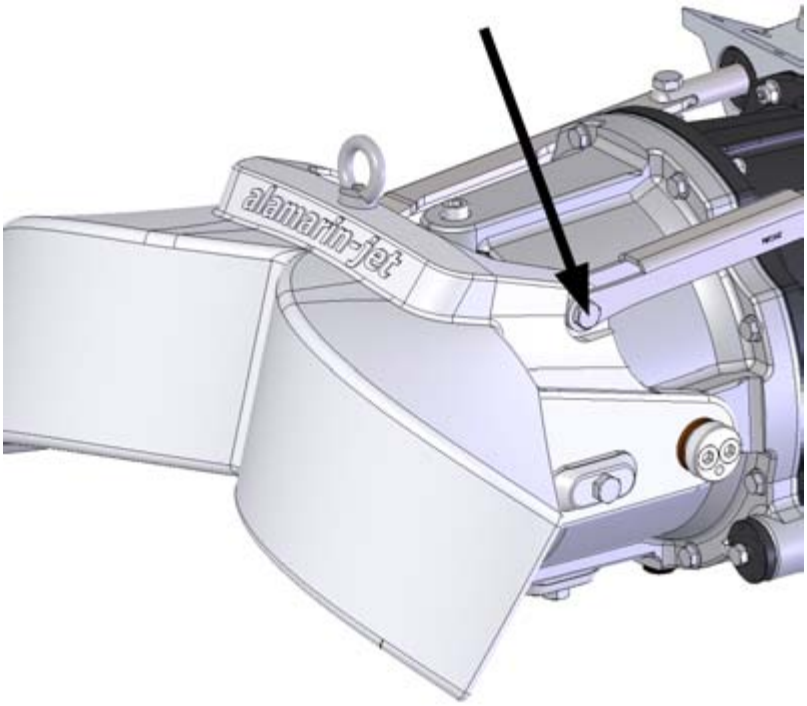

Figure 85. Connecting the reversing deflector connecting rod

2. Detach the control cylinder connection from the steering nozzle (figure 86, point A).

3. Open the steering nozzle joint screws (figure 86, point B).

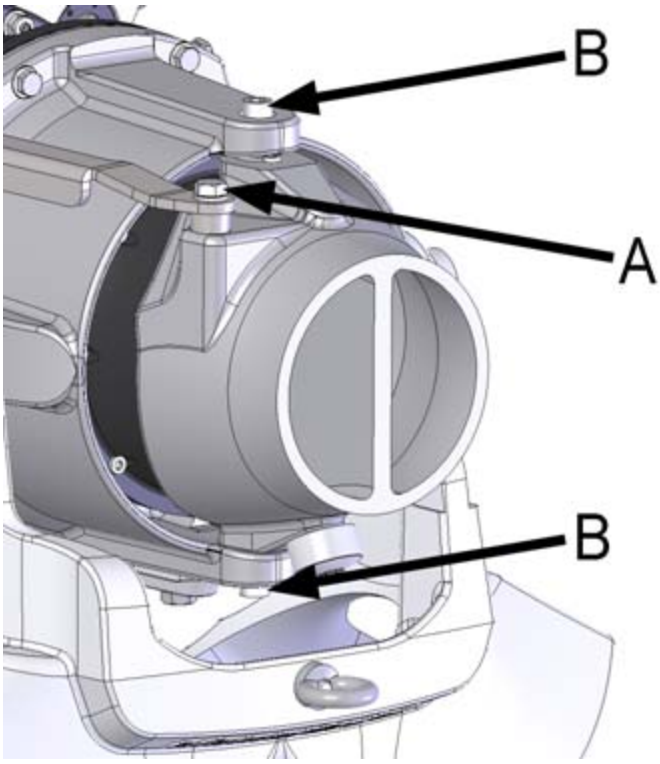

Figure 86. Removing the steering nozzle

5.1.2. Repairing the steering nozzle

A worn or damaged connecting rod 10823, joint peg 10825 and joint pegs 10616 (2 pcs) and anode can be replaced from the steering nozzle.

