CALLESEN DIESEL

Service Manual

Type 427

powering marine safety

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FIRST START AND TRIAL RUN

When the engine has been installed and everything has been properly checked, the engine is ready for trial run.

Before the engine is started for the first time, proceed as follows:

Oil level

Check the existing quantity of lubricating oil; the oil level should be seen on the oil gauge (or dip stick) on the side of the oil container, which is cast together with the starboard side of the crankcase (below the exhaust pipe). In case the oil does not reach the maximum mark about 2-3 cm from the top of the gauge, and while the hand pump can still pump pressure on the manometer, oil should only be replenished after the engine has been idling for about a quarter of an hour, as unskilled people may have pumped the oil from the container down to the crankcase, to which the overflow valve is leading. The oil will then, when the engine has run for a while, appear again in the oil container, as the return pump which sucks from both ends of the crank sump is larger than the forward pump.

Check the oil level in the clutch case for clutch and reversal. Ensure that the oil is kept between the marks on the dip stick in the portside of the clutch shield. This checking should be made when the engine has been started and is idling. The water pumps and sterntube (if not oil lubricated type sterntube) are lubricated by means of grease presses fitted for this purpose; the sterntube must be completely filled with grease. All remaining grease cups must be filled and screwed down as well to ensure that every part is well lubricated. Do not forget to grease the teleflex cables for the manoeuvring box in the wheelhouse well with graphite grease at mounting. Oil lubricated sterntube ("Sublime") - see separate instruction.

Water level

The freshwater system of the engine is filled with pure water through the cover of the expansion tank; fill up with so much water that the water level is approximately in the middle of the water gauge when the engine is cold. Afterwards the circulation pump has to be vented.

Fuel system

Fill the fuel tank and see to it that the shut-off cocks on tanks and coarse filters, which may close for the inlet pipes to the engine, are open whereafter air relief of the fuel system is undertaken. First the coarse filter (water trap) is vented by means of the cock in the top: This cock should always remain open because the overflow piping from the filter is led to the water trap. From the cock a pipe should be led upwards to minimum 1 m above the top of the tank. Thereafter the inlet piping must be vented by loosening it on the feed pump until the oil is flowing through without air bubbles.

Then loosen the air cocks above the fuel filter fitted on the frontside of the engine, and by means of the handpump pump oil through until all air has escaped (the handpump is operated by turning its handle anti-clockwise until it can be moved up and down). The air cock in the aftermost end of the heavy inlet pipe on the fuel pumps should be loosened and not retightened until all air has escaped.

Thereafter loosen the air cocks on the upper frontside of the fuel pumps and move the regulating rods in the fuel pumps forward and backward while at the same time pumping by hand until the fuel is running through completely free of air bubbles; only then the air cock should be retightened.

In case the unions in the top of the fuel pumps have been loosened, these should not be retightened too hard as the pumps may hereby be deformed, with the result that the regulating rods will go too tight and the engine will not regulate very well.

Open the decompression cocks on the cylinder heads and turn the engine to top dead centre 1 (foremost cylinder); ensure that the fuel pump piston is lifted at the same time; if not, turn the engine another revolution (as it is a 4-stroke engine, the camshaft is only turning one revolution every time the crankshaft is revolving twice).

Now check whether the vent screws on the nozzle holders are tightened up and adjust the governor handle to about 225 revolutions. Thereafter advance the regulating rods in the fuel pumps to the maximum position. Thereafter, turn the flywheel backward and forward above "Top 1" about 20-30º to each side, until a crackling sound is heard from the nozzle, indicating that the oil is spraying through.

Exactly the same procedure is carried out for each of the other cylinderes, and when the fuel oil has been pumped through and the engine hereby has been turned at least about 10 turns, having pumped pressure on the lubricating oil system by the handpump to distribute the lubricating oil in bearings and cylinders, the engine is ready for start.

When the governor handle has been adjusted to lowest revolution number, the regulating rods of the fuel pumps should be able to be moved quite easily backward and forward. Any paint or rust-protecting agent must be carefully removed and the regulating rods well greased.

After charging the starting air vessel to a minimum of 25 and a maximum of 30 kp/cm² ***(NOTE! USE ONLY COMPRESSED AIR. OXYGEN MUST NOT BE USED IN ANY CIRCUMSTANCES AS AN EXPLOSION WOULD BE INEVITABLE, EXPOSING EVERYBODY NEAR THE ENGINE TO GREAT DANGER)*** turn the engine so that the mark "Start" on the flywheel is in top position and at the same time check whether the fuel pump piston in the aftermost pump is in top position; if not, turn the engine another turn. Engines with 4, 5, 6 and 8 cylinders need no turning. Before starting, check whether the seacock is open and whether the clutch is free. Close the decompression cocks as well as the charging valve in the aftermost cylinder cover and adjust the governor handle to about 225 revolutions.

Lubricating oil system - Start

Now pump pressure on the lubricating oil system (**should always be remembered before starting**) and start the engine by quickly turning the handle of one of the main shut-off valves at the end of the starting air receivers about 1 turn to the left. As the engine is supplied with automatically controlled starting valve in all cylinder heads, it will go on running on air as long as the shut-off valve is kept open. As soon as the engine is firing, the shut-off valve is closed and under normal conditions the shut-off valve is not kept open for a longer period than to use 2-3 atm. air for each start. At start, a hissing sound is heard from the air distributor at the front of the camshaft. This is only the air pressure which is closed by the starting valve.

As soon as the engine has been started, check immediately whether there is pressure on the lubricating oil system. Normally, the engine is equipped with a pressure control which has to be connected to an alarm device (bugle, bell, lamp or the like) which gives a warning when the lubricating pressure for some reason is dropping below 0.5 kp/cm² or fails to appear.

The alarm device should be connected to generator (not to the batteries with handswitch) by a contact relay which will cause only a faint current to pass through the contacts of the pressure control and the thermostat, as otherwise the contacts here would soon be destroyed. If the alarm device is giving signal the engine must of course be stopped immediately and the fault must be found and corrected.

The grease cups must be tightened up, and of course it should be checked whether all pipings and other connections are tight and that the engine is getting cooling water.

If there is a leakage between cylinder and cylinder head which may be due to some nuts having been loosened when mounting stiffeners on the engine, the engine must be stopped and the nuts of the cylinder heads be retightened by means of the ring striker wrench supplied and a heavy blacksmiths's hand hammer. To ensure that the cylinder heads are tightened straightly, check by means of a feeler if the free space between the cylinder and the cylinder head in each corner is exactly equal. Before measuring, paint or putty, if any, must be scratched away to ensure that the measuring surfaces are completely clean.

After having checked that everything is in order after the first start and when the engine has been running until it has become warm (about 40ºC), it can be loaded gradually, so that full power is reached about 1 hour after having reached operating temperature, which is about 65-70ºC (the cooling water system is normally supplied with a thermostat which is acting when the temperature becomes too high, about 90ºC; it is connected to the same alarm device as the lubricating oil pressure control).

The temperature of the turbocharger should be checked on the thermometer. It should not be essentially warmer than the water outlet pipe on the engine.

The marine engines are as standard equipped with hydraulical clutch and hydraulically operated reversing device for the propeller blades. The propeller is engaged by pushing the clutch handle in the middle of the instrument box completely forward, and the propeller is given pitch to "Ahead" by pushing the handle on the right hand side of the control desk forward.

When the engine is operating at full load, which means at 425 rpm (the number of revolutions is stamped on the factory's type label), the regulating rods in the fuel pumps should be able to move freely in the longitudinal direction; can be read on the fuel pump indicator (is mounted as standard on all engines above 300 HP), but only about 1 - 2 mm in the direction in which the quantity of the fuel oil is increased; if the regulating rod is going completely to block, there will be no control of the output of the engine. However, if this happens, the engine is overloaded and should have the propeller pitch reduced by pulling the propeller pitch lever astern until the regulating rod is free. Thereafter fasten the limiting bolts found in the reversing tower on top of the clutch shield, so that the engine cannot be overloaded neither on "Ahead" nor on "Astern".

The charging of the starting air receivers is carried out by means of the charging valve, which is placed on the aftermost cylinder cover. The valve is opened by turning the valve handle to the left until the stop, about 1/2 revolution. Then open the cock on the starting air receiver which has to be charged with air. After having finished pumping, close the valve on the starting air receiver first and thereafter the charging valve on the engine. When closing the latter valve, a hissing sound will be heard; this is only release of air from the charging pipe. Every time after having finished charging, it is necessary after a little while to retighten the charging valve on the engine, because the valve spindle is heated during the charging procedure, and when cooling down it contracts and maybe slackens. If the valve is not shut properly, sooting may cause the spindle to stick.

Never alter the blocking of the governor and the toothed rods of the fuel pumps. In case the lead seals are broken, the factory's guarantee will cease to be valid. The adjustment has been made so by the factory that the output of the engine can be about 5% above normal full load.

When the engine is working at full load, and the governor rod is free, as described above, the exhaust should be nearly smokeless. It is important to check this, as too much development of smoke means that the engine is not in order, and that it should not be operated before the defects have been repaired. At full load the exhaust temperature should be about 450 - 500ºC, for turbocharged engines up to 525ºC.

Smoky exhaust after the first start may be due to defects or faults arising during installation, for instance:

1. The engine does not get sufficient air for combustion because the engine room is too tightly closed and the necessary ventilation is lacking; there should always be one or several ventilating ducts having a total area at least equalling the size of the suction pipe of the engine.

2. The suction filter on the suction manifold (turbocharger) of the engine may be clogged.

3. Air in the fuel system.

4. Dirt in the fuel system (filter clogged).

5. The exhaust piping partly clogged or a too small dimension is used. Use always the same pipe dimensions as the exhaust manifold.

6. Loading pressure too low.

Remedies:

1. Check whether the ventilation is in order.

2. Check the filter and remove all impurities from the engine room.

3. Vent the fuel system.

4. Check fuel filters: The oil should be able to pass through in full jet when pumping with the hand-pump.

5. Check the exhaust piping.

6. See turbocharger instruction book "Cause of working troubles".

During the first running of the engine under loaded condition, see to it that the cooling water temperature (thermometer on the foremost cylinder head) in the freshwater system is rising to about 70ºC. If not, something is wrong with the thermostat which is built into the by-pass piping of the freshwater system.

Should the engine get too hot, it may be because of air in the system or incorrect fitting of the expansion container. The cooling water (seawater) which passes through the cooler and from there

outboard does not exceed a temperature of about 30-40ºC (under tropical conditions a little higher, which is about 25ºC above the inlet water temperature).

During the first trial run, the sterntube must be lubricated sufficiently (apply a not too heavy "sterntube grease", better too thin than too thick), and the stuffing box frequently checked for heating; its temperature must not be higher than one is able to hold a hand constantly on the side of the stuffing box bearing. If it heats up more than normal, it is probably only because the stuffing box is tightened up too hard. It must be slackened, and if this is not enough, the cotton tallow packing or perhaps the "Crane" metal packing, if any (hamp packing or similar should rather not be used as these materials are wearing the shaft), should be taken out and the rings be pushed loosely in after having been lubricated with grease, whereafter the gland can be tightened quite a little. Newer engines which are equipped with special stuffing boxes outside and inside the sterntube are lubricated with ordinary engine oil in the sterntube (regarding oil types - see page 18).

When the engine has been running for about 2-3 hours at full load without any trouble, the trial run can be concluded.

The engine is stopped by pushing the governor handle completely down to stop and thereafter the toothed bars of the fuel pumps are pushed astern.

IT IS THE DUTY OF EVERY CUSTOMER OR HIS REPRESENTATIVE TO WITNESS THE TRIAL RUN TO MAKE THEMSELVES ACQUAINTED WITH THE ENGINE AND TO COMPLAIN ABOUT DEFECTS/FAULTS, IF ANY. ANY COMPLAINTS ABOUT THE TRIAL RUN BROUGHT FORWARD AT A LATER DATE WILL NOT BE HONOURED LATER ON.

USE AND ATTENDANCE

After the trial run has taken place as described, the plant is handed over to the purchaser in good and proper condition and with good and proper handling, the engine will render many years' satisfactory service.

It is of **great importance** for the user to understand that a modern engine plant demands careful attendance and absolute cleanliness. First of all, avoid carrying dirt (sand or the like) into the engine room, and avoid having cotton waste and other materials lying on the floor plates as such things are liable to be sucked in by the suction filter which will clog and cause loss of power and higher fuel consumption; at worst it may even damage the engine plant.

The engine is constructed to be easy to keep clean which should never be neglected.

Before starting the engine, pressure must always be pumped on the lubricating oil system by means of the handpump. Then you will be sure that there is oil in all bearings and on the cylinder paths. Immediately after having started the engine, check whether there is pressure on the lubricating system and whether the water level can be seen on the water gauge on the expansion container.

When the above mentioned is in order, the engine may confidently be loaded; however, it is recommended - especially as long as the engine is new - to bring load on little by little so that the various parts warm up together gradually. After the engine has run for a short time under load, check

the cooling water temperature. As described above, it must be about 65-70ºC. If this level is exceeded, the alarm device will give a warning.

The oil pressure can be checked in the wheelhouse where manometers for lubricating oil and clutch oil pressure are fitted. As mentioned before, the lubricating oil system is connected to the alarm device which will give a warning in case the oil pressure drops below approximately 0.5 kp/cm².

It is recommended, during daily operation, to inspect the engine approximately every 3-4 hours to see if everything is in order. At the same time lubricant should be applied where necessary (water pumps and sterntube).

The small air filters on the valve covers should be cleaned every two months. The starting valves in the cylinder covers should be lubricated about every three months: Loosen the plug which goes down into the large fitting above the valve and pour down about 6-8 drops of oil on the valve, but not more, and screw the plug up again.

During operation the engine oil level should be checked daily, the oil level of the clutch case approx every week; in both cases when the engine is warm and idling.

A small grease cup is placed on the front end of the engine at the flywheel and on the aftermost end cover near the flange coupling. This grease cup should be lubricated only little every week, approximately, for lubrication of the shaft packing ring.

In case the lubricating oil pressure "before filter" rises to more than 5 kp/cm² when the engine is warm, the filter inserts should be replaced by new ones. Normally, the pressure is about 4 kp/cm². The filters can be replaced during operation as the oil filter is equipped with a conversion cock and the engine can run on one filter or the other, respectively, or on both filters at the same time. The latter is normal. The clutch and reversal oil pressure must be 7 kp/cm² unloaded and 9 kp/cm² at full revs.

On newer engines a two-step overflow valve is fitted; in this case normal oil pressure is about 9 kp/cm² and during reversing the pressure rises to about 16 kp/cm² and drops to 9 kp/cm² again after the operation.

If the engine starts smoking after having been used for a prolonged period (it may have many different reasons, see "Working Trouble"), the cause of the smoking must be identified and remedied as soon as possible, as thick formation of smoke will cause great wear of the cylinders and pistons and may result in sticking piston rings, damaged valves etc. If, under the given conditions, it is impossible to correct the fault at once, reduce the load until the smoke nearly disappears.

If the cooling or bilge pump starts leaking, the stuffing boxes must be tightened up; if necessary, the pumps must be repacked. On newer engines the stuffing boxes are equipped with special packing rings.

When checking the pump valves, remove the air vessel under which the valves (balls of synthetic rubber) are placed (see 7-62).

Should the oil pump of the lubricating system fail for some reason, the engine can be operated if the oil pressure is kept up by means of the hand pump. All larger engines are equipped with by-pass pipes and switchcocks so that the suction pump as well as the pressure pump can be used for lubricating the engine.

As mentioned before, the engine has been adjusted by the factory to be able to yield about 5% above the stated output. This overloading possibility is intended as a reserve for a few very special occasions, and it is not wise to make use of it under normal conditions! It is therefore recommended never to load the engine plant more than always to leave about 1-2 mm free before the toothed rods of the fuel pumps are fully against the blocking piece of the governor.

Before stopping the engine after use, check whether there is sufficient air in the starting air vessels (about 30 kp/cm^2). When charging, the shut-off cock on the air vessel should be screwed completely up against the blocking. Thus, air access to the spindle is being blocked, thereby preventing wear.

The grease nipple on the propeller shaft must be filled at least once a week to keep the packing round the pull rod tight and at the same time to keep the grease in the propeller. If water is coming out near the flange coupling, the pull rod should be repacked.

During periods of hard frost or when drop of temperature may cause risk of ice formation, anti-freeze mixture can be filled on the freshwater system of the engine in the proportion indicated on page 7-55. Then it will only be necessary to drain the seawater system, i.e. piston pumps and cooler with associated piping. In case the freshwater system is drained, make sure that all water is drained off the engine as well as the cooler and centrifugal pump.

As long as the engine is running satisfactorily, avoid disassembling anything, and in case there are problems beyond what must be considered normal, which might need readjustment, you should call in a skilled man.

If the engine is cared for and attended to as mentioned above, it will usually not require much maintenance but you must always be sure that you are in a position to help yourself in an emergency case requiring the use of the spare parts supplied with the engine. Therefore, these spare parts should always be in good order and kept in an easily accessible place, where they are not exposed to rust or other kinds of damage.

Whenever some of the parts have been used, the stock should always be completed as soon as possible for use at later emergencies.

INSPECTION AND CONTROL

As mentioned before, do not tamper with the engine as long as it is in good order and running satisfactorily.

However, it is necessary to exchange the lubricating oil about every 1500-1800 working hours, or approximately twice a year. Before draining off the oil, run the engine warm until the oil is thin. The draining is done by opening the large cock on the oil container; at the same time empty the filters by opening the air screws and removing the bottom plugs. If the filter inserts are not comparatively new, they should be replaced at the same time. Concerning oil quantities, see sheet 4-68.

The clutch oil should be replaced after about 5000 working hours, however, at least every 2 years. The turbocharger oil should be exchanged every 1000 working hours.

The pistons should not be drawn unless the oil consumption becomes too high. Then the oil control rings and probably also the compression rings should be replaced.

Normally, the valves should not be interfered with until they are no longer completely tight. Usually, this can be heard in the exhaust when the engine is idling, or when starting difficulties appear. Turn the pistons against top with closed compression cocks. If the valves can be heard blowing in the exhaust or suction channels, they need grinding. To grind the valves, it will be necessary to remove the cylinder covers. See also sheet 7-6.

The valve clearance which can be adjusted by means of an adjusting screw in the rocking lever must be 0.60 mm for the exhaust valve as well as for the suction valve. The same value applies to cold and warm engine.

Main bearing clearance is between 0.10 mm and 0.12 mm, crank bearing clearance 0.15 mm. The space between piston and cylinder cover is 2.20 - 2.40 mm. The copper packing between cylinder and cover is 1.00 mm. The indicated space between piston and cylinder cover equals a compression pressure of about 38 kp/cm². At this pressure the engine is certain to start even at low temperatures.

The engine has to work on an firing pressure of about 65 kp/cm². To obtain this pressure the fuel must be injected as follows: When the mark in the pump lever in the oval hole at the bottom of the fuel pump is in middle position, the top marking on the flywheel must be 48 mm before top measured on the circumference of the flywheel for turbocharged engines, and 78 mm before top for engines without turbocharger. This method is only a rough checking; for fine adjustment a drip pipe should be used - see sheet 7-45.

The adjustment of the valves should be as follows: Suction opens 524/270 mm before top, exhaust closes 524/150 mm after top, measured on the circumference of the flywheel, for engines with turbocharger and without turbocharger, respectively. All indicated valve and fuel pump adjustments apply to a flywheel diameter of 1000 mm.

The freshwater and oil cooler must be cleaned in the saltwater circuit at suitable intervals (when necessary). For this purpose remove the end covers and clean the cooler pipe by means of a brush. Rinse the cooler. Check the anodes and, if necessary, replace them on same occasion.

If the alarm device supervising the cooling water temperature is giving a signal, the cause may be that the thermostat is broken (if so, the thermostat can be removed; it is placed in the front flange on top of the cooler) or that the cooler has to be cleaned. It may also be due to insufficient water in the cooling system, because of a leaking water or oil cooler.

If the water has been drained off for repair of the engine, it may be impossible to replenish enough water, usually because the expansion tank piping has clogged, for which reason the pipes must be cleaned. Should the oil cooler leak, it will be indicated by rising oil level because water is running out into the lubricating oil; this will only happen when the engine is not running. When the engine is running and there is pressure on the lubricating oil, the oil may possibly be seen in the cooling water outboard.

If there is a leakage in the freshwater circuit of the cooler, it is indicated by too little freshwater which, however, cannot normally be seen until the engine has been stopped; when the engine is running there is pressure in the cooler, for which reason the volume of freshwater does not decrease. Should the latter happen, the cooling water system will only have to be replenished, preferably with freshwater, but otherwise with seawater. Then you can run the engine safely until arriving in harbour where the cooler can be repaired.

The coarse filter (water trap) must be emptied of water and mud about once a week by opening the lower cock until pure fuel oil is running out.

The fuel filters should be cleaned at suitable intervals, about every six months or when necessary, and when the inserts are too poor they should be replaced. A set of filters should always be kept in reserve. This is very important as poor filters may damage pumps and injectors.

Normally, the injectors are checked once a year (provided that the engine is running satisfactorily) and the pressure adjusted at the same time. They are to be adjusted at 240 kp/cm² by hand-pumping. At the same time the injector filters must be cleaned.

If the engine has been disassembled for inspection, a trial run is necessary to ensure that everything is in good order.

When the engine is installed in a wooden vessel, the alignment of the engine should be checked every year and, in any case, when heating begins at the inner stern bearing. Alignment is very easy to carry out. There are four threaded holes in the foundation, one in each corner. The engine can be set up here and alignment plates placed below the engine.

WORKING TROUBLES

START:

If the engine does not work after having been put in starting position and the starting valve has been opened, the cause may be:

1. There is no air or insufficient pressure in the starting air receiver; the pressure should be at least 22-25 kp/cm². Maybe the valve is opening too slowly or too little. The manometer readings may be wrong.

2. The air pipes from the receiver starting valve to the engine starting valve may be clogged or disconnected. Maybe the starting air pipe to the air distributor cover or the air distributor ducts are clogged by soot.

3. Water in the starting air receiver. Water should be drained off the receiver about twice a year.

4. The starting valve does not open (remember lubricating). If the starting valve is sticking, it can be loosened by pouring a little oil onto the piston after having removed the large fitting; by means of the tools delivered operate the valve until it comes back again quite easily when being pressed downwards. See sheet 7-203 (7-60) under starting air system.

5. The automatic starting valve disc in the air distributor may have been displaced half a turn after dismounting. Perhaps the driving pin is broken. Adjustment of disc valve see sheet 7-63 under starting air system.

6. The valves are hanging or leaking (regarding valve grinding see under cylinder cover sheet 7-6); perhaps the pistons should be drawn and cleaned because the piston rings are sticking (coking). This is usually the case when the engine runs 1-1½ turn and then stops. Instructions for drawing of pistons are indicated under crank and piston, sheet 7-230 (7-14a).

The faults have to be located and remedied.

When the engine at start is turning round but does not ignite, the cause may be:

1. That there is no fuel supply, either because the fuel tank is empty, the fuel filter clogged, or the overflow valve not in order; when the outlet pipe on the filter has been removed it should be possible to pump the oil through in full jet by means of the feed pump. There may be air in the fuel feed pipes. (The injectors should squeak, when the engine is turned)

2 There may be water in the fuel oil pipes. The lowest cock on the coarse filter must be opened about every week to drain off any water and mud.

3. The governor may be wrongly adjusted, so that the engine does not receive any fuel. (Perhaps you may have forgotten to open a little).

4. The feed pump may be defective (spring broken).

5. The fuel pumps may be defective, perhaps the pump spring is broken.

6. The cylinders and pistons of the fuel pumps are worn out so that the quantity of fuel is too small for starting. Cylinders and pistons must be replaced.

7. Leaking valves.

8. Seized piston rings.

9. Clogged suction filters.

IDLING:

The engine will, after having been started and still being cold, run at varying revs, especially at slow speed. After having run for some minutes and being warmed up, it should run at absolute regular revs. If this is not the case, there may be air in the fuel feed pipes; or it may be due to the governor; or perhaps the toothed rods in the fuel pumps are jamming. If the fuel pumps have been adjusted, uneven adjustment of the pumps may be the cause. - Normally there are small marking lines and numbers 10-15-20-25 etc. on the toothed rods of the fuel pumps. When the toothed rods are pushed forward as far as possible, the marks 28-29 should stand on level with the arrows on the rear end of the pumps, corresponding to max. load of the engine. In case the toothed rods have been wrongly adjusted, these marks can in an emergency be used for new adjustment of the pumps (normally the starting up should be carried out with measuring glass).

LOADING OF THE ENGINE:

If the engine does not operate with its usual power, the fault may be:

1. Air in the feed pipes.

2. Soot in the fuel filter.

3. A defect in the injectors. Injection pressure by hand-pumping 240 kp/cm^2.

4. Too low charging pressure. Filter for turbocharger or the turbocharger itself should perhaps be cleaned.

5. The fuel pumps are not equally adjusted (see adjustment under "Idling"), or they might be worn. The delivery valve spring of the fuel pump may be broken.

6. Leaky valves.

7. Coked piston rings.

8. Worn out pistons and cylinders.

9. Worn or cracked bearings.

10. Defective fuel feed pump (the spring may be broken). Perhaps the piston is hanging because the pump flanges are unevenly tightened. Whether the fuel pump is working can be checked by loosening the handle of the hand pump; the handle should move up and down, when the engine is working.

11. The clutch is slipping because the oil pressure is too low (too little oil), or the clutch is worn out. If the oil pressure in the clutch and reversing mechanism fails, the cause may be a sticking overflow valve, which must be cleaned and adjusted. The overflow valve is placed in the portside under the cover on which the clutch oil cooler is mounted. As to adjustment - see sheet 7-67 under clutch. If the oil pressure failure is due to a defect in the hydraulic system, which cannot be remedied at sea, you can manage this way:

    Remove the cover on the starboard side of the clutch. Screw the six 3/4" screws with square heads, which are supplied, into the aftermost clutch cone through the large openings in the clutch case. Take care that they are tightened smoothly and exactly equally to avoid jamming of the cones as in this case the clutch will slip. Loosen the propeller shaft flange coupling from the engine and draw it so far backwards that the two half pipe sections can be laid around the pull rod. In case they cannot be fitted because the propeller shaft cannot be pushed far enough astern, the sections can be sawn into pieces and laid at two or more times. The flanges should then be tightened together again. Take care that the flange couplings are completely together. The propeller is then blocked at "Ahead".

12. The propeller shaft or the propeller may be damaged.

The faults must be remedied, and as far as possible it is recommended to have this done by a skilled expert.

REGULATIONS FOR FUEL OIL AND LUBRICATING OIL

FUEL OIL.
The engine is tested on the factory's testbed with the fuel oil (gas oil) which is usually available on the market. If the use of another type of fuel oil might be intended, the factory should be asked for advice.

LUBRICATING OIL.
For lubricating of the engine a good grade diesel engine oil, which is highly self-purifying, a so-called D3 oil should be used. Such an oil can be supplied by all recognized oil companies. All the year

round, an oil with a viscosity equalling SAE 30 should be used. It is important that the oil has a high flash point and can emulsify with water.

CLUTCH OIL
A special hydraulic oil should be used, as stated below.

STERNTUBE GREASE
Use a thin (soft) special sterntube grease, which can emulsify with water. This grease can also be applied to the other grease cups.

OIL LUBRICATED STERNTUBE WITH "SUBLIME" PACKING GLANDS
Same oil as engine.

GREASE FOR AUTOMATIC GREASE GUN (DE LIMON)
As stated below.

THE FOLLOWING OILS CAN BE USED FOR CALLESEN MARINE DIESEL ENGINES 4-STROKE, TYPES 422, 425 AND 427

MAKE	***ENGINE/OIL LUBRICATED STERNTUBE***	***CLUTCH***
ESSO = EXXON	EXXMAR 12 TP 30	NUTO H 68
Q8	MOZART DP 30	HAYDN 68
BP	ENERGOL DS 3-103	ENERGOL HLP 68
SHELL	RIMULA 30	TELLUS 33
CHEVRON	DELO 300 SAE 30	OC TURBINE OIL 68
MOBIL	MOBILGARD 312	DTE HEAVY MEDIUM
GULF	SUPER DUTY SAE 30	HARMONY 68
TEXACO	TARO 30 or XD 30	REGAL (R&O) 68
CASTROL	MARINE MLC 30	HYSPIN AWH 68

	AUTOMATIC GREASE GUN	***TURBOCHARGER***
ESSO = EXXON	BEACON EP 2	NUTO H 68
BP	ENERGREASE MM-EP 2	ENERGOL THB 68 or BARTRAN HV 68
SHELL	ALVANIA R 3	TURBO OIL 78
CHEVRON	INDUSTRIAL GREASE HEAVY	OC TURBINE OIL 68
MOBIL	MOBILUX EP 3	DTE HEAVY MEDIUM
GULF	GOLD CROWN EP GREASE 2	HARMONY 68
TEXACO	MULTIFAK EP 2	REGAL (R&O) 68
CASTROL	SPHEEROL AP 3	HYSPIN AWH 68

MAINTENANCE OF CALLESEN DIESEL ENGINES

Before start
Check oil level in engine, turbocharger and clutch as well as water level in freshwater tank. Open the seawater and fuel valves. Pump pressure on the lubricating oil system by means of the hand pump. Turn the engine 1 turn - if necessary, in starting position. Before start, pressure must be pumped up again so that the manometer indicates pressure.

During operation
Immediately after starting the engine, check the lubricating oil and hydraulic oil pressure. The engine should be loaded gradually until normal operation temperature is attained.

During operation the engine must be inspected every 4 hours, approximately. At the same time, water pumps and sterntube must be lubricated. If the sterntube is oil-lubricated, check the oil level.

Before stop
Check the starting air bottles. The bottles must be pumped to 30 kp/cm². If grease-lubricated, the sterntube must be lubricated.

After each stop
The sternshaft pullrod must be lubricated through the grease nipple at the flange coupling. Grease must be pumped in until resistance is felt. The pressure is relieved after approx 20 minutes by opening the valve on the flange coupling.

Every week
The Stauffer cups on the end covers (at flywheel and clutch casing) must be lubricated a little (about half a turn). The coarse fuel filter (water trap) should be emptied of water and sludge through the bottom cock at least once a week or when necessary. Inject cleaning water into the turbocharger at full load. If the turbo pressure drops considerably, the turbocharger must be dismounted for cleaning.

Check the Hynautic remote control and bleed it, if necessary (see the Hynautic instructions). If the upper and lower movements are not synchronized, move the handle to both extreme positions a few times.

Lubricate the Jet pumps, if any, by turning the Stauffer cups approximately half a turn.

Every month
Check the lubrication of the rocking lever. Check also the oil under the rocker covers. If this oil is black and thick, exchange the system oil.

Every second month
Clean the small air filters on the valve covers and the air inlet filters. If very dirty, the filters should be cleaned at shorter intervals.

Lubricate the starting valves with a few drops of oil.

Check (and exchange, if necessary) all corrosion anodes. If corroded away, the anodes must be checked and exchanged at shorter intervals.

Empty the starting air bottles of water.

Clean the fuel filters at the front of the engine at suitable intervals. Exchange the inserts if they are in a poor state.

Every six months or more often
Clean the seawater side of the cooler (the inner side of the pipes).

If the engine is smoking and the cause cannot be found in the fuel filters or the feed pump, check whether the injector holes are worn. The injectors should be pressure tested, too. Pump by means of the handpump up to 240 kp/cm²

Exchange of lubricating oil:
Heavily loaded engines: After about 500-700 working hours or according to oil analyses.
Other engines: After about 1000 working hours
Minimum twice a year.

The lubricating oil filter inserts should be replaced when oil is exchanged or when the pressure difference on the manometers "Before filter" and "After filter" exceeds 2 kp/cm² The turbocharger oil must be exchanged every 1000 working hours.

Every year
Adjust valves and check the lubrication of the rocking levers.

Check the water pump valves.

Check the air distributor. Remove the cover and lubricate the disc valve.

Every 2 or 3 years
Change the clutch oil and the clutch oil filter. If water has come into the clutch, the oil must be changed immediately. It may have to be changed several times until it is completely clear as new oil. sThe clutch oil filter insert must be replaced at the same time as it dissolves in water.

Every 3 or 4 years or every 15,000-18,000 working hours
1 or 2 crank bearings must be dismounted for checking. Change the turbocharger bearings after 12,000 working hours.

If the engine is not started for some time, the opening of the exhaust pipe should be covered by a bucket or a plactic bag to prevent rain and moisture from getting into the pipe, as it will loosen soot. If may cause difficulties in starting the engine if this soot is jammed in the valves.

TO BE REMEMBERED WHEN ENGINE IS INSPECTED

Cylinder Covers and Cover Fittings
If the covers have been dismounted, it must always be checked whether they are leaking. Press the fuel pumps to the bottom when engine is idling; if there are any leakages, a whistling sound will be heard which is caused by the explosions going through the copper packings. In this case the cylinder cover must be retightened or the cylinder head gasket must be exchanged. Cylinder cover mounting instructions - see 7-49.

Valves
Check and adjust the valves (see 7-45).
As to grinding of valves and valve seats - see 7-6.

Starting Valves
Check whether the starting valves are leaking. If there have been starting difficulties and one or more starting valves have coked, see to it that all pipes in the starting air system and all air distributor cover ducts are open; if necessary, dismount the pipes for annealing and cleaning.

If it is impossible to tighten all starting valves completely, blank off the valve in question by mounting a copper disc (or a coin without hole) between the fitting and the cylinder head hole to avoid getting coke into the other valves.

Repair instructions - see 7-60.

Charging Valve
Check whether the valve shaft is tight against the fitting in top. Adjust if necessary. Maximum turn of the spindle is 3/4 of a turn (see 7-129).

Filters
Check fuel and lubricating oil filters as well as air filters frequently (see "Maintenance of CALLESEN diesel engines", 7-95).

Crank Bearings
When dismounting the crank bearings for inspection (see 7-14), check also whether all crank plugs are tight.

Camshaft
Check the adjustment and lift of the fuel pumps (see 7-45). If the adjustment is incorrect, call in skilled assistance. Check the adjustment of the air distributor (see 7-63).

Water Pumps
Check the valves of the cooling and bilge pump (see mounting instructions 7-62).

Circulation Pump
Check the circulation pump. On the lower side of the bracket are two holes. One of them is connected to the shaft packing ring which is blocking the engine oil, and the other is connected to the carbon ring packing gland which is blocking the water. When the engine is running, ensure that nothing comes out of the holes and that the holes have not been blocked.

Check whether there are cracks in the hose connections.

As to withdrawal of rotor - see 7-12.

Cooler
Check and clean the oil and freshwater coolers in accordance with maintenance directions 7-10.

Clutch and Reversal
Check the crossbar bolt for pull rod for wear and tear.

Check and, if necessary, replace the corrosion anodes in the clutch oil cooler.

When failure of clutch pressure is experienced: Check clutch filter and oil level of the clutch. The oil level must be sounded when the engine is idling (disengaged).

Check the over-pressure valve: No oil must leak during reversing manoeuvres. Check the reversing mechanism before calling at a port, especially after prolonged journeys. Reduce the engine revs to 250 rpm and reverse from ahead to astern.

Lubricating Oil Analyses
While engine is running, drain off approximately 2 litres of oil at the flange under the lubricating oil filter. Then drain off the oil sample.

TECHNICAL DETAILS FOR CALLESEN DIESEL TYPE 427 AND 427 T

Engine type		**C**	**D**	**E**	**F**	**H**
Lubricating oil filling	liter	160	180	200	220	260
Hydraulic oil filling	liter	50	50	55	55	
Freshwater filling	liter	230	290	350	410	530
Capacity:						
Lubricating oil pump	m³/h	2.3	2.3	4.0	4.0	6.0
Return oil pump	m³/h	2.45	2.45	4.25	4.25	6.5
Clutch oil pump	m³/h	2 x 3.5	2 x 3.5	2 x 4.75	2 x 4.75	
Cooling and bilge pump	m³/h	9.3	9.3	14.4	14.4	29.0
Circulation pump	m³/h	14.0	14.0	22.0	22.0	30.0
Fuel feed pump	l/h	96	96	146	146	2 x 146

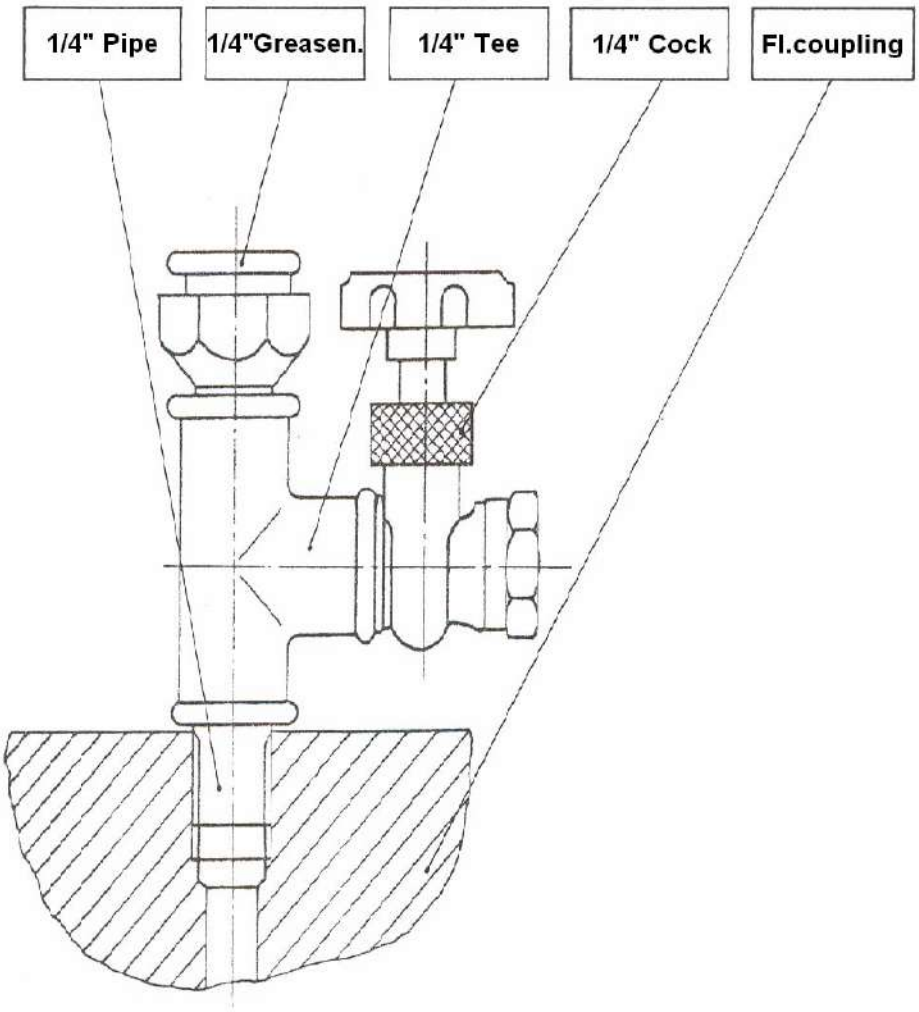
MAX. ALLOWABLE:

Cooling water temperature	ºC	90
Ignition pressure	kp/cm²	65
Exhaust temperature, without/with turbo	ºC	500/525
Main bearing and crank bearing clearance	mm	0.20
Axial clearance crank-pilot bearing	mm	0.30
Deflection measured between crank webs (autolog)	mm	0.08
Wear of cylinder	mm	0.25
Gap in piston ring	mm	4.00
Wear of track	mm	0.40
Clearance between piston and piston pin	mm	0.05
Clearance in piston pin bush	mm	0.20
Distance between piston and cylinder head	mm	2.40
Axial clearance for bush in intermediate wheel	mm	0.20
Clearance in camshaft bearing	mm	0.10
Axial clearance for rocking levers for valves	mm	0.20
Clearance in valve guide, pump lever guide and valve lever guide	mm	0.20
Clearance in eccentric strap for water pump	mm	0.20
Wear of piston water pump	mm	1.00
Clearance in distributor bearing in clutch	mm	0.10
Axial clearance of thrust bearing in clutch, 427 C-D (SKF22326)	mm	1.3
Axial clearance of thrust bearing in clutch, 427 E-F (SKF22236)	mm	1.5
Axial clearance of thrust bearing in clutch, 427 H (SKF24156)	mm	2.0

MIN. ALLOWABLE:

Lubricating oil pressure	kp/cm²	2.0
Clutch oil pressure	kp/cm²	5.0
Opening pressure of nozzles	kp/cm²	240
Torque for staybolt	kpm	300
Torque for M8 bolt at retaining element	kpm	4
Torque for bolts for connecting rod and main bearing 1¼" WG	kpm	76
Torque for main bearing bolt M 33	kpm	100
Drive of governor wheel	mm	0.9
Exhaust and suction valve clearance	mm	0.6

OPERATION OF RELIEF VALVE FOR LUBRICATION OF PULL ROD AND PROPELLER HEAD



After having stopped the engine, pump grease in with closed cock until resistance is felt. To increase the flow of the grease you might oprerate the reversal to ahead and astern pumping.

The grease must draw out into the propeller head and the cock should be kept closed for about 20 minutes.

Then open the cock and leave it open for about 15 minutes to allow the excess pressure to leave the system. If grease is not pressed out of the cock, the system is not filled up and you will have to pump more in. Operate the reversal to ahead and astern and close the cock again until next lubrication.

For lubrication use a thin (soft) special sterntube grease.

DESCRIPTION OF "SUBLIME" STERNTUBE SEALING

AFT SEALING

The aft sealing consists of:

1) an inner casing (9 and 14) with chromium steel bush (5)
2) an outer casing (1 and 13)

Inner casing

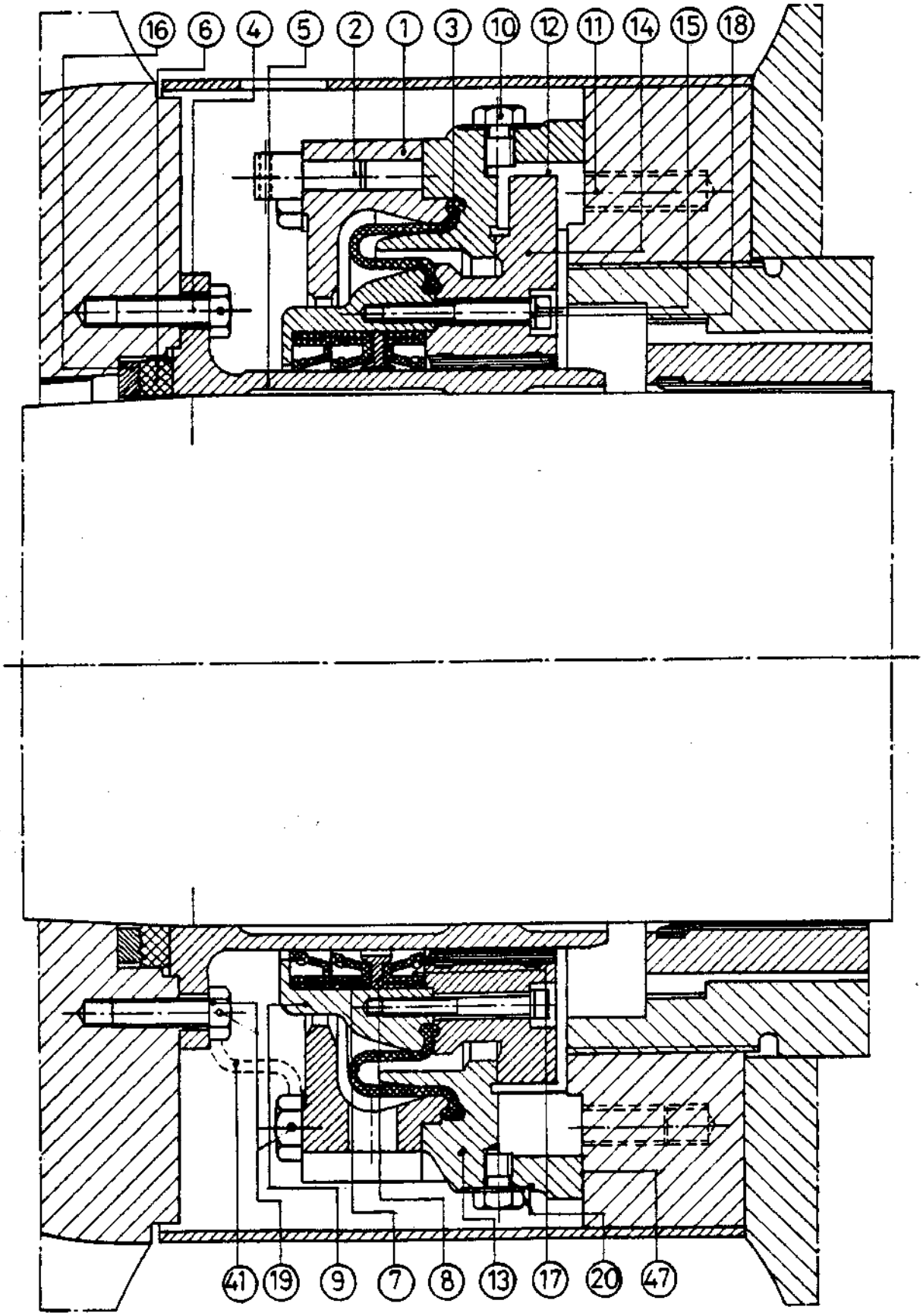
The inner casing consists of two rings (9 and 14) which are exactly centered to each other. The bronze ring (9) is supplied with 3 rubber sealing rings. The two aft sealing rings (7) prevent the entry of saltwater, and the third ring (17) is to seal against oil from the sterntube. The lips of the sealing rings are pressed upon the chromium steel bush (5) by means of a spring and water pressure, respectively oil pressure. The water pressure corresponds to the draught of the ship; the height of the overhead tank (2 - 3 m above the water line) determines the oil pressure. The rubber of the sealing rings is seawater- and oil resisting. The support ring (8) ensures a long lifetime and a good sealing capacity. The bearing ring (14) ensures that the sealing rings follow exactly the movements of the propeller shaft. This bearing ring is cast inside with white metal. The chromium steel bush (5) is pushed over the shaft and fastened on the propeller so that it rotates with the shaft. In case of wear of the aft end bearing the lips of the sealing rings are kept centrically in the right position by means of a bearing ring (14) which ensures a durable sealing.