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

1. Place the joint pegs in the stator holes (figure 87, point A) and install the steering nozzle.

   The upper peg must be held in place while guiding the steering nozzle in place. The screws in the joints of the steering nozzle go in the joint peg holes (figure 87, point B)

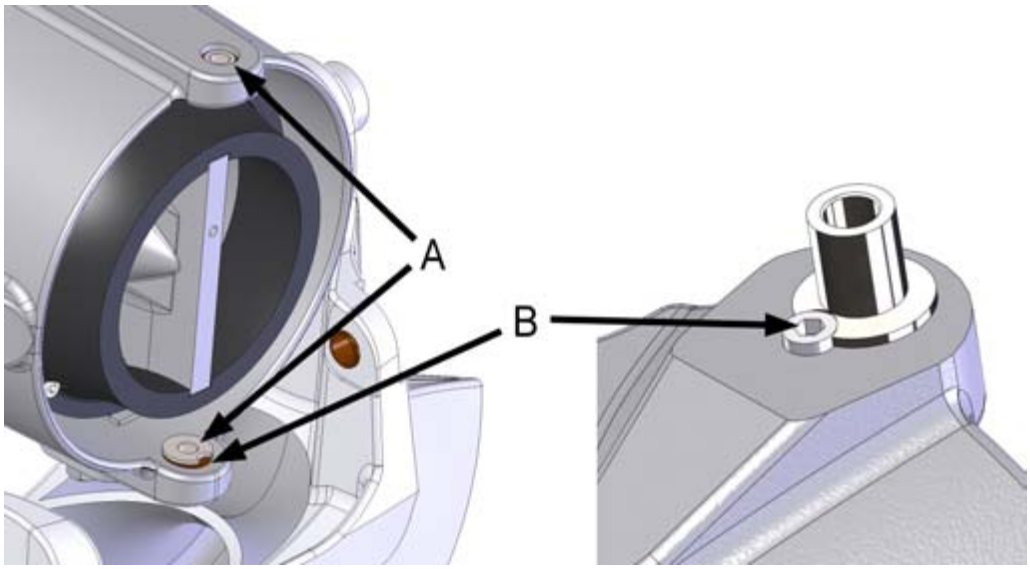

Figure 87. Nozzle joint pegs

2. Screw the joint screws in place and tighten them to a torque of 50 Nm.

   Use a thread locking compound (such as Loctite 242).

3. Attach the cylinder connecting rod with the steering nozzle's joint peg and screw.

   Use a thread locking compound (such as Loctite 242) and tighten the screw to 50 Nm.