In order to prevent any leakage of oil or water between shaft and bush, a bronze and rubber ring is placed in the propeller boss. Between bearing ring (14) and ring (9) a sleeve (3) of oil- and seawater resisting rubber is pressed. The rubber sleeve ensures a flexible and durable sealing between the inner casing (9 and 14) and the outer casing (1 and 13), and makes it possible for the inner casing (with sealing rings) to follow the shaft.

Outer casing

The outer casing (1 and 13) is mounted on the sterntube by means of stainless steel screws (11). The ring (13) is precisely fixed by a recess against the sterntube. The bearing ring is notched to prevent any axial or rotary movement and wreckage of the flexible rubber sleeve. By any damage of the rubber sleeve a stop on the bearing ring is serving as an emergency sealing. All the screws (4, 10 and 11) which are placed in the water are made of stainless steel.

By means of a sliding gauge with a depth gauge and the measuring device on the ring (1) it is easy to check the wear of the aft end bearing


16
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47

FORWARD SEALING

The forward sealing has the same construction as the aft sealing, however, instead of the rubber sleeve, simple sealing rings are used as it is known from experience that the front end bearing is never worn worth mentioning.

The forward sealing consists of a casing (1). In this casing two sealing rings (2) and two supporting rings are retained by means of a seeger circlip (5). The two sealing rings are running on a chromium steel bush (6) which by means of the clamp ring (13) runs around with the shaft.

The lips of the sealing rings are pressed firmly on the chromium steel bush by means of a spring and the oil pressure from the sterntube. The sealing against oil from the sterntube is always guaranteed.

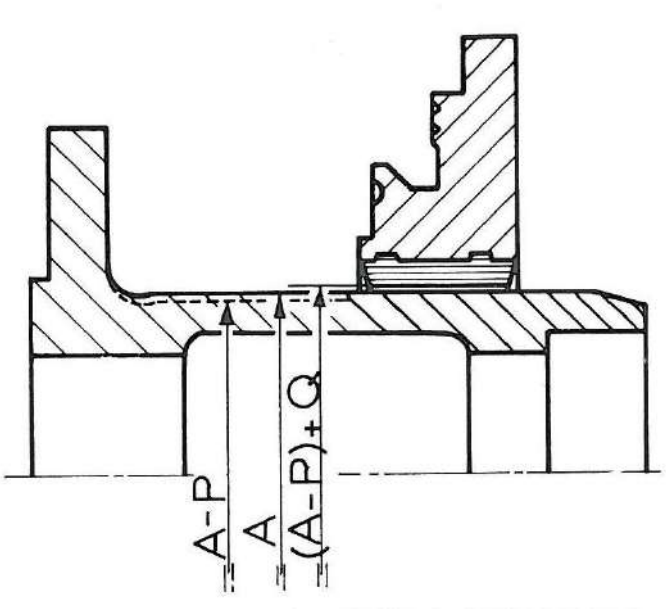
In order to ensure a long lifetime, the foremost ring is used first and afterwards the adjacent one, simply by shutting the needle valve (9). The second sealing ring which has constantly been uncharged and well cooled, takes over the sealing immediately.

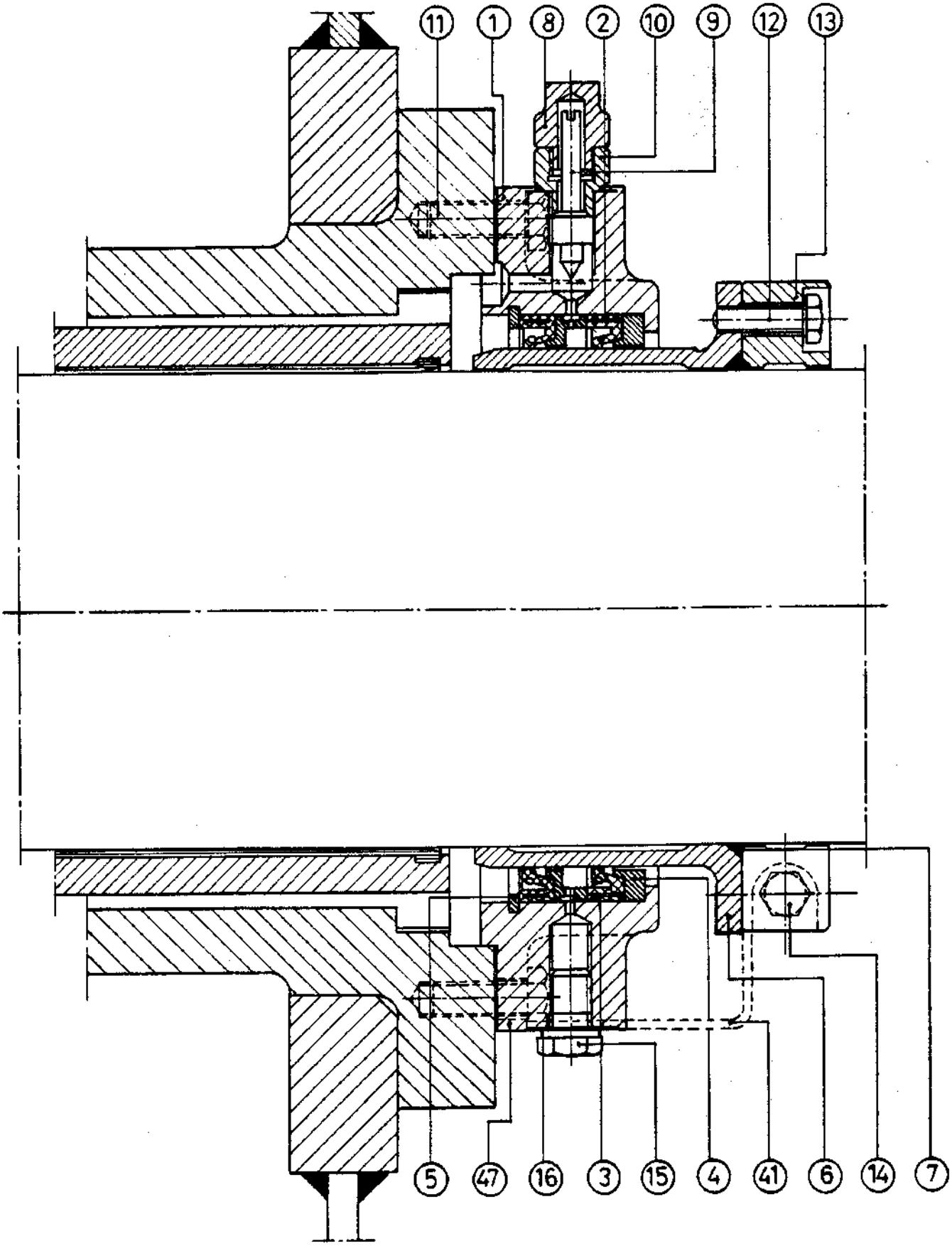
In order to avoid leackages between the propeller shaft and the chromium steel bush a rubber ring (7) is pressed in between the clamping ring and the shaft.

Repair of the chromium steel bush

In case of repair the chromium steel bush of the fore- and after packing gland can be ready machined and polished to a minimum diameter (A-P); the spring in the sealing rings can then be shortened in length by max. 5%.

Type A	P max.	Q Max. Min.
155	1,5	0,2
170	1,5	
190	1,5	
200	1,5	0,4




11
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13
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47
16
3
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41
6
14
7

MOUNTING INSTRUCTIONS

Mounting of the seals takes place as a whole unit. The seals are built together in the work shop and the bushes mounted. All you have to do at dock or slip, is to push the bushes with the seals over the shaft.

Aft sterntube sealing
After mounting the propeller shaft, the aft sterntube sealing with chromium steel bush which is fixed by mounting clips to the sealing case, is pushed as a whole unit over the shaft and fastened to the sterntube, oil and water tight.

The stainless steel bolts (11) have to be secured two by two by chromium steel wire (19). The measuring bolt (2) has to be in top position. During the erection, the aft sealing filling plug (10) in the outer casing (13) can be changed temporarily by a hoisting bolt. When refitting the filling plug (10) do not forget the copper washer (20). After fitting the propeller the pressure ring (16) and rubber ring (6) have to be put into the propeller boss. Now the chromium steel bush (5) can be fitted against the propeller boss. The stainless steel bolts (4) have to be secured two by two by chromium steel wire (19). After removing the mounting clips you have to measure by means of a slide gauge the distance from the measuring bolt (2) to the chromium steel bush. This dimension is written down for checking the wear of the aft end bearing.

When dismounting the sealing you have to use the same procedure.

Forward sterntube sealing
The forward seal with chromium steel bush (6) which is fixed to the sealing casing by mounting clips, can be placed on the propeller shaft as a complete set with rubber ring (7) and clamping ring (13). The seal has to be placed on the propeller shaft before or after inserting the shaft into the sterntube.

After mounting the aft seal, the forward seal has to be fitted oil and watertight to the sterntube by means of the packing. After removing the mounting clips the clamping ring can be mounted on the shaft and against the chromium steel bush. The rubber ring has to be pressed between clamping ring and bush. Distance between flange of chromium steel bush (6) and sealing casing (1) has to be kept (see drawing of forward seal).

During mounting and dismounting it is necessary to take care that the chromium steel bushes are not drawn out of the sealings as the lips could be damaged when the bush is pushed in again.

Mounting clips of aft and forward seal are delivered with sterngear.

OPERATION INSTRUCTIONS

Starting
By means of a handpump the oil has to be pumped out of the tank into the sterntube and overhead tank. While filling the sterntube the air escape valve (10) of the aft sealing has to be open.

The sterntube is fully filled if the oil in the overhead tank and the gauge glass does not drop but flows back through the overflow pipe to the tank. The air escape valve is closed again.

After filling and de-aerating the sterntube, the air escape valve has to be fitted oiltight. After filling the sterntube with oil you have to wait before rotating the propellershaft, because:

a) The oil will penetrate slowly between shaft and sterntube bearings. The oil level in gauge glass has to be observed continuously, especially during the first operation hours.

b) With oil pressure on the sterntube you can test the oiltight fitting of the forward sealing against afterpeak, and after sealing against sternpost and propeller.

If you acted as under a or b) and if the needle valve (9) is opened, the sterntube bearings and sealings are ready for operation.*The needle valve is delivered in open condition.*

Normal operation
Normal maintenance is limited to observing the oil level in the overhead tank by means of the oil gauge and if necessary to refill the tank.

Operation troubles
Leakage in the piping, sterntube, forward- or aft seals will be visible when the oil level in the overhead tank and the oil gauge drops.

Should any damage of the rubber sleeve occur a stop on the bearing ring serves as an emergency seal. If the forward seal is leaking you only have to shut the needle valve, the other sealing ring which was always uncharged and well cooled guarantees a perfect and immediate sealing.

Changing the sealing rings
If you have to mount new sealing rings you have to remove the chromium steel bush and dismount the seals. After mounting the new rings, the chromium steel bush has to be put into the seals very carefully.

DISMANTLING AND ASSEMBLING OF PROPELLER BLADES AND HEAD

Before stopping the engine, set the propeller pitch at zero position.

When dismounting the propeller head cover, take care that the joint surface is not damaged. When the joint bolts have been unscrewed, the cover can be loosened by turning the blades. When the cover has been removed, the blades can be taken out by turning them around the sliding journal. Thus, neither pull rod nor flange coupling have to be dismantled.

When blades and sliding blocks have been refitted, lubricate all moving parts with engine oil. Do not fill up with grease until the cover has been mounted.

Prior to assembling the propeller head, see that the joint surface is completely free from dirt and burrs, and prior to mounting the cover, clean the threaded holes of the propeller head carefully to remove grease and dirt; otherwise the bolts may not be tightened sufficiently. Lock the joint bolts by means of the stainless locking screws bored into the cover.

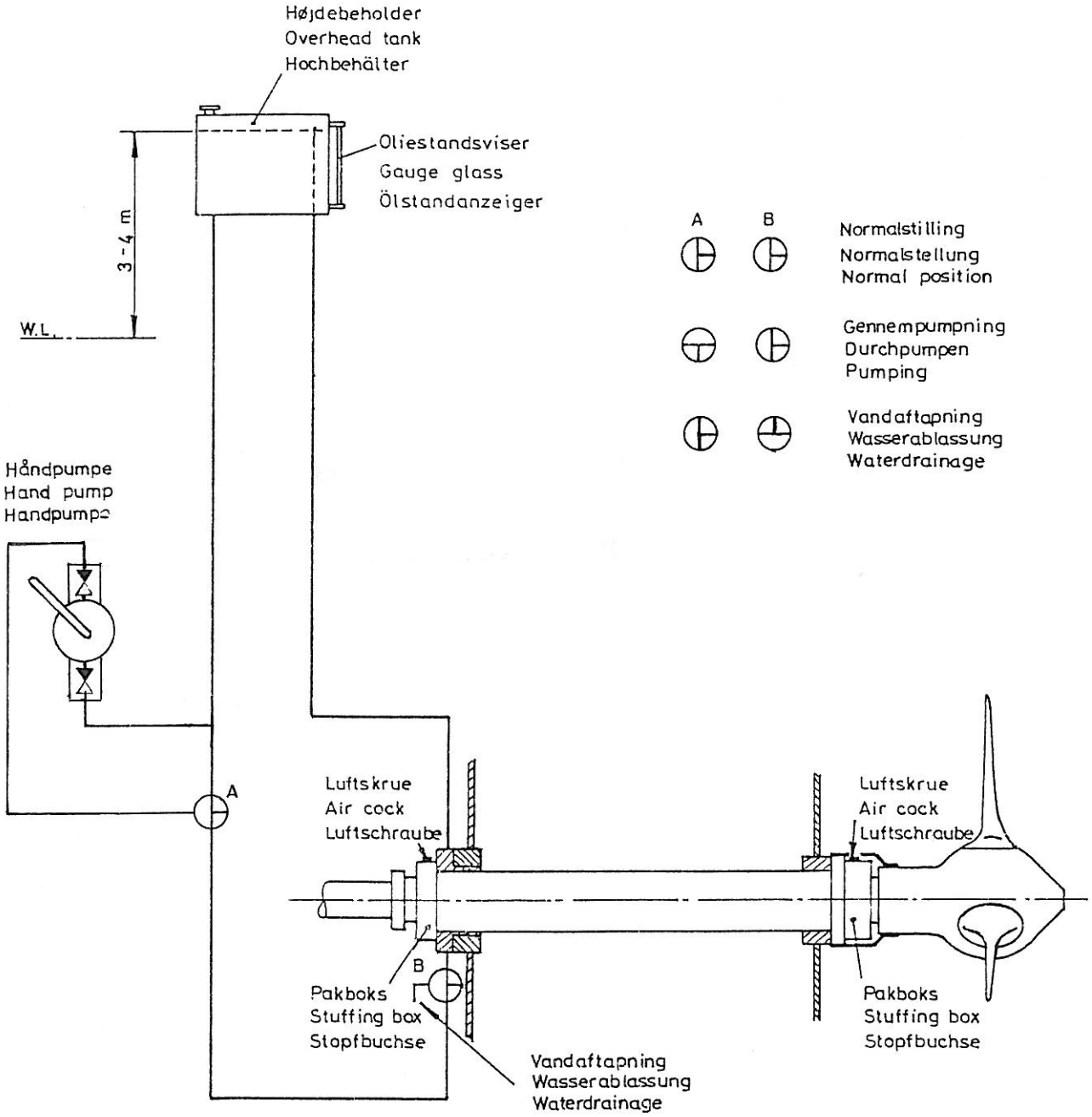
Then fill the propeller head with thin grease or sterntube oil SAE 140 as follows:

Place the head so that the filling hole is pointing straight downwards and the air relief hole straight upwards. Fill grease into the bottom hole. The head is filled when grease is beginning to run from the top hole. Finally, fill the joint bolt holes with tallow.

If the pull rod has been dismantled or when the pull rod is being mounted for the first time, proceed as follows:

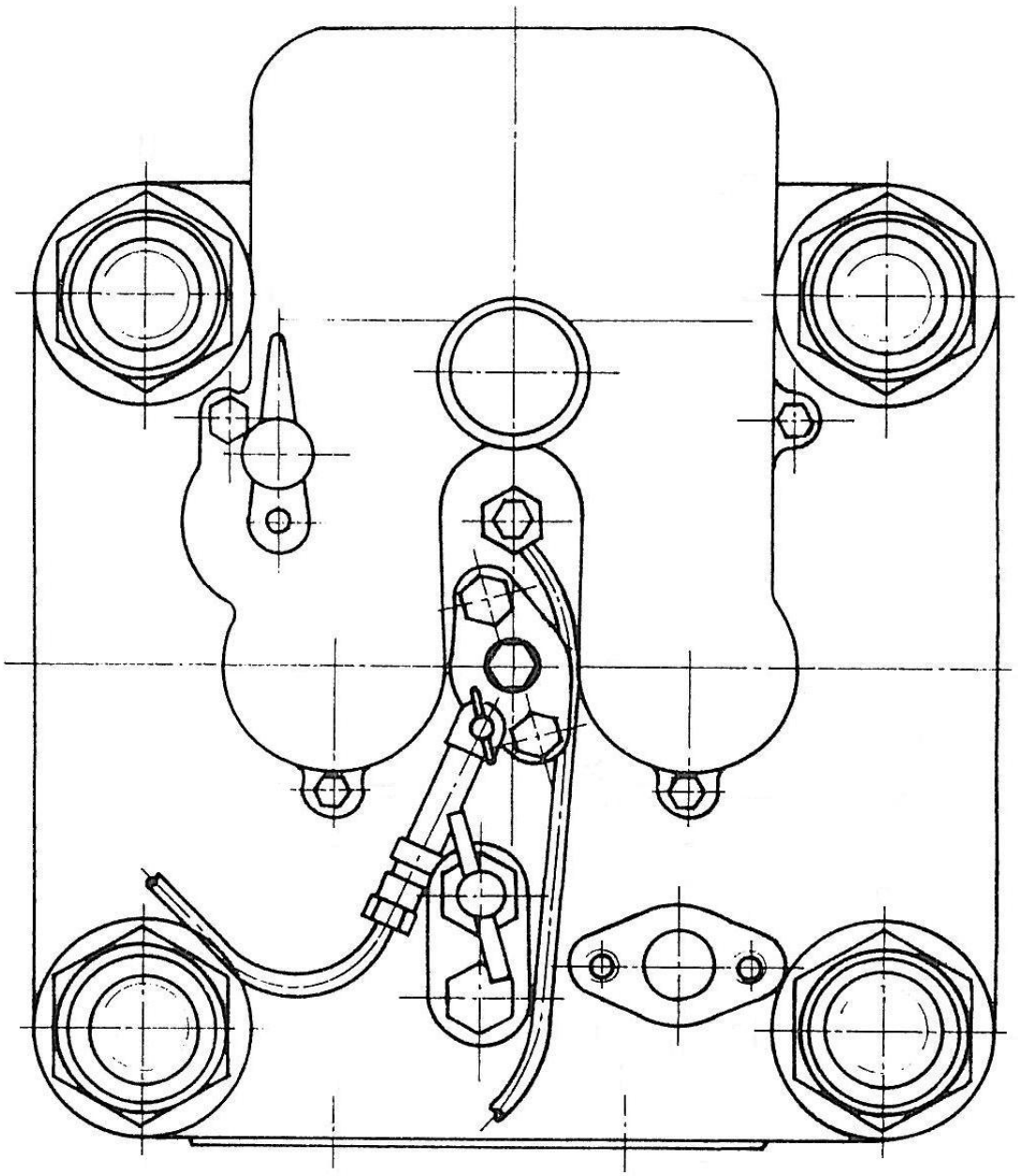
Screw the pull rod into the piston rod or the intermediate shaft sleeve by turning the propeller shaft. Screw the pull rod home and then about 1/4 - 3/8 turn back so that the holes in the flange couplings are facing each other.

RØRDIAGRAM FOR PROPELLERANLÆG.
PIPE DIAGRAMM FOR STERNGEAR.
ROHRDIAGRAMM FÜR PROPELLERANLAGE.



Smøremiddel: Motor-olie SAE 30
Lubricant: Engine-oil SAE 30
Schmiermittel: Motor-Öl SAE 30

FASTENING OF CYLINDER COVER



1. For mounting of cylinder cover the distance between cylinder cover and block should be identical in all 4 corners. The distance must be controlled by a feeler gauge.

2. In case of fastening by means of a ringstriker wrench the direction indicated under item 1 should also be observed.

3. In case of fastening by means of a torque wrench, the direction indicated under item 1 should also be observed. Torque: Type 427 = 300 kpm. – Type 425 = 255 kpm.

4. In case of hydraulic fastening the manometer should indicate a pressure of approx. 250 Bar (Type 427) and approx. 240 Bar (Type 425).