4. Attach the connection of the reversing deflector connecting rod (figure 85).

5.2. Control cylinder

5.2.1. Removing the control cylinder

1. Remove the hydraulic hoses from the cylinder (figure 88, point A).

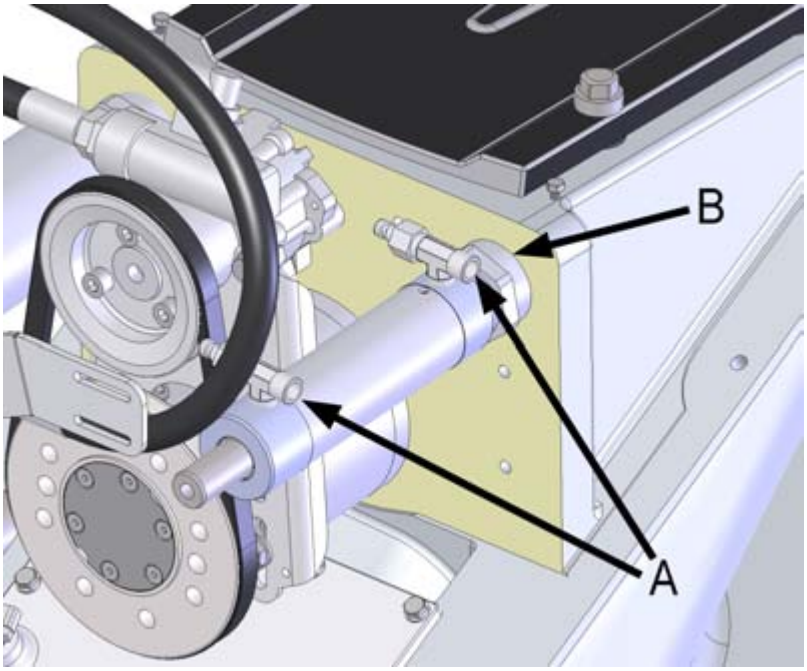

Figure 88. Cylinder hydraulic hoses

2. Remove the connection between the control cylinder connecting rod and piston rod (figure 89).

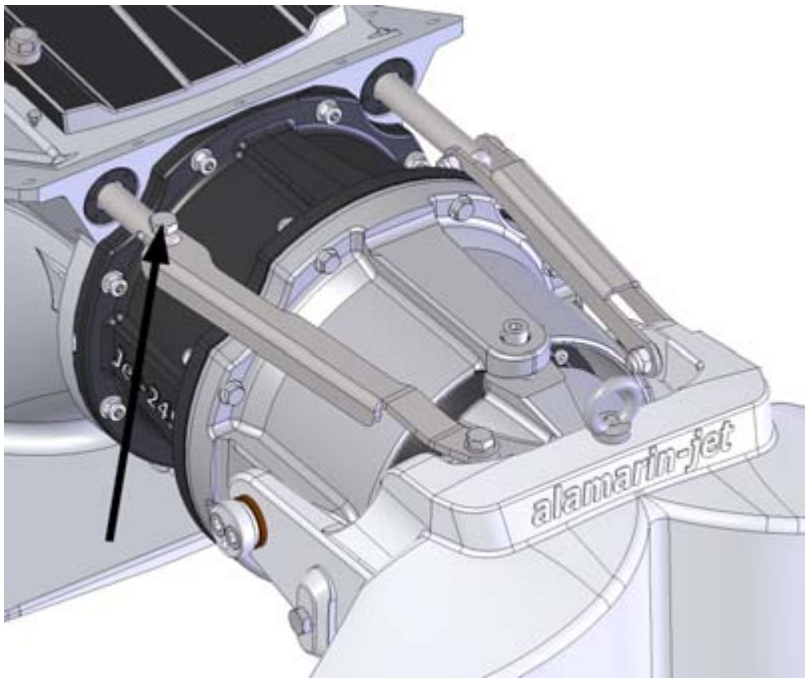

Figure 89. Connection between the control cylinder connecting rod and piston rod

3. Open the fastening nut of the cylinder (figure 88, point B).

   If the opening is not possible with normal tools, you can use special tools 10718.

4. Unscrew the cylinder from the jet's body towards the engine room.

5.2.2. Repairing the control cylinder

Worn or damaged parts of the cylinder can be replaced.

The code for the seal kit is P9908.

NOTE!

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

The cylinder rear end seal (figure 64, point A) is a wearing part and must be replaced regularly. The replacement can be performed with the cylinder in place.

The seal sleeve must be replaced as an assembly as disconnecting the seal damages the seal groove. The sleeve is also subjected to wear when the cylinder is operated.

The code for the seal sleeve kit is P9909.

Replacement is described in section 4.2.2. *Repairing the cylinder*, page 45.

5.2.3. Installing the control cylinder

The control cylinder is installed in the same way as the reversing deflector cylinder. This is described in section 4.2.3. *Installing the cylinder*, page 46).

6. Stator

6.1. Removing the stator

The stator can be removed as a complete unit with the reversing deflector and steering nozzle or one part at a time. Be sure to always first disconnect the lubrication hose from the stator angle fitting (figure 90).

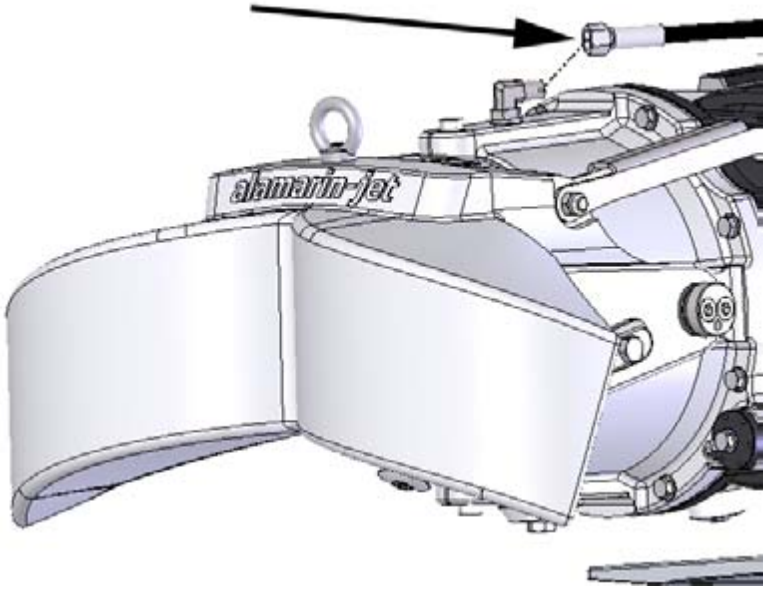

Figure 90. Disconnecting the lubrication hose

Detachment one part at a time:

1. Remove the reversing deflector and the steering nozzle (sections 4.1.1. *Removing the reversing deflector*, page 39 and 5.1.1. *Removing the steering nozzle*, page 59).

2. Open the stator fastening screws (8 pcs, figure 91).

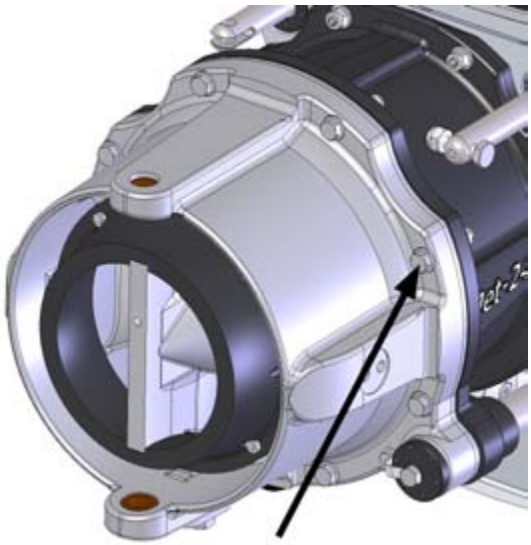

Figure 91. Stator fastening screws

3. Pull the stator off.

   If the stator cannot be detached easily, you can use a screwdriver by inserting it between the stator and impeller tunnel (figure 92). Please note that this will damage the seal between the parts, which means that it must be replaced.

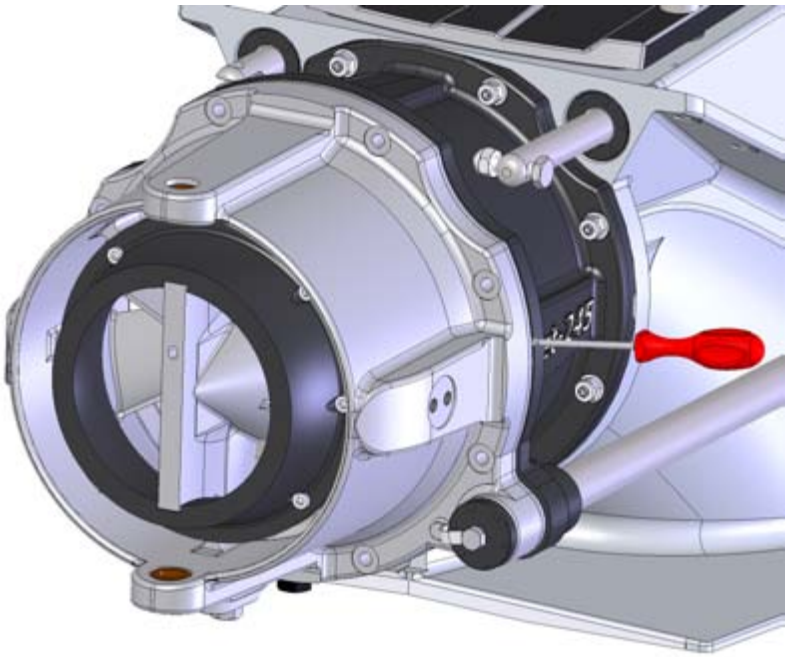

Figure 92. Removing the stator

Removing the stator as a complete unit:

1. Remove the joint between the reversing deflector and the hydraulic cylinder (figure 85) as well as the joint between the steering nozzle and the steering cylinder (figure 86, point A).