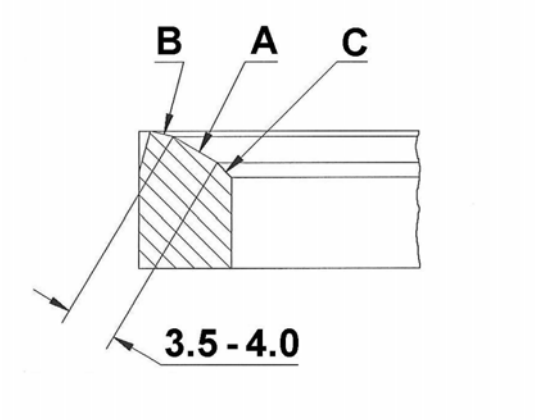
INSTRUCTION FOR VALVE GRINDING

If you find that the valve seats are loose you have to check by means of a thickness gauge how much space there is between the seat and the cylinder cover. If there is more than 0.05 mm you have to change the seat, if less than 0.05 mm the seat has to be caulked before grinding.

When removing the seat, the surfaces in the cylinder cover are not to be damaged and before inserting the new seat, you have to examine the surface in the bottom of the hole to see if it is in order. If not, you have to grind it with carborundum, if necessary by means of the old seat. The reason is that if the seat does not bear against all over, the seat will not be cooled sufficiently.

First the seat must be ground by a Tyrolit stone.

Before grinding the valve seat please observe that the valve guide is sufficiently tightened.



Face the stones for:

A = 30.5º - 31.0º

B = 15.0º

C = 45.0º

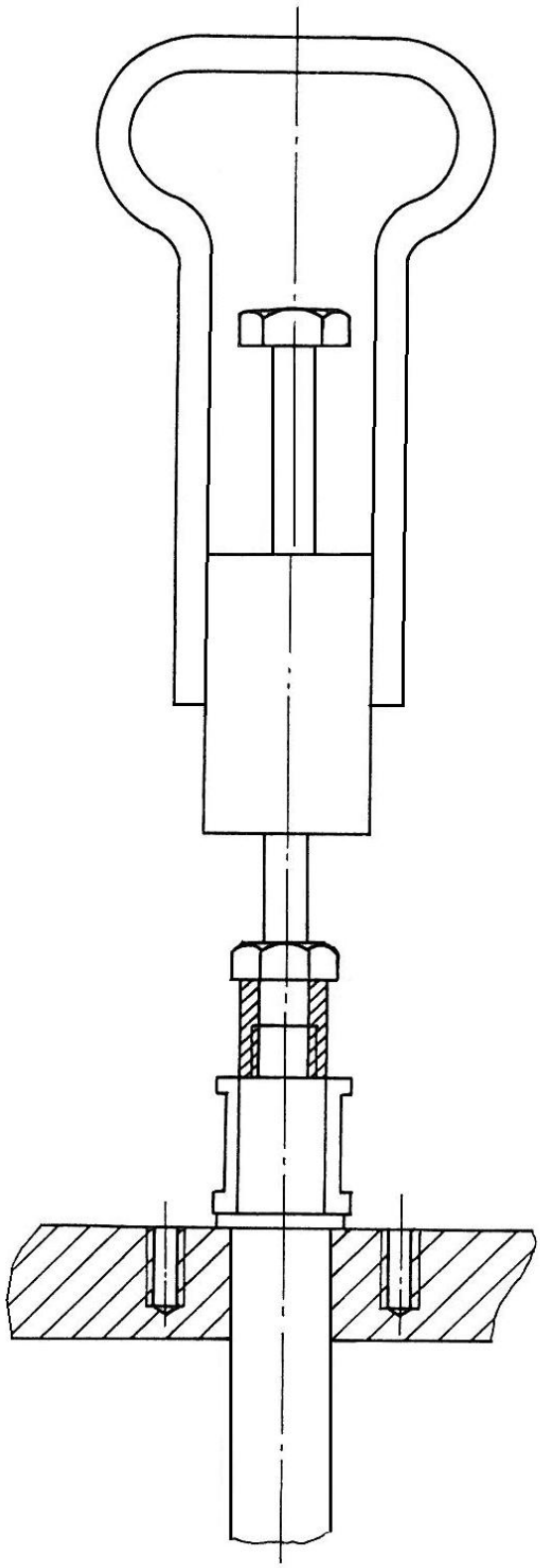
Start grinding the surface **A** with a slight pressure so that the seat becomes round. Thereafter **B** and **C** are to be faced so that the seat will get a width of **3.5 – 4.0 mm**. Before grinding with the valve and carborundum, you have to examine that the valve lies hardest on the bigger diameter of the area A. when you have ground af few times with carborundum, the valve should touch all over. This should be checked by means of a thin coat of China ink.

Please observe: when grinding valves *you must only grind one way*. The valve should be lifted at return.

Having finished the grinding and having cleaned the valve carefully, MOLYKOTE should be applied to the valve shaft before mounting.

	422	**425**	**427**	**427 TK-G**
Inlet valve	20700	16700	16700	16701
Exhaust valve	20701	16701	16701	16701
Valve seat	20707	16737	16737	16737

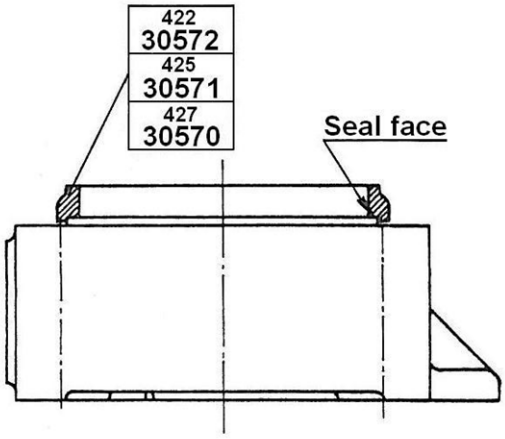
DRAWING OF NOZZLE HOLDER



First you have to remove the cap nut on the nozzle holder.

Thereafter the drawing tool (16978) for the nozzle holder should be mounted as shown on the drawing and by means of the drawing tool you can draw the nozzle holder.

Before you mount the nozzle holder again, you have to clean the packing surfaces, and grease the shaft at the nozzle holder with a heat resistant compound, e.g. Molykote HSC.



GRINDING OF CYLINDER COVER

The cylinder head is placed with the bottom upwards.

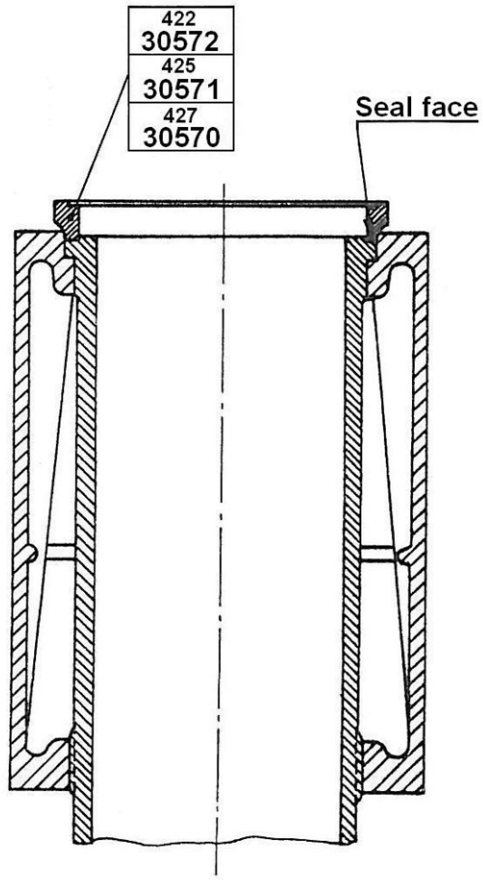
The seal face of the cylinder head is lubricated with carborundum.

The grinding ring is placed as illustrated on the drawing.

The ring is turned backwards and forwards while at suitable intervals the ring is moved ¼ revolution.

The grinding is continued until the seal face is without marks and grooves.

After grinding the cylinder head is cleaned carefully against carborundum.



GRINDING OF CYLINDER LINER

The grinding is made with the liner mounted in the cylinder block.

The seal face of the liner is lubricated with carborundum.

The grinding ring is placed as illustrated on the drawing.

The ring is turned backwards and forwards while at suitable intervals the ring is moved ¼ revolution.

The grinding is continued until the seal face is without marks and grooves.

After grinding the liner is cleaned carefully against carborundum.

Regarding mounting of cylinder liner - see page 7-26.

FUEL PUMP AND VALVE ADJUSTMENT OF ALL TYPES

ADJUSTMENT OF VALVE AND PUMP MEASURED IN MM ON FLYWHEEL

	TYPE	FLYWHEEL DIAMETER	1160	1000	960	950	900
Valve clearance at cam 0.45	427 (15 mm element)	Suction opens before top	314	270		257	
		Exhaust closes after top	174	150		142	
		Fuel pump with drip pipe	151	130		124	
	427 T (17 mm element)	Suction opens before top	607	524		498	472
		Exhaust closes after top	606	524		498	472
		Fuel pump with drip pipe	81	70		66	63
	427 (500 rpm)	Suction opens before top	314	270		257	
		Exhaust closes after top	174	150		142	
		Fuel pump with drip pipe	165	142		135	
	427 TK (20 mm element)	Suction opens before top	607	524		498	472
		Exhaust closes after top	606	524		498	472
		Fuel pump with drip pipe: 69 bar ignition pressure 74 bar ignition pressure	23	20 40		19 38	18 36
Valve clearance at cam 0.4	425	Suction opens before top		230	221		
		Exhaust closes after top		185	178		
		Fuel pump with drip pipe		150	144		
	422	Suction opens before top		230	220		
		Exhaust closes after top		185	175		
		Fuel pump with drip pipe		160	154		
	425 T	Suction opens before top		525			
		Exhaust closes after top		525			
		Fuel pump with drip pipe		62			

Firing order, clockwise running:

3 cyl: 1-3-2, 4 cyl: 1-2-4-3, 5 cyl: 1-3-5-4-2
6 cyl: 1-5-3-6-2-4 8 cyl: 1-3-5-7-8-6-4-2

Firing order, anti-clockwise running:

3 cyl: 1-3-2, 4 cyl: 1-2-4-3, 5 cyl: 1-2-4-5-3
6 cyl: 1-4-2-6-3-5 8 cyl: 1-3-5-7-8-6-4-2

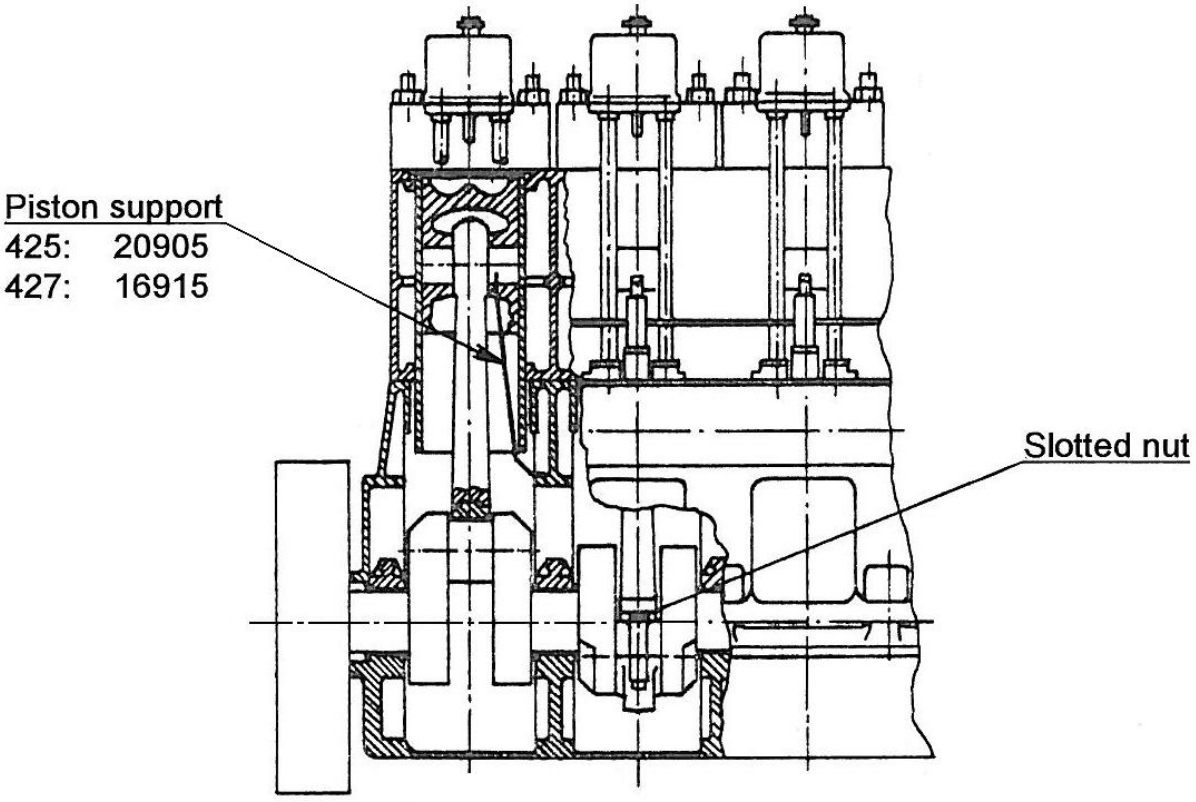
Adjusting screw for fuel pump:

422: 2.2 mm 425: 2.2 mm 427: 5.5 mm

Clearance from upper edge of liner to piston:

422: 1.4 - 1.6 mm 425: 1.6 - 1.8 mm 427: 1.8 - 2.0 mm (piston 17247)
16.8 - 17.0 mm (piston 18230)

DISMOUNTING OF CRANK BEARING AND MOUNTING OF PISTON SUPPORT



The crank covers are dismounted.

The slotted nut on the operating side is to be loosened while the slotted nut on the opposite side is dismounted.

The crank should be turned to top for the cylinder in question.

The remaining slotted nut is removed and the base of the bearing is lowered down into the oil pan.

Be careful of the filler

If the crank is turned approx. 30º towards starboard, the base of the bearing can be removed through the opening in the crank case.

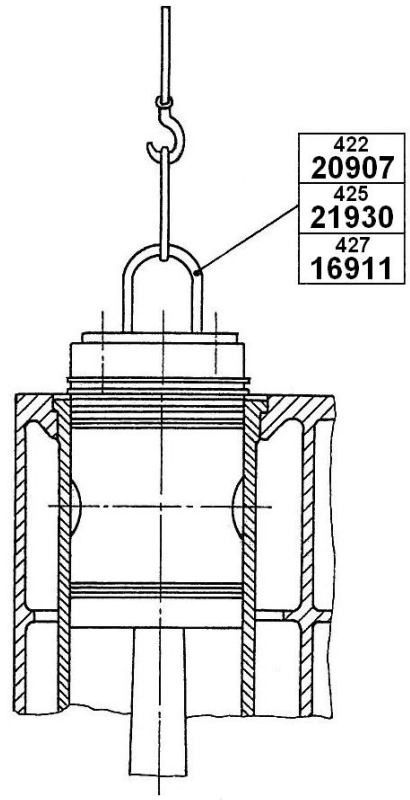
Subsequently the crank should be turned to top and the piston support (16915) placed as shown on the drawing.

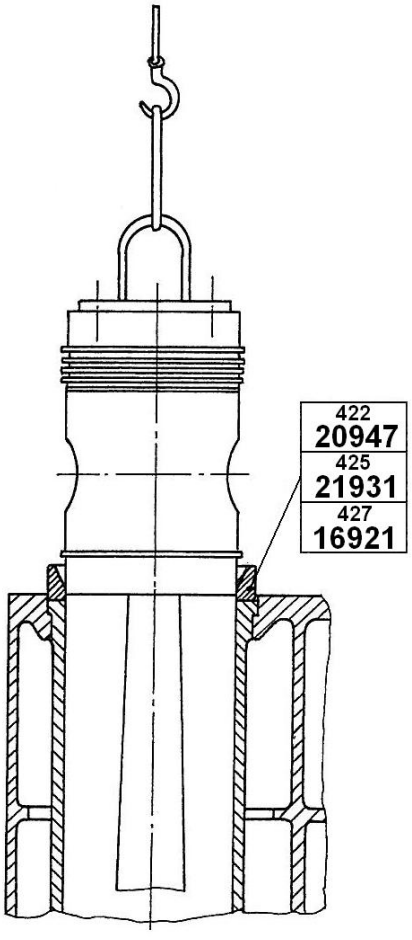
While holding the bearing in order to prevent it from falling into the oil pan, the crank should be turned to port side and the upper part of the bearing can be removed together with the filler for the piston height.

The bearing and the crank pin are to be checked.

Before mounting the parts again they should be cleaned carefully.

DRAWING OF PISTON AND DISMOUNTING OF CRANK BEARING





The pistons should not be drawn until oil consumption is too great. Then the oil control rings and probably also the compression rings have to be replaced.

Dismounting of piston and bearing:

The cylinder cover is dismounted. The uppermost 5 cm of the cylinder lining are cleaned from soot.

The lifting tool is fastened to the piston - see drawing (on recent engines type 427, use an M 12 eye bolt).

The crank covers are dismounted.

The forelocks in the connecting rod studs are removed and the slotted nuts are loosened. The nut in starboard side is unscrewed.

The crank is turned to top for the piston in question.

The last slotted nut is unscrewed and the base of the bearing is lowered into the oil pan. The pase of the bearing is removed (prodcedure - see 7-14).

The piston is lifted and the upper part of the bearing is turned 180°, then lowered and removed. The filler for piston height is removed together with the upper part.

Mounting of piston and bearing:

The piston guide is placed at the top of the cylinder lining (see drawing).

The piston is lowered and the rings are turned into the places at the same time. The ring gaps must be staggered.

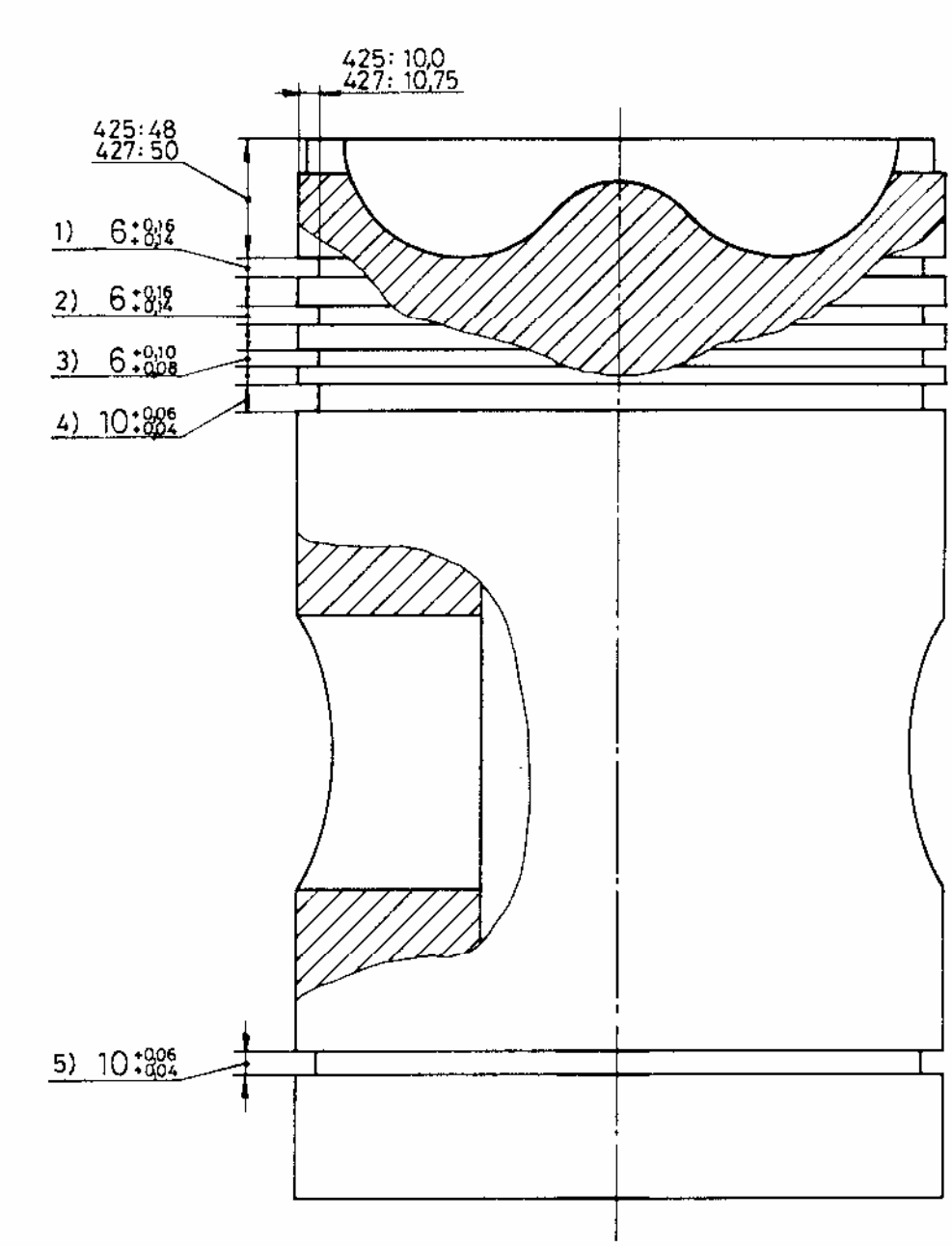
The piston is lubricated a little with oil.

The top of the bearing and the filler for the piston height are lifted into their places.

The base of the bearing is mounted. The slotted nuts are fastened and secured (torque for 422/425: approx 64 kpm and for 427: approx. 76 kpm).

The crank housing covers are mounted.

REPAIR OF GROOVES FOR PISTON RINGS



1) Compression ring (chromium plated)
2) Compression ring
3) Compression ring
4) Oil control ring (chamfer facing upwards)
5) Oil control ring (chamfer facing downwards)

Acceptable wear of grooves for compression rings: 6 + 0,4 mm

Oversize for chromium ring: 1) $7\ ^{+\ 0.16}_{+\ 0.14}$ mm 2) $8\ ^{+\ 0.16}_{+\ 0.14}$ mm

DIRECTIONS FOR MOUNTING OF CYLINDER LINER

Before mounting, the cylinder liners must be ground in the block. At first, a smooth coat of medium-fine carborundum must be applied to the horizontal part of the liner - take care that the carborundum does not get on the cylindric guiding piece. Then grind with fine carborundum.

Now the packings must be fitted on the top of the crankcase in a thin coat of oil. If the original coating was double, the packings must be double-coated again. - The block can be positioned.