2. Open the six fastening screws of the stator (8 pcs, figure 91).

3. Remove the stator carefully using a screwdriver (figure 92).

4. Pull the stator, the steering nozzle and the reversing deflector out as a single assembly (figure 93).

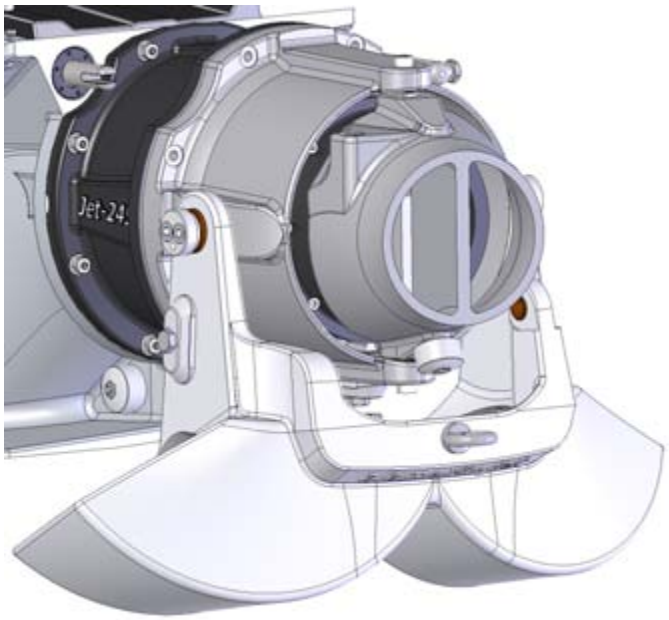

Figure 93. Removing the stator as a complete unit

6.2. Repairing the stator

Replaceable parts in the stator include:

- seals (figure 94, points A and B), seal B is between the choker and the stator
- choker (figure 94, point C).
- anodes (figure 94, points D and E)
- steering nozzle plastic bearings (figure 94, point F)

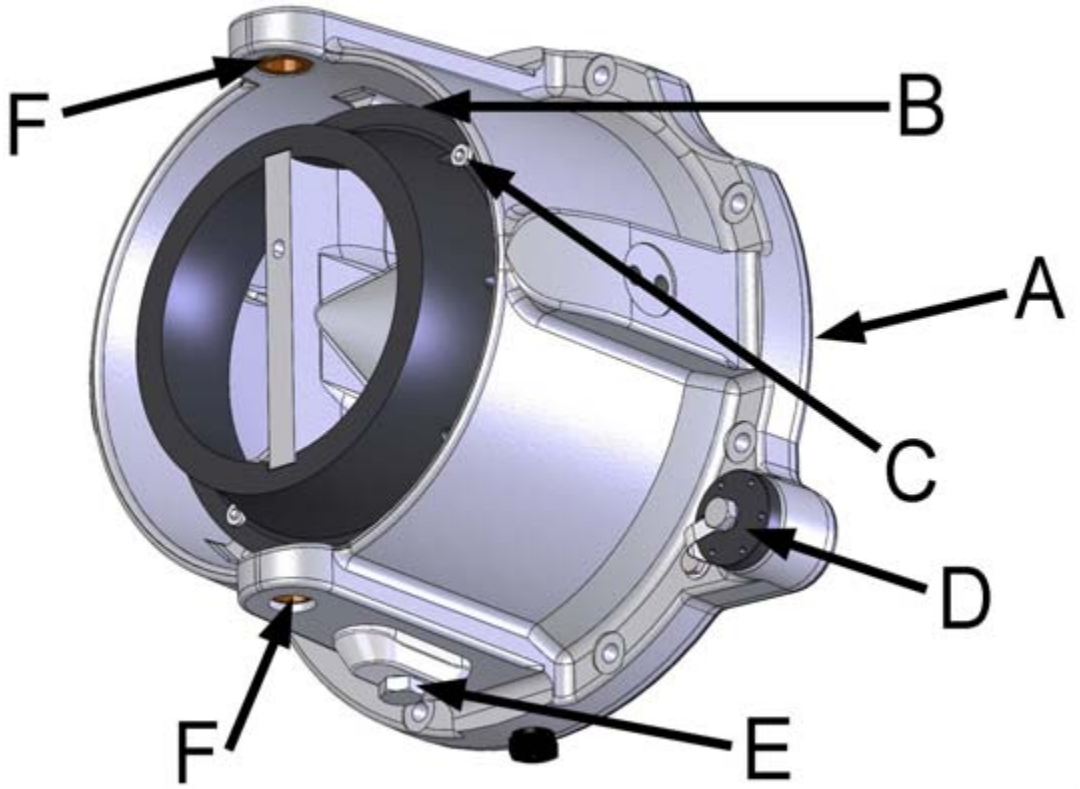

Figure 94. Stator's replaceable parts

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 95). 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.