Before moutning the cylinder liners, new o-rings must be fitted. They should be inserted with a little silicone or stiff grease, e.g. Dow Corning MS4 Silicone Compound. Then mount the pistons and check the height of the pistons when in top dead centre.

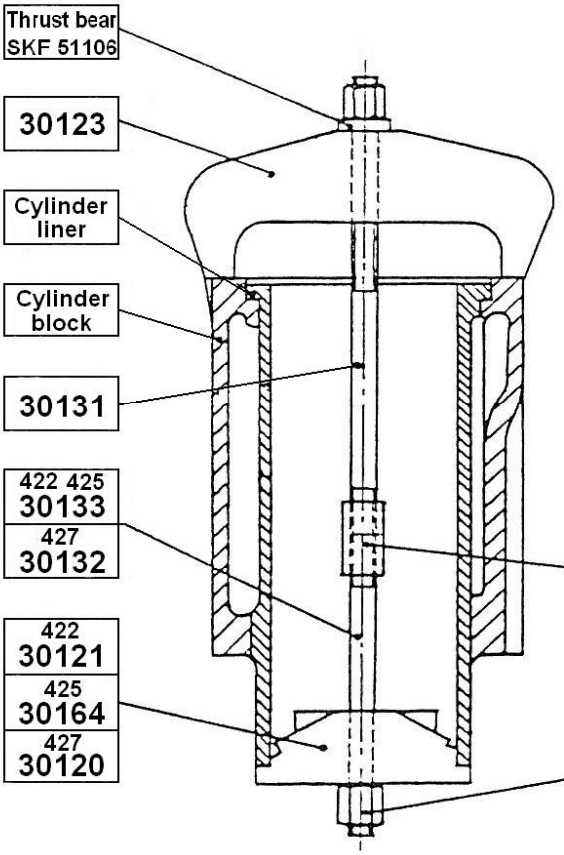
Distance from piston to cylinder head: 2.2 - 2.4 mm. Distance from upper edge of liner to piston: 1.8 - 2.0 mm (applies to type 427 only - see also 7-45).

Mounting of piston: See 7-14 and 7-14a.

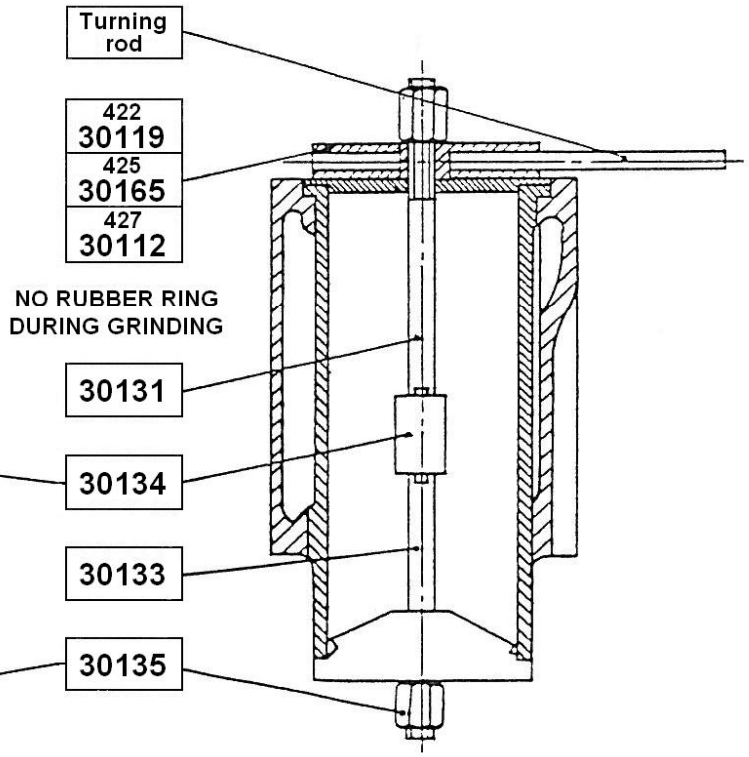
Tightening of cylinder cover: See 7-49 (427 TK-G: 7-202).

WARNING! If incorrectly fitted, the liner could be deformed and may be the cause of damage. It is important to apply a thin layer of grease to the <u>entire</u> surface of the o-ring. The parts must be completely clean.

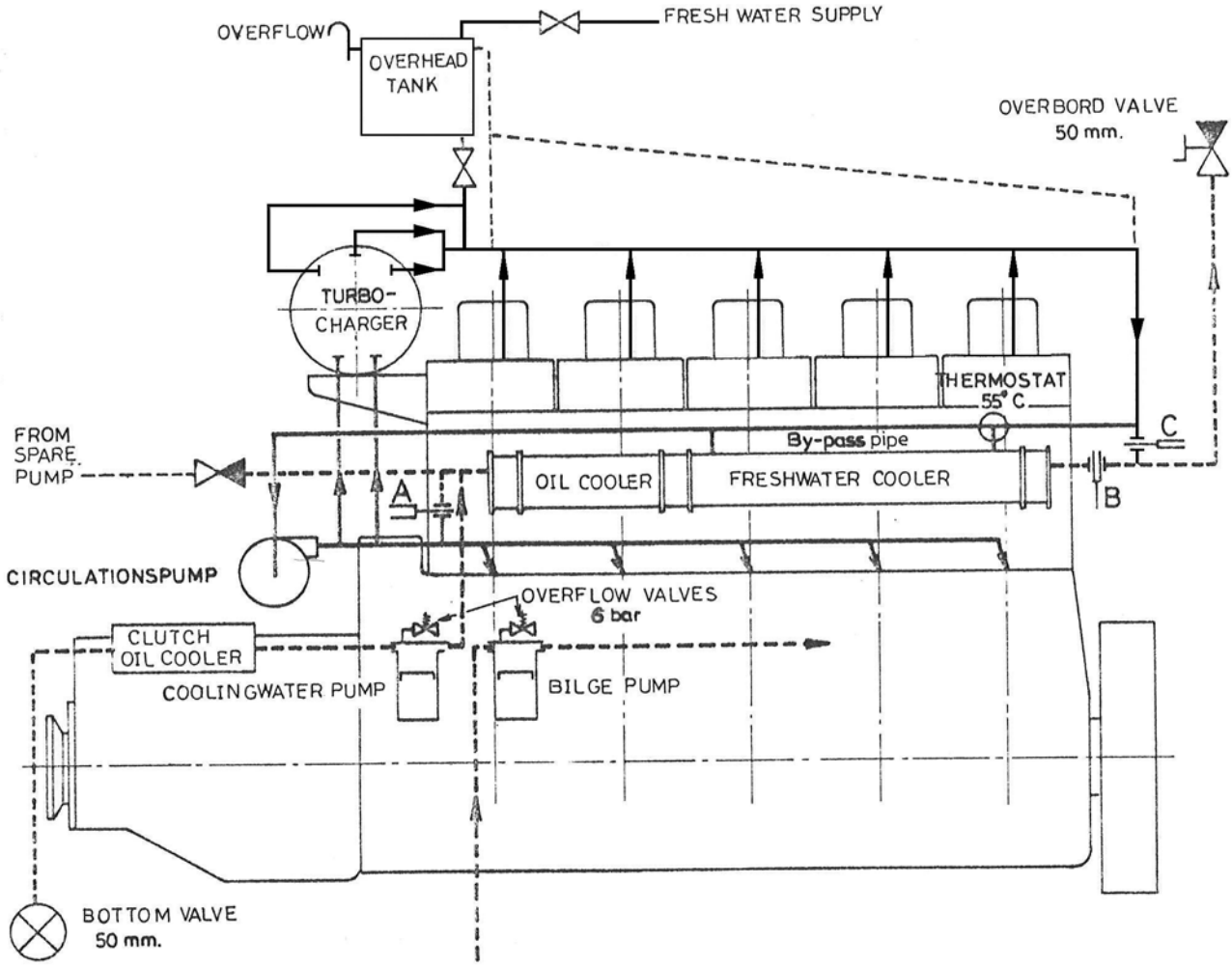
Dismounting of cylinder liner



Grinding of cylinder liner



COOLING WATER SYSTEM TYPE 427 T



SIGNATURES:

——— Freshwater pipe ø60/54 steel pipe

– – – – – – – Seawater pipe ø56/50 copper rør

– – – – – – – Air relief pipe ½" steel pipe

Blind flange

closed open

CAPACITIES:	**Type C-D**	**Type E-F**
Cooling water pump:	9.3 m³/h	14.4 m³/h
Bilge pump:	9.3 m³/h	14.4 m³/h
Circulation pump:	14.0 m³/h	22.0 m³/h

EMERGENCY COOLING:

In case of failure in the freshwater system, seawater can be led direct on the engine by opening blind flanges A and C and closing B.

OPERATION AND MAINTENANCE OF FRESHWATER AND OIL COOLER

Structure

The cooler is made up of two parts - an oil cooler and a freshwater cooler. As shown on the sketch, (sheet No. 7-11) the seawater is led through the pipes in the cooling element. The freshwater is led around the pipes in the cooling element. Because of the follower plates, there is a transverse flow around the pipes. The same applies to the oil in the oil cooler.

Putting into operation

Normally, the cooler is bled when the freshwater and lubricating oil system is being filled. The same applies to the oil cooler. Retighten all tightenings when normal operating conditions have been achieved. Check whether the thermostat keeps the correct temperature.

Cleaning

The seawater circuit of the cooler should be cleaned and checked twice a year. Sailing in muddy waters may increase the need for cleaning. Increased cooling water temperature may be caused by foul pipes. If so, the seawater outlet temperature drops below normal. Dismantle both end covers (1) and (12) and the side cover on the spacer (5) before cleaning.

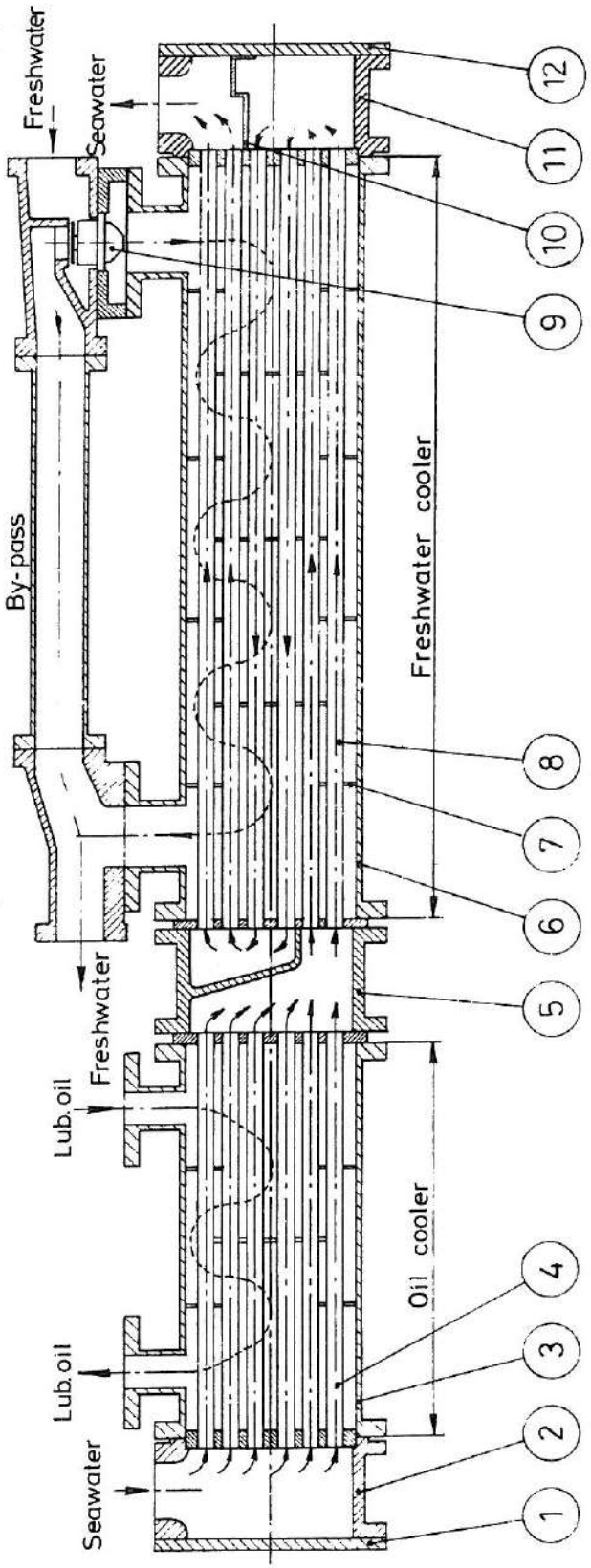
Clean the pipes by means of the brush supplied. A steel brush should not be used, as it may damage the pipe surface. Push mud and sediments out of the pipes to the spacer and clean the spacer. Finally, the cooler is rinsed out with clean water.

Before fitting the covers again, the entire system should be checked for damages and corrosions. The soft-iron anodes fitted on the end covers and side cover should be replaced if there is too much corrosion. The same applies to the dividing plate (10).

It is very important not to interchange the end covers. The end cover (12) with the dividing plate should be positioned in such a way that the dividing plate is horizontal and above the centre of the cooler as shown on the drawing.

Cleaning of the freshwater side is rarely necessary. If it is to be done, the freshwater element (8) must be removed. When refitting it, take care that the element is positioned in such a way that the cuts in the edge of the dividing plates (7) are facing downwards. The spacer (5) side cover must be vertical.

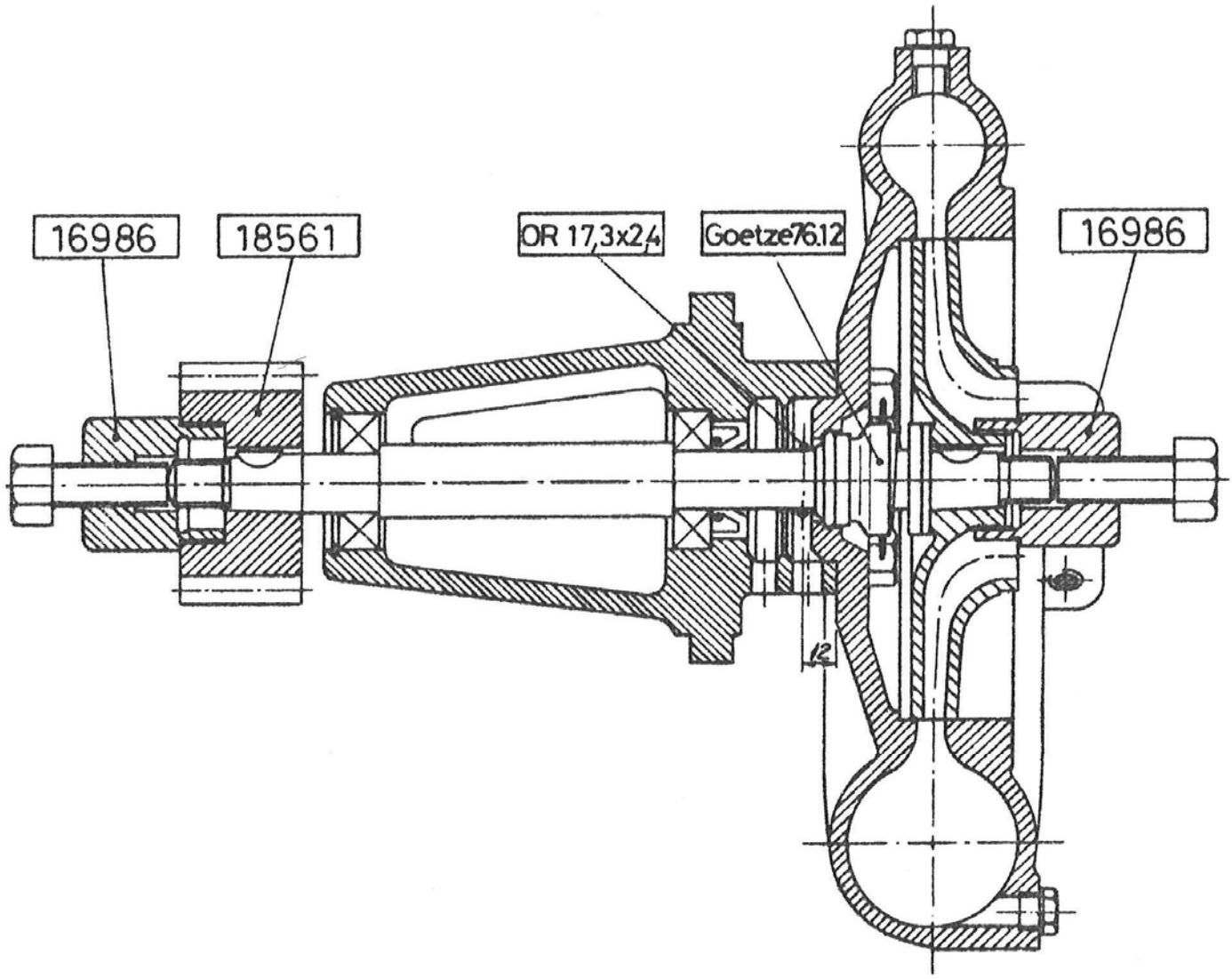
SKETCH OF OIL AND FRESHWATER COOLER



1. End cover
2. End piece
3. Cap for oil cooler
4. Element for oil cooler
5. Spacer
6. Cap for freshwater cooler
7. Follower plate
8. Element for freshwater cooler
9. Thermostat
10. Dividing plate
11. End piece
12. End cover with dividing plate

N.B.! For type 427 H the following applies.: The thermostat 9 is placed in the foremost supply pipe on the freshwater cooler.

REPAIR OF CIRCULATION PUMP



Dismounting

The rotor is dismounted by means of the puller (16986) as shown on the drawing.

The keyway in the rotor should be in top position during the pulling; otherwise the disc key could fall down into the spiral case.

For dismounting of gearwheel (18561), apply puller (16986) as well.

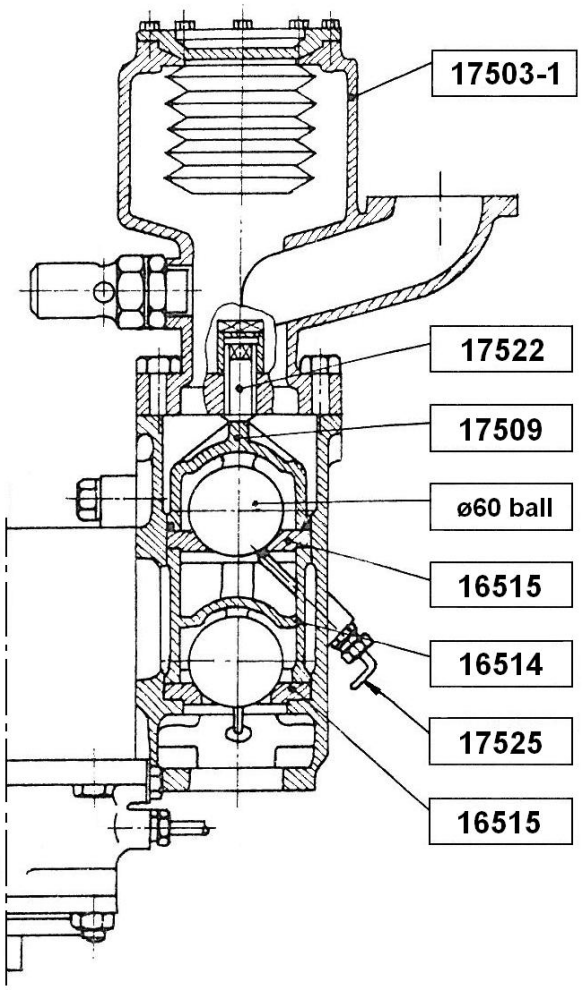
Assembling

O-ring ø17.3 x 2.4 **must** be remembered.

No grease must be found between the seal faces on the packing gland (Goetze 76.12).

The rotor must not be drawn higher up on the cone than before the pulling.

DISMOUNTING OF BALL VALVE IN THE PISTON WATER PUMP



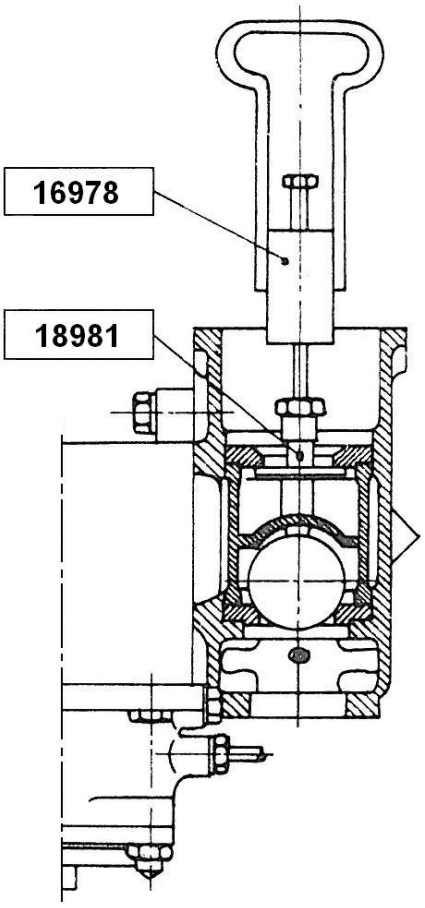
Dismounting
Remove air vessel (17503-1)

Distance piece (17509) is set free by putting a wrench over the ribs and turning it round. The distance piece can then be removed.

The valve tappets (17525) and the ø 60 rubber ball are removed.

The valve seat (16515) is drawn up by means of the puller (18981) and the nozzle hammer (16978)

When the distance piece (16514) has to be drawn up, the puller (18981) is replaced by the puller (18982).



Assembling
The wide rib of the distance pieces should face the pistons.

Before mounting the air vessel on the valve housing, the jack screw (17522) has to be loosened. Otherwise leaks might occur in the joint.

QUANTITY OF ANTI-FREEZE MIXTURE FOR FROST PROTECTION OF CALLESEN DIESEL ENGINES

Type	Water quantity in engine including header tank	Anti-freeze mixture (litres) for protection to:				
		-10°C	-15°C	-20°C	-25°C	-30°C
422 - 425 B	approx 85 litres	20	26	32	36	40
422 - 425 C	approx 120 litres	29	36	44	50	56
422 - 425 D	approx 155 litres	37	46	57	65	72
422 CT	approx 145 litres	34	43	54	60	67
422 DT	approx 180 litres	42	56	66	76	84
427 B-BT	approx 170 litres	40	51	63	72	79
427 C-CT	approx 230 litres	54	69	85	97	107
427 D-DT	approx 290 litres	68	86	107	122	133
427 E-ET	approx 350 litres	81	103	130	147	162
427 F-FT	approx 410 litres	96	121	151	172	190
427 HT	approx 550 litres	127	162	203	231	254

NOTE!

When the anti-freeze mixture has been filled up and the engine has been running for 30 minutes, the mixture is checked by means of a hydrometre.

FROST PROTECTION OF CALLESEN DIESEL ENGINES

Data for ESSO and BP anti-freeeze mixture

- The anti-freeze mixture is an etylenglykol product mixed with special additives which can prevent the cooling water from freezing and reduce rust, corrosion and foam formation in the cooling system.

- The anti-freeze mixture has a boiling point of approx 200ºC and therefore does not evaporate at the engine operating temperature.

- The anti-freeze mixture is chemically stable at the engine operating temperature and neutralizes acid compounds which are produced in the cooling system.

- The anti-freeze mixture has a good thermal conductivity.

- The anti-freeze mixture is innoxious to lacquer and does not attack any of the various components and materials contained in the cooling system.

- The anti-freeze mixture is not inflammable.

Operating instructions

When filling up with anti-freeze mixture the following procedure is recommended:

1. Drain off all cooling water.

2. Rinse the cooling system through until clean water is appearing at the drain of places. **NEVER USE COLD WATER FOR A WARM ENGINE!**

3. Check cooling hoses and connections for leaks. Hoses have to be replaced as soon as cracks are beginning to show. Leaks on connections must be repaired by replacement of the packings.

4. Check thermostat for correct operation.

5. Close drain-off places and fill 1/3 of the cooling system with water.

6. Fill with anti-freeze mixture according to the table and then fill up with water until 1/3 of the overhead tank is filled. See sheet 7-55-2A.

7. Ventilate the cooling system and check that the cooling water reaches 1/3 up into the overhead tank.

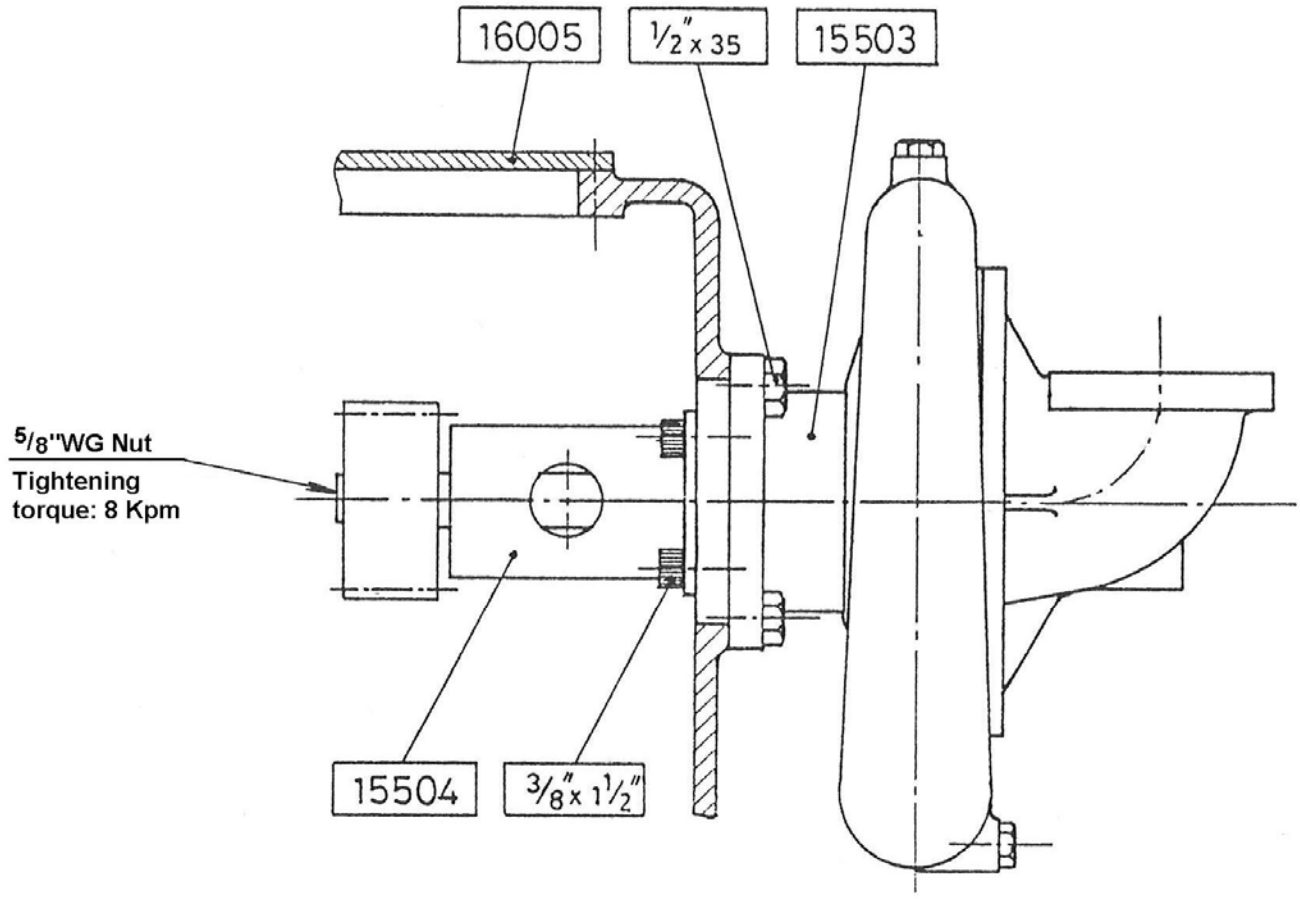
8. The engine is started and brought to normal operating temperature. The water height in the overhead tank is checked, if necessary refilled.

9. The freezing point of the anti-freeze mixture is to be checked by means of a hydrometre.

10. When the required freezing point has been attained, the overhead tank is refilled with 5 liters of anti-freeze mixture and the remainder with water. If the required freezing point has not been attained, it is necessary to add further anti-freeze mixture.

11. If the cooling system is in order, the anti-freeze mixture will not be utilized, but the freezing point of the anti-freeze mixture should be checked at regular intervals.

ADJUSTMENT OF TOOTH CLEARANCE FOR CIRCULATION PUMP TYPE 427 E-F



The bearing housing (15504) can rotate and is provided with an eccentric recess for guiding of the pump.

Adjustment of tooth clearance

The four unbraco screws 3/8 x 1½" are tightened loosely so that the bearing housing (15504) can be turned on the bracket (15503) by hand. The pump is put into the right place and the four bolts ½" x 35 mm in the outer flange are tightened. The cover (16005) on the crank case just above the pump is removed and the bearing housing turned through the whole until a 0.05 mm feeler gauge can be placed between the gear wheels.

The engine is turned and the tooth clearance of the small wheel is checked for every 90º. Afterwards the engine is turned further so that the big wheel can also be checked for every 90º. When the adjustment is correct, i.e. when the minimum clearance is 0.05 mm, the pump is removed again and the unbraco bolts tightened and secured by a wire. A guide pin is bored into the 8 mm hole in the eccentric flange. The guide pin is knocked entirely in and secured with a burr.

REPAIR OF COKED STARTING VALVE

Remove the upper part of the starting valve, whereby the tool (16977-1) and the drawing tool for nozzle holder (16978) can be mounted as shown on the drawing.

For loosening of the valve, Caramba or equal is used.

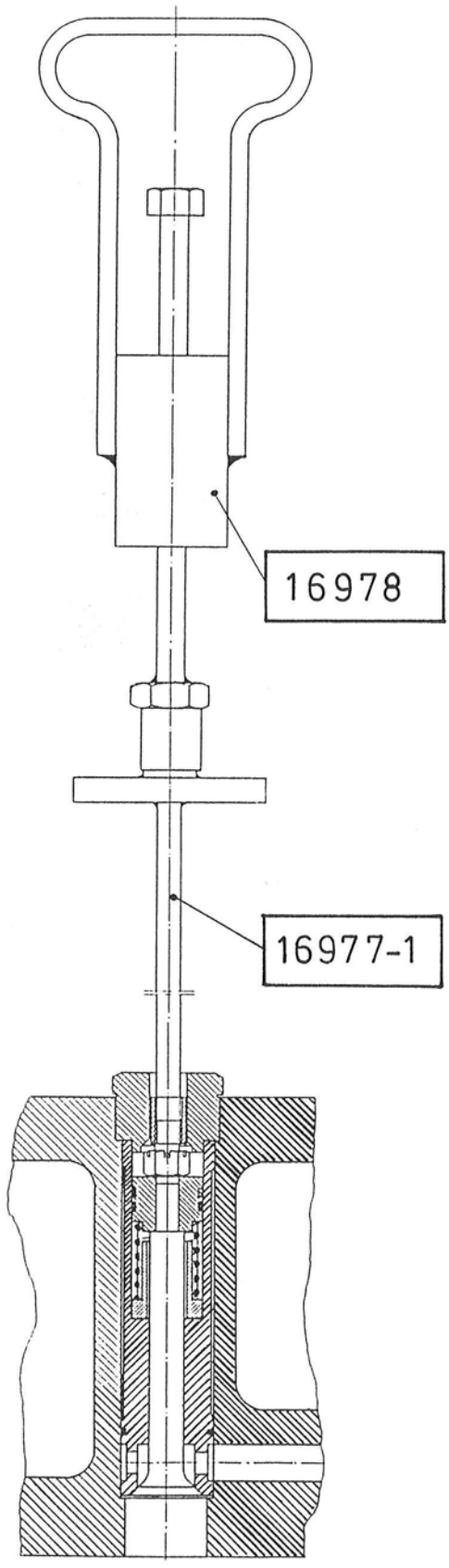
By means of the tool for drawing of nozzle holder, the starting valve can be stroken loose.

When the valve is sufficiently loose to be moved by hand, the drawing tool should be removed.

Now the starting valve must be moved up and down by means of the tool (16977-1), until the spring can draw the valve back to its position.

Finally lubricate the valve with oil.

NB! The motion of the valve is only 2 - 5 mm.

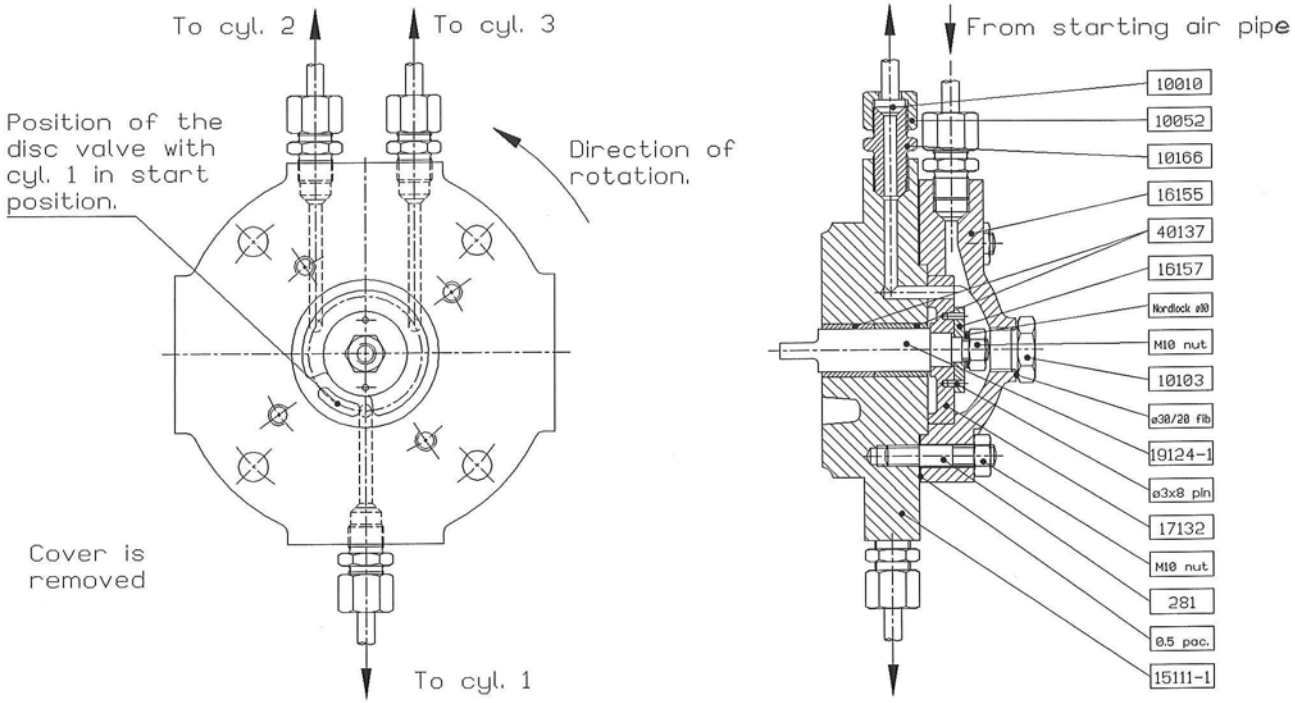


Dismounting of starting valve

If the starting valve is to be repaired or exchanged, the whole starting valve arrangement can be removed as stated on 7-207.

NB! On older engines it is necessary to dismount the cylinder head and to pull the starting valve out at the bottom.

REPAIR OF STARTING AIR DISTRIBUTOR TYPE 427 C
(RUNNING CLOCKWISE)



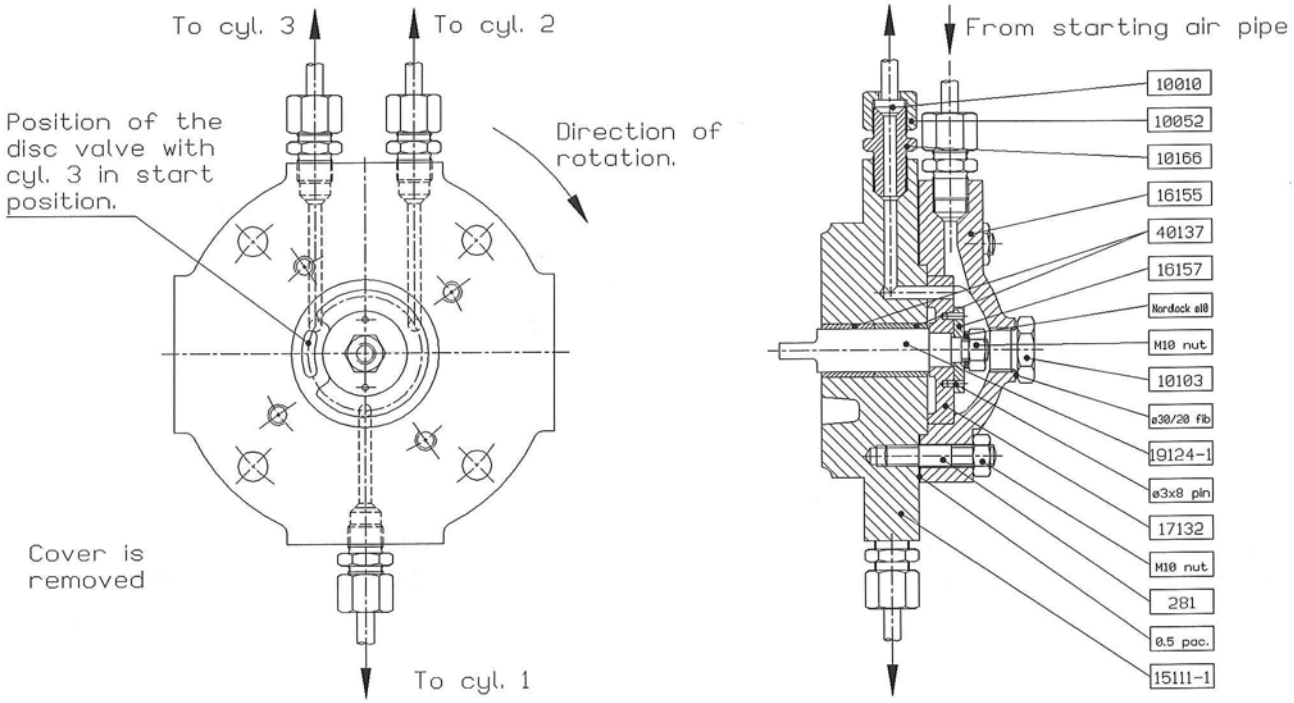
For maintenance of the starting air distributor, the cover (16155) has to be dismounted and the disc valve (17132) to be lubricated on the sealing face.

Mounting of new disc valve or journal

On the sketch the position of the disc valve is shown with cylinder 1 in start position. There has to be an overlap of 0.5 - 1.0 mm between the bore for the starting air pipe and the recess in the disc valve. When this is in order, the breaking pins can be bored in.

NOTE! As the engine is a four-stroke engine, one cannot be sure that cylinder no. 1 is in starting position even though the top mark for cylinder 1 is at the top, as it may be one revolution wrong. The easiest way to check this is by dismounting the pressure pipe on fuel pump no. 1, giving full index to the fuel pumps and turning the engine past the top position for cylinder no.1. If fuel gets out of the pump, it is the correct position for adjusting the starting air distributor. If no fuel gets out of the pump, the engine must be turned one revolution.

REPAIR OF STARTING AIR DISTRIBUTOR TYPE 427 C
(RUNNING ANTI-CLOCKWISE)



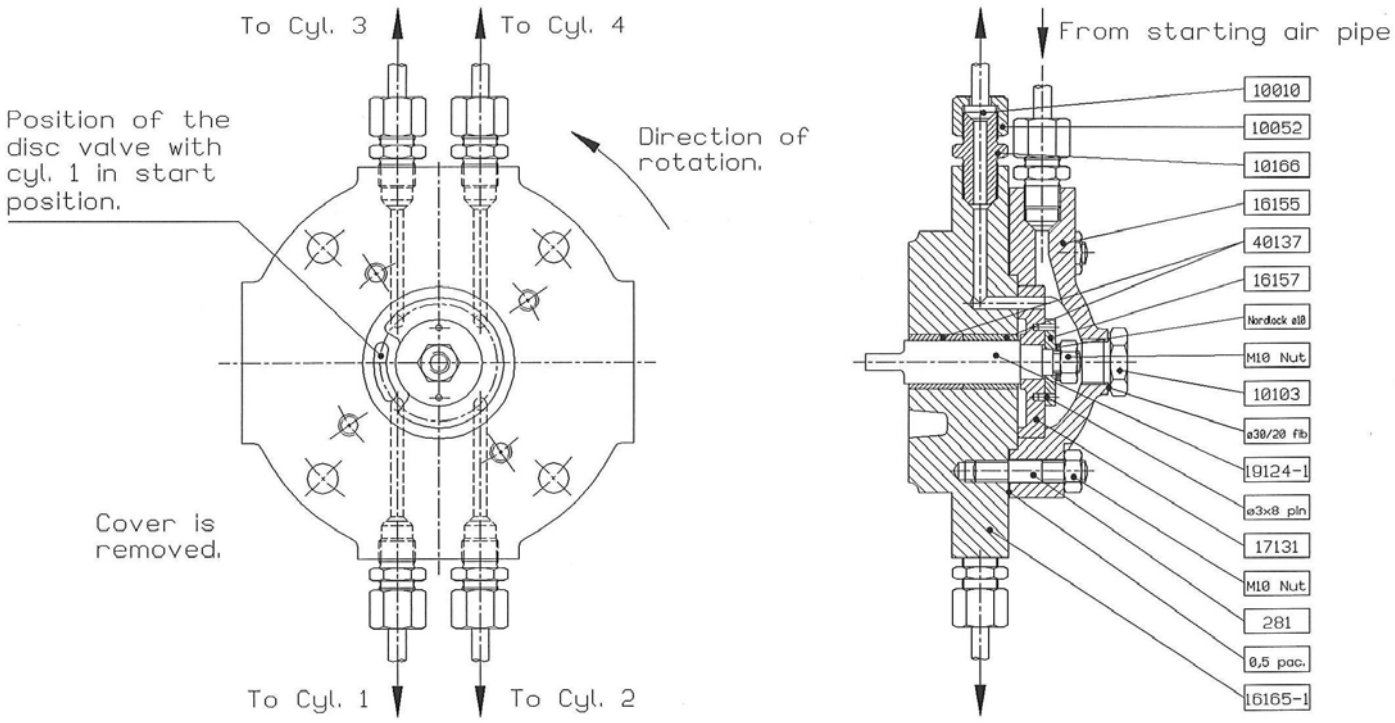
For maintenance of the starting air distributor, the cover (16155) has to be dismounted and the disc valve (17132) to be lubricated on the sealing face.

Mounting of new disc valve or journal

On the sketch the position of the disc valve is shown with cylinder 3 in start position. There has to be an overlap of 0.5 - 1.0 mm between the bore for the starting air pipe and the recess in the disc valve. When this is in order, the breaking pins can be bored in.

NOTE! As the engine is a four-stroke engine, one cannot be sure that cylinder no. 3 is in starting position even though the top mark for cylinder 3 is at the top, as it may be one revolution wrong. The easiest way to check this is by dismounting the pressure pipe on fuel pump no. 3, giving full index to the fuel pumps and turning the engine past the top position for cylinder no.3. If fuel gets out of the pump, it is the correct position for adjusting the starting air distributor. If no fuel gets out of the pump, the engine must be turned one revolution.