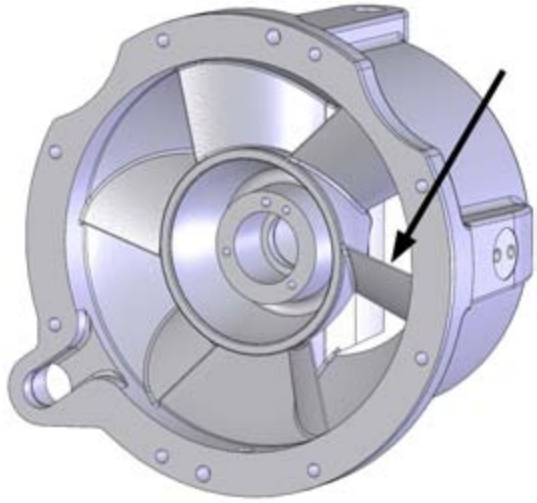

Figure 95. Stator blades

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.

Seals

Leaking seals must be replaced.

Changing the choker seal:

1. Remove the choker (figure 94, point C) fastening screws (6 pcs).
2. Pull the choker off.
3. Remove the old seal (figure 96).

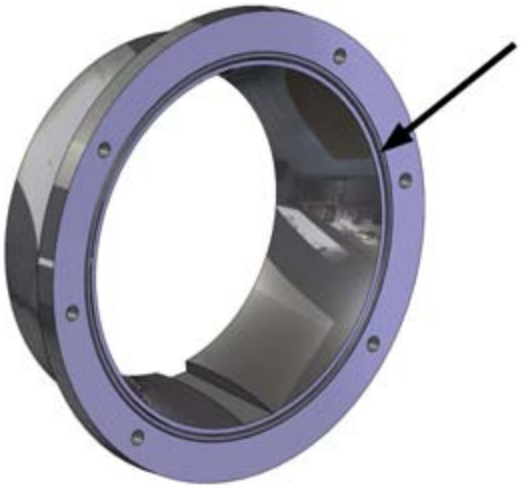

Figure 96. Choker seal

4. Place the new seal in the groove with waterproof petroleum jelly (such as Shell Gadus S2 V220AC).
5. Fasten the choker back into place.

   The tightening torque of the fastening screws is 10 Nm. Use a thread locking compound (such as Loctite 242) for the fastening.

6.3. Installing the stator

1. Ensure that the stator seal is undamaged and the dowel pins are in place either in the stator or the impeller tunnel (figure 97).

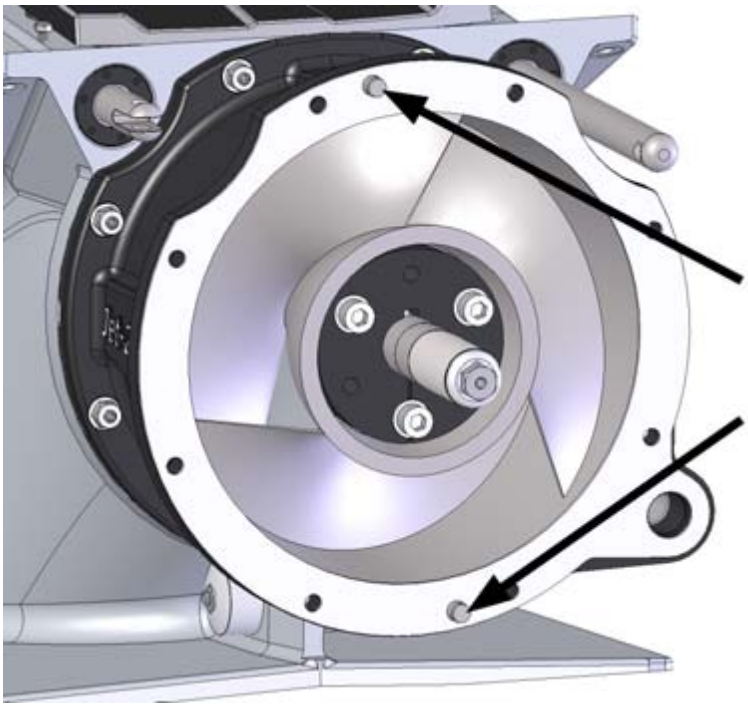

Figure 97. Installing the stator

2. Clean the end of the impeller shaft and push the stator into place so that the shaft end enters the rear bearing housing and the dowel pins enter the holes that are intended for them.
3. Tighten the screws evenly to a torque of 25 Nm.
4. Finish the installation by connecting the rear bearing lubrication hose to the stator angle fitting.

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.