REPAIR OF STARTING AIR DISTRIBUTOR TYPE 427 D
(RUNNING CLOCKWISE)



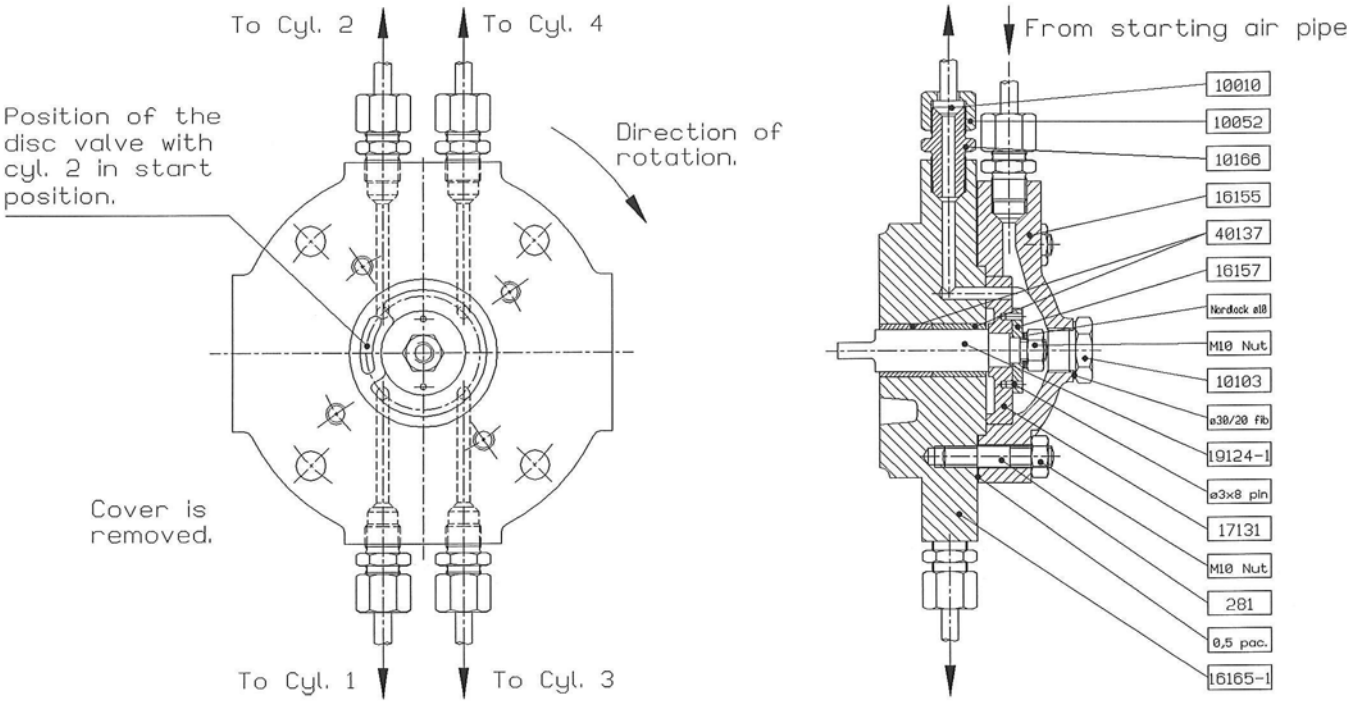
For maintenance of the starting air distributor, the cover (16155) has to be dismounted and the disc valve (17131) to be lubricated on the sealing face.

Mounting of new disc valve or journal

On the sketch the position of the disc valve is shown with cylinder 1 in start position. There has to be an overlap of 0.5 - 1.0 mm between the bore for the starting air pipe and the recess in the disc valve. When this is in order, the breaking pins can be bored in.

NOTE! As the engine is a four-stroke engine, one cannot be sure that cylinder no. 1 is in starting position even though the top mark for cylinder 1 is at the top, as it may be one revolution wrong. The easiest way to check this is by dismounting the pressure pipe on fuel pump no. 1, giving full index to the fuel pumps and turning the engine past the top position for cylinder no.1. If fuel gets out of the pump, it is the correct position for adjusting the starting air distributor. If no fuel gets out of the pump, the engine must be turned one revolution.

REPAIR OF STARTING AIR DISTRIBUTOR TYPE 427 D
(RUNNING ANTI-CLOCKWISE)



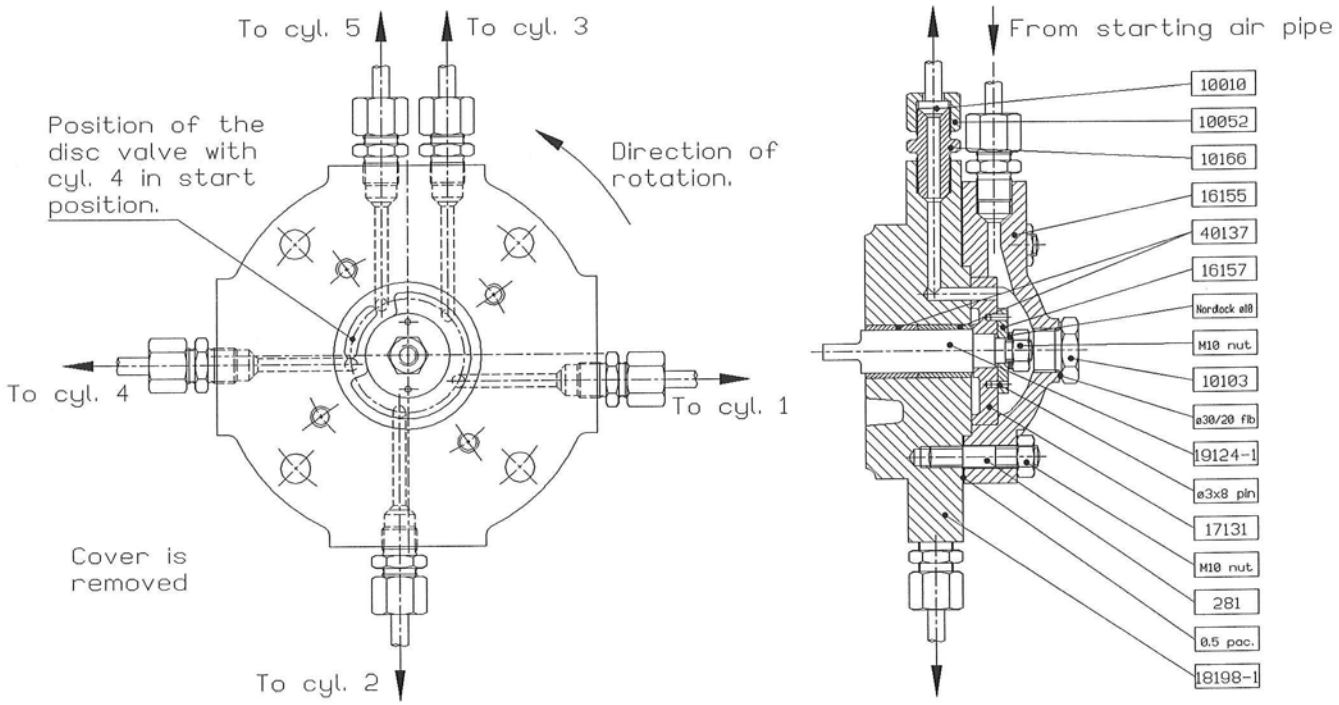
For maintenance of the starting air distributor, the cover (16155) has to be dismounted and the disc valve (17131) to be lubricated on the sealing face.

Mounting of new disc valve or journal

On the sketch the position of the disc valve is shown with cylinder 2 in start position. There has to be an overlap of 0.5 - 1.0 mm between the bore for the starting air pipe and the recess in the disc valve. When this is in order, the breaking pins can be bored in.

NOTE! As the engine is a four-stroke engine, one cannot be sure that cylinder no. 2 is in starting position even though the top mark for cylinder 2 is at the top, as it may be one revolution wrong. The easiest way to check this is by dismounting the pressure pipe on fuel pump no. 2, giving full index to the fuel pumps and turning the engine past the top position for cylinder no.2. If fuel gets out of the pump, it is the correct position for adjusting the starting air distributor. If no fuel gets out of the pump, the engine must be turned one revolution.

REPAIR OF STARTING AIR DISTRIBUTOR TYPE 427 E
(RUNNING CLOCKWISE)



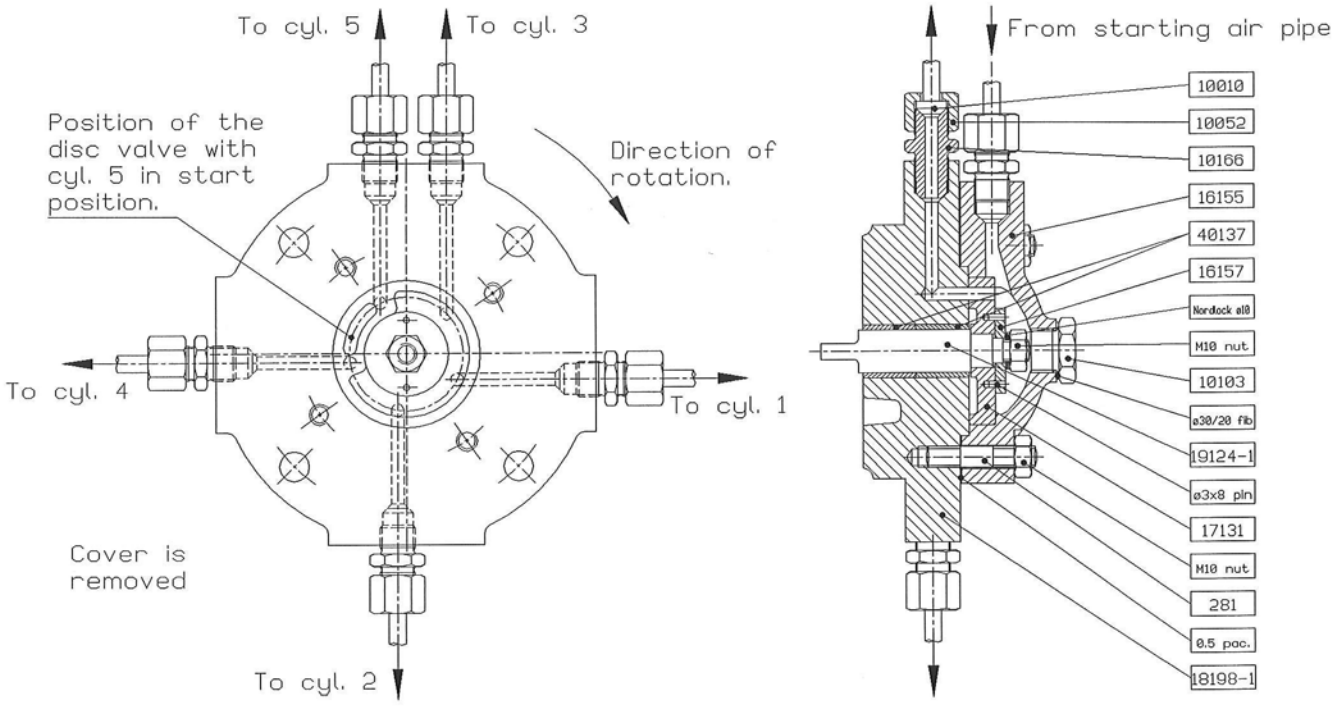
For maintenance of the starting air distributor, the cover (16155) has to be dismounted and the disc valve (17131) to be lubricated on the sealing face.

Mounting of new disc valve or journal

On the sketch the position of the disc valve is shown with cylinder 4 in start position. There has to be an overlap of 0.5 - 1.0 mm between the bore for the starting air pipe and the recess in the disc valve. When this is in order, the breaking pins can be bored in.

NOTE! As the engine is a four-stroke engine, one cannot be sure that cylinder no. 4 is in starting position even though the top mark for cylinder 4 is at the top, as it may be one revolution wrong. The easiest way to check this is by dismounting the pressure pipe on fuel pump no. 4, giving full index to the fuel pumps and turning the engine past the top position for cylinder no.4. If fuel gets out of the pump, it is the correct position for adjusting the starting air distributor. If no fuel gets out of the pump, the engine must be turned one revolution.

REPAIR OF STARTING AIR DISTRIBUTOR TYPE 427 E
(RUNNING ANTI-CLOCKWISE)



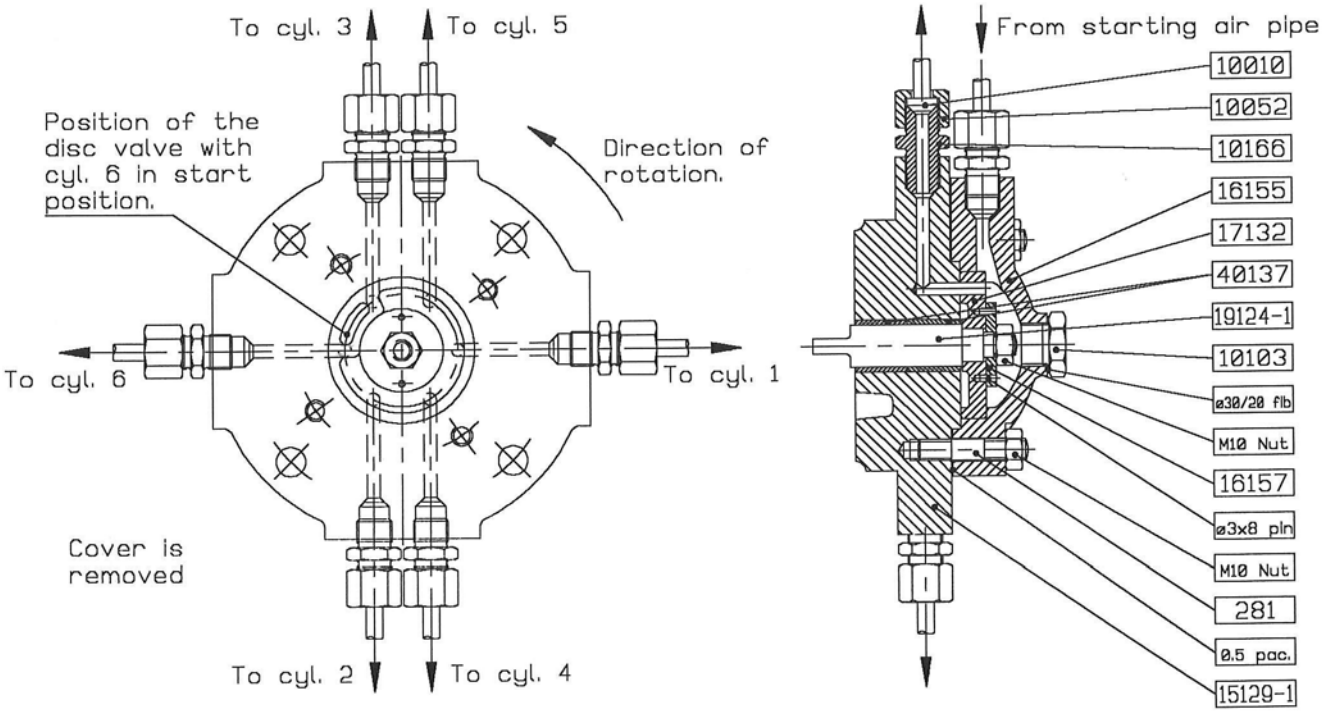
For maintenance of the starting air distributor, the cover (16155) has to be dismounted and the disc valve (17131) to be lubricated on the sealing face.

Mounting of new disc valve or journal

On the sketch the position of the disc valve is shown with cylinder 5 in start position. There has to be an overlap of 0.5 - 1.0 mm between the bore for the starting air pipe and the recess in the disc valve. When this is in order, the breaking pins can be bored in.

NOTE! As the engine is a four-stroke engine, one cannot be sure that cylinder no. 5 is in starting position even though the top mark for cylinder 5 is at the top, as it may be one revolution wrong. The easiest way to check this is by dismounting the pressure pipe on fuel pump no. 5, giving full index to the fuel pumps and turning the engine past the top position for cylinder no.5. If fuel gets out of the pump, it is the correct position for adjusting the starting air distributor. If no fuel gets out of the pump, the engine must be turned one revolution.

REPAIR OF STARTING AIR DISTRIBUTOR TYPE F
(RUNNING CLOCKWISE)



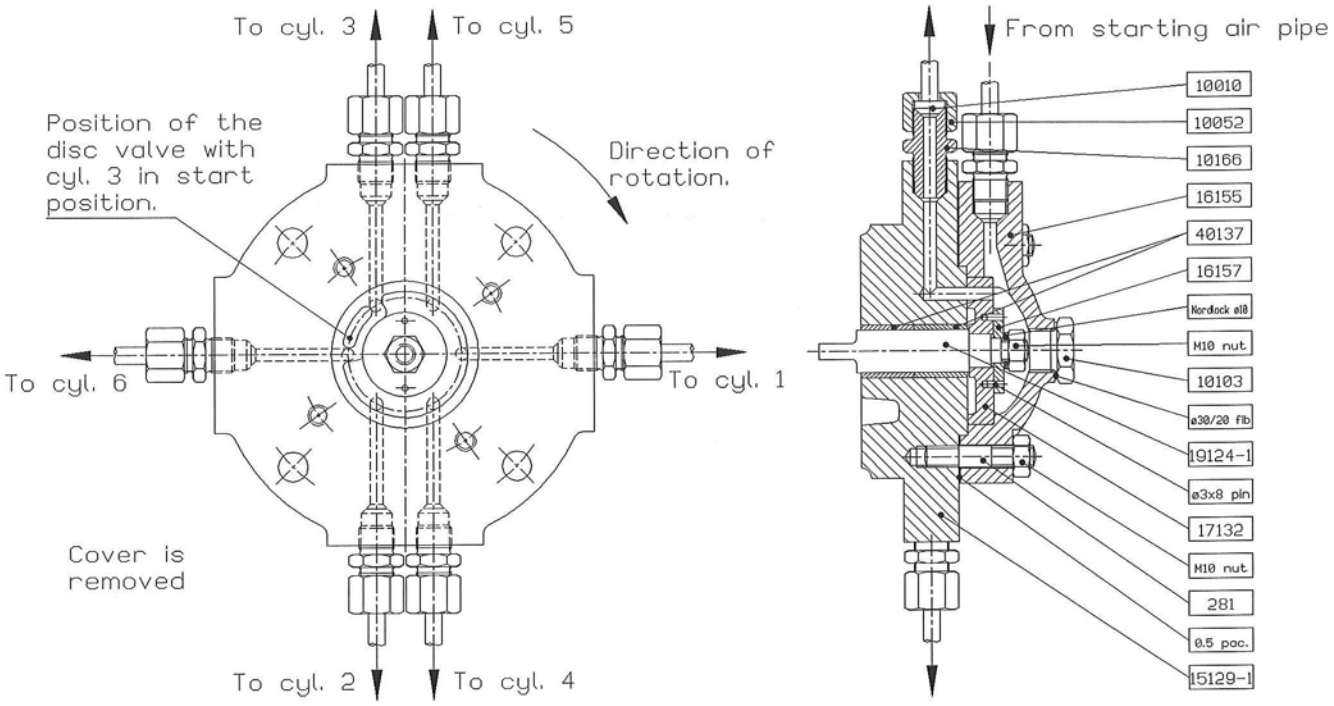
For maintenance of the starting air distributor, the cover (16155) has to be dismounted and the disc valve (17132) to be lubricated on the sealing face.

Mounting of new disc valve or journal

On the sketch the position of the disc valve is shown with cylinder 6 in start position. There has to be an overlap of 0.5 - 1.0 mm between the bore for the starting air pipe and the recess in the disc valve. When this is in order, the breaking pins can be bored in.

NOTE! As the engine is a four-stroke engine, one cannot be sure that cylinder no. 6 is in starting position even though the top mark for cylinder 6 is at the top, as it may be one revolution wrong. The easiest way to check this is by dismounting the pressure pipe on fuel pump no. 6, giving full index to the fuel pumps and turning the engine past the top position for cylinder no.6. If fuel gets out of the pump, it is the correct position for adjusting the starting air distributor. If no fuel gets out of the pump, the engine must be turned one revolution.

REPAIR OF STARTING AIR DISTRIBUTOR TYPE 427 F
(RUNNING ANTI-CLOCKWISE)



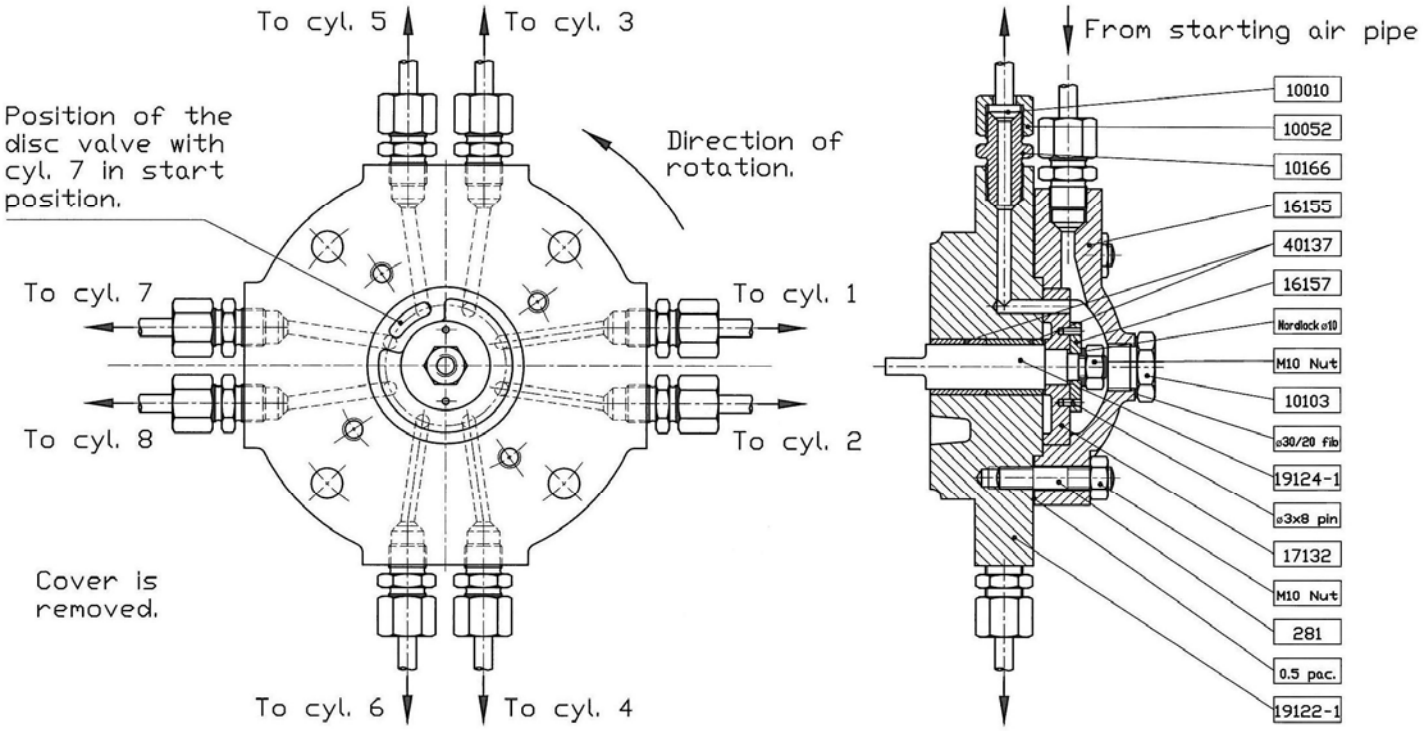
For maintenance of the starting air distributor, the cover (16155) has to be dismounted and the disc valve (17132) to be lubricated on the sealing face.

Mounting of new disc valve or journal

On the sketch the position of the disc valve is shown with cylinder 3 in start position. There has to be an overlap of 0.5 - 1.0 mm between the bore for the starting air pipe and the recess in the disc valve. When this is in order, the breaking pins can be bored in.

NOTE! As the engine is a four-stroke engine, one cannot be sure that cylinder no. 3 is in starting position even though the top mark for cylinder 3 is at the top, as it may be one revolution wrong. The easiest way to check this is by dismounting the pressure pipe on fuel pump no. 3, giving full index to the fuel pumps and turning the engine past the top position for cylinder no.3. If fuel gets out of the pump, it is the correct position for adjusting the starting air distributor. If no fuel gets out of the pump, the engine must be turned one revolution.

REPAIR OF STARTING AIR DISTRIBUTOR TYPE 427 H
(RUNNING CLOCKWISE)



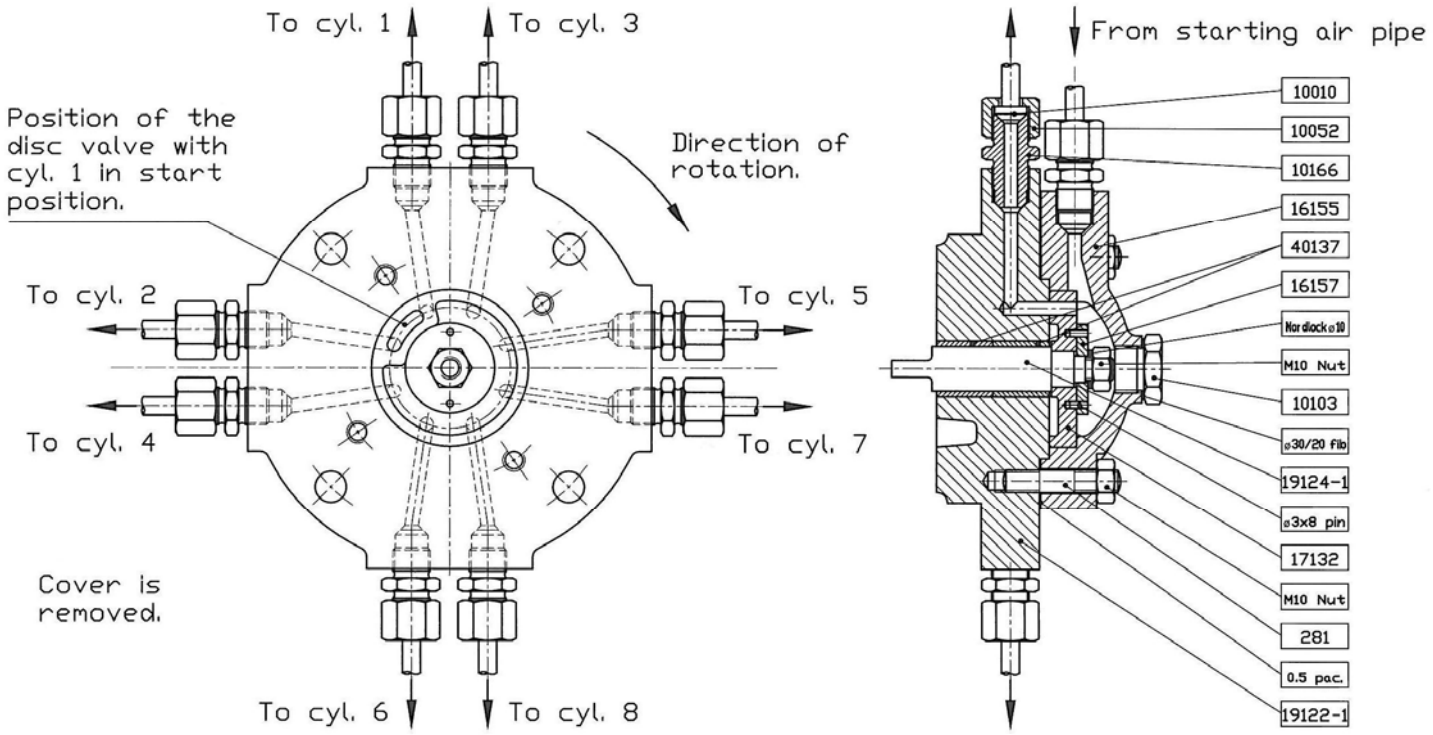
For maintenance of the starting air distributor, the cover (16155) has to be dismounted and the disc valve (17132) to be lubricated on the sealing face.

Mounting of new disc valve or journal

On the sketch the position of the disc valve is shown with cylinder 7 in start position. There has to be an overlap of 0.5 - 1.0 mm between the bore for the starting air pipe and the recess in the disc valve. When this is in order, the breaking pins can be bored in.

NOTE! As the engine is a four-stroke engine, one cannot be sure that cylinder no. 7 is in starting position even though the top mark for cylinder 7 is at the top, as it may be one revolution wrong. The easiest way to check this is by dismounting the pressure pipe on fuel pump no. 7, giving full index to the fuel pumps and turning the engine past the top position for cylinder no.7. If fuel gets out of the pump, it is the correct position for adjusting the starting air distributor. If no fuel gets out of the pump, the engine must be turned one revolution.

REPAIR OF STARTING AIR DISTRIBUTOR TYPE 427 H
(RUNNING ANTI-CLOCKWISE)

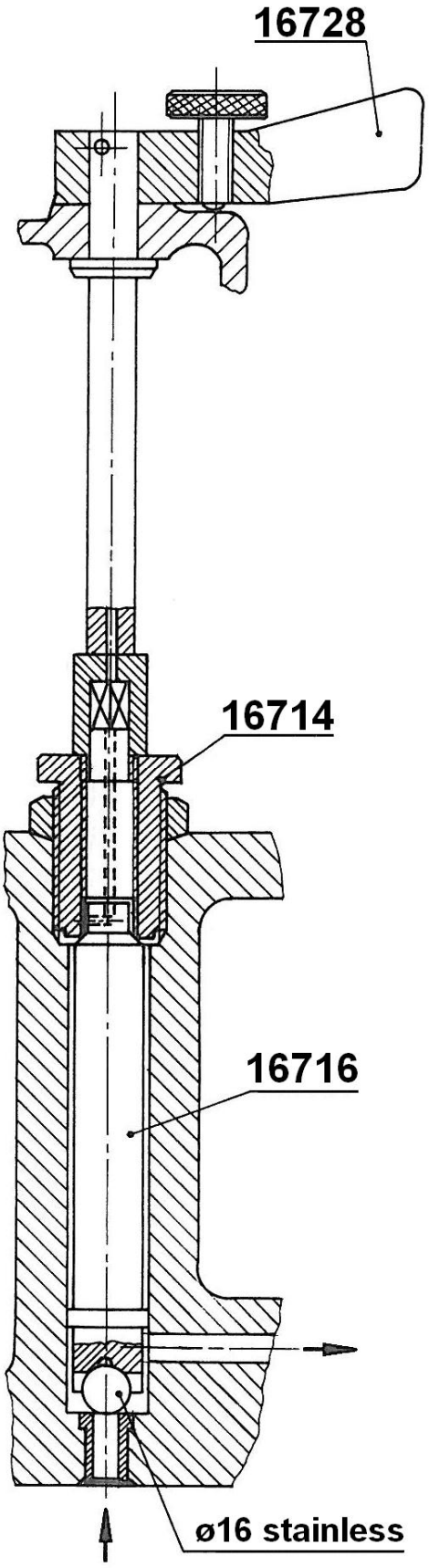


For maintenance of the starting air distributor, the cover (16155) has to be dismounted and the disc valve (17132) to be lubricated on the sealing face.

Mounting of new disc valve or journal

On the sketch the position of the disc valve is shown with cylinder 1 in start position. There has to be an overlap of 0.5 - 1.0 mm between the bore for the starting air pipe and the recess in the disc valve. When this is in order, the breaking pins can be bored in.

NOTE! As the engine is a four-stroke engine, one cannot be sure that cylinder no. 1 is in starting position even though the top mark for cylinder 1 is at the top, as it may be one revolution wrong. The easiest way to check this is by dismounting the pressure pipe on fuel pump no. 1, giving full index to the fuel pumps and turning the engine past the top position for cylinder no.1. If fuel gets out of the pump, it is the correct position for adjusting the starting air distributor. If no fuel gets out of the pump, the engine must be turned one revolution.



DESCRIPTION OF CHARGING VALVE

For charging of the starting air receivers there is usually placed a charging valve on each engine.

Mode of operation

The valve is opened by turning the handle (16728) 3/8 turn to the left. Thereby the spindle (16716) is lifted so that the ball can move up and down, and at the same time the air supply upwards is closed as the upper breast of the spindle is pressed up against the union (16714).

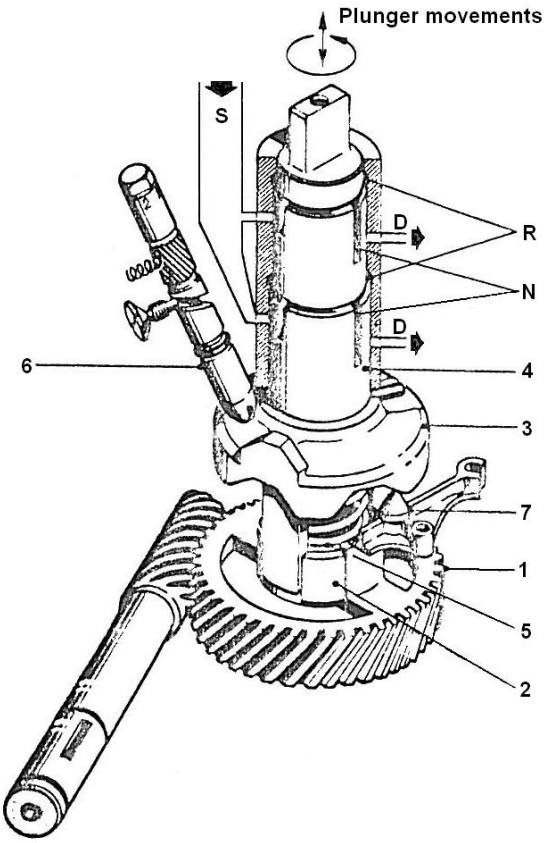
Ball as well as seat and spindle are made of stainless steel.

The valve is now automatic as the ball is lifted and air flows into the air receiver when the pressure in the cylinder of the engine is higher than the pressure in the receiver.

During the suction stroke of the cylinder in question the pressure in the cylinder is lower than the pressure in the air receiver, and the ball will automatically close against the seat and prevent air from flowing from the receiver into the cylinder.

OPERATING INSTRUCTIONS FOR DELIMON GREASE LUBRICATING PUMP

The Delimon grease lubricating pump type FZ-A is a single plunger pump with 8 outlets. The pump is driven by means of an oscillating lever via an intermediate driver, whereby the transmission between the drive shaft and the pumps will be 50:1.



1. MODE OF OPERATION

On the upper side of the worm gear (1), which is driven by the engine, there are two followers, in the recess of which a cross-piece (2) engages. A cam plate (3) engages with the cross-piece. The cam plate is positively connected to the plunger (4). The spring (5), located between the cross-piece and the cam plate, exercises an upwards force onto the cam plate. On the upper side of the cam plate there is a cam which - as the cam plate rotates - operates six adjustable spindles arranged round the periphery of the pump and causes a suction stroke of the plunger each time.

The lubricant is fed under slight pressure to the pump suction chamber (S).

On the lower side of the cam plate are six further cams which - as the cam plate rotates - operate a pressure cam (7) in the pump housing, each time causing the plunger to execute a compression.

The shaft has two sets of three vertical slots (N) which two by two terminate in an annular channel (R). During the suction stroke, lubricant is drawn from the suction chamber (S) into the vertical slots in the plunger and from there into the annular channels (R).

During the compression stroke, the lubricant is forced out of the annular channel via a vertical slot into the pressure channel (D).

Normally, the pump can operate against a back-pressure of 75 bar, or 100 bar for a short period.

2. CONSTRUCTION OF THE PUMP

Reservoir

The metal reservoir is usually available with a capacity of 6 litres. The cover can be opened and if necessary secured against unwanted opening by means of a padlock.

The reservoir contains a feed unit (9) which consists of a scraper to scrape grease off the reservoir walls and a worm conveyor to make a slight pressure in the pump suction chamber.

A strainer is fitted in the basis of the reservoir to present dirt from getting into the pump suction chamber.

Pump body
The pump body contains a control sleeve (14) to guide the plunger and for each outlet an adjustable spindle (27) to preset the stroke of the plunger and consequently the quantity delivered. The allowable number of revolutions of the feed piston is max 6 rpm when it is oscillatting lever driven.

Driving power
The piston water pump of the main engine is provided with a rocking lever which actuates the oscillating lever (39). Through the actuator unit this causes the worm gear (34) to rotate in the same direction always, regardless of the direction of rotation of the drive shaft.

Numbers on this page refer to the drawing on page 4.

3. STARTING UP

Installation and connection of the lubricating pump
Install the pump vertically and fix it in position. The oscillating lever should be connected to the rocking lever on the piston water pump of the engine.

Filling lubricant reservoir and piping
Clean all piping carefully by tapping and purging and pre-charge with clean grease prior to installation using a grease gun. When starting up for the first time, it is recommended to fill the grease reservoir up to the strainer with oil and the fill up with grease. Otherwise the pump has to go for some time in order to bleed the system.

Before connecting up the piping, run the pump at full output until grease issues evenly and air-free from each outlet. Connect the lines to the pump (using the sealing rings supplied) and run the pump until air-free grease issues. Fill the bearing to be lubricated with grease and connect the lines to the lubrication points. The installation is then ready to start up as soon as the quantity of lubricant to be delivered has been preset to the required level.

Is a single outlet not used, you could either carry it back to the reservoir or assemble it with another outlet. **Not used pipe connections must never be closed** as in such a case leakages could arise in the pump. On pumps which is delivered with closed outlets there are not to be made any changes, changing of fittings etc.

Adjustment of the quantity delivered
At maximum delivery, equalling 0,1 cm^3 lubricant per outlet and plunger stroke, the mark on the outlet number plate is facing the figure 4 stamped on the head of the adjustable spindle (27). Turning the spindle clockwise reduces the quantity. Avoid reducing below 1/5 of maximum quantity. On pumps having 7 to 12 outlets, each adjustable spindle controls the quantity of two outlets, one above the other.

The arrow on the outlet number plate indicates the outlet ports associated with the adjustable spindle.

By changing the drive speed or the internal transmission ratio of the pump, or by changing the angle of the oscillating lever, the quantity by each outlet - and consequently the total quantity - can be varied.

4. MAINTENANCE

Filling the grease reservoir

As soon as about three quarters of the contents of the reservoir have been used up, the reservoir should be refilled. The level of grease should never be allowed to drop so low that the feed worm is exposed, otherwise air may get into the lines. When filling, ensure that clean grease only is used and that no dirt gets into the reservoir when the cover is opened, otherwise it may result in operating problems .

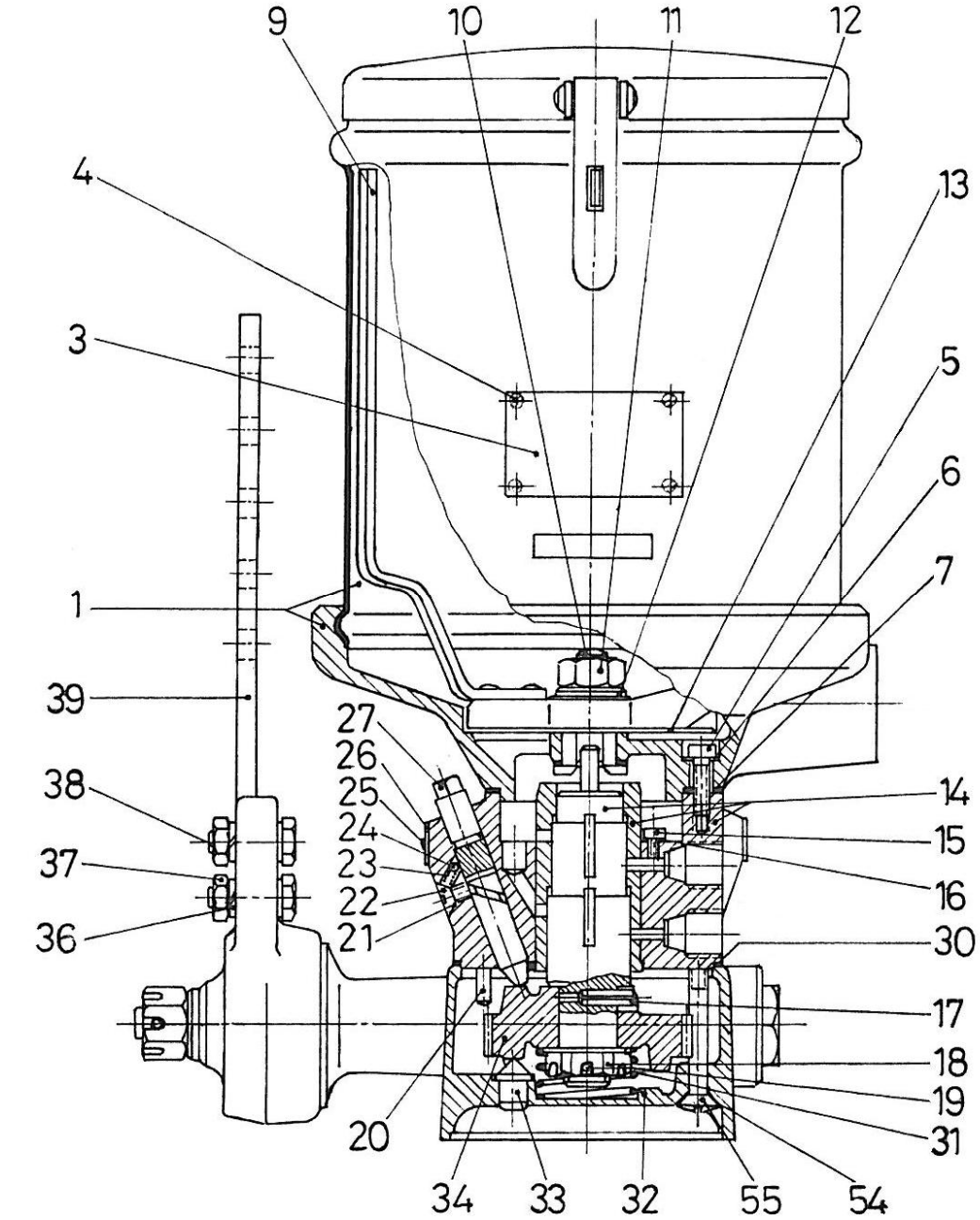
Always use a EP2 grease with a consistency of 00-0-1-2. Recommended lubricants - see sheet no 7-98.

Cleaning of strainer and lubricating pump

The strainer should be cleaned at equal intervals as dirt from the grease might have settled. After loosening the nut and lifting the grease scraper, it is easy to dismount the strainer. It is recommended to clean all parts of the pump thoroughly in kerosene once a year. After cleaning all parts should be lubricated in oil before refitting.

Parts list

1	Container with neck ring	26	Label
3	Label	27	Adjusting spindle
4	Cheese head screw	30	Cylinder tightening
5	Cheese head screw	31	Pressure spring
6	Spring ring	32	Gear housing
7	Packing	33	Pressure cams
9	Feeder 6 litre	34	Worm wheel i = 54:1
10	Catch bolt	36	Spring ring
11	Hexagon nut	37	Hexagon nut
12	Disc	38	Hexagon headed screw
13	Strainer	39	Steering knuckle arm
14	Cylinder with bush and piston	40	Screw plug
15	Cheese head screw	41	Drive shaft i = 54:1
16	Tightening ring	42	Burst ring
17	Spacer bushing	43	Disc
18	Slotted nut	44	Distance bush
19	Spacer bushing	45	Disc
20	Slotted pin	46	Slotted nut
21	Tightening ring	47	Spacer bushing
22	Stud	48	Woodruf key
23	Pressure spring	49	Catch housing
24	Ball	54	Conical tightening ring
25	Semi-circular slotted pin	55	Filister screw head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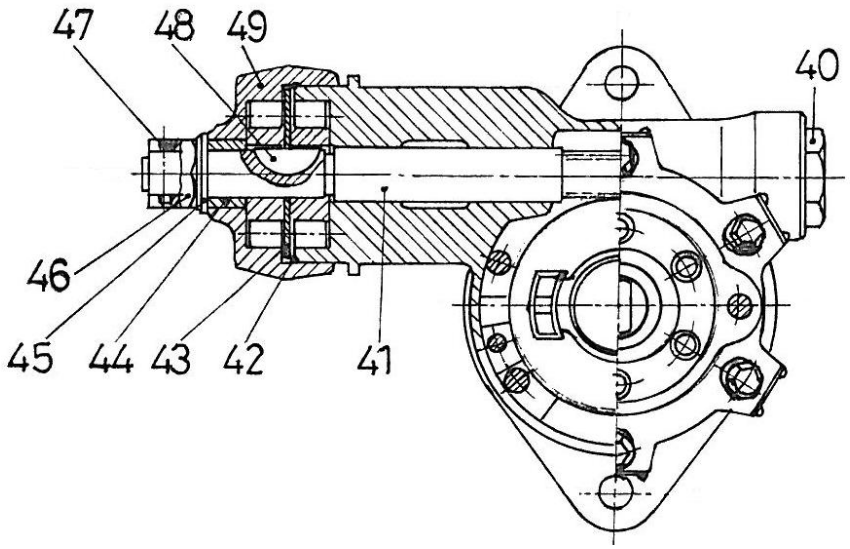
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ANBEFALEDE SMØREMIDLER FOR
DELIMON FEDTSMØREPUMPE TYPE FZ

RECOMMENDED LUBRICANTS FOR
DELIMON GREASE LUBRICATION PUMP TYPE FZ

EMPFEHLENSWERTE SCHMIERMITTEL FÜR
DELIMON FETTSCHMIERPUMPE TYP FZ

FABRIKAT / MAKE	***FEDTTYPE / GREASE TYPE / FETT TYP***	***BASE***	***PENETRATION NLGI/ASTM***
BP	Energrease LS2	Lithium	265 - 295
CASTROL	Spheerol AP3	Lithium	235
	Impervia CS	Calcium	280
CHEVRON	Industrial Grease Heavy	Syntetisk natrium	250
ESSO	Beacon 3	Lithium	240
GULF	Gold Crown EP Grease 2	Lithium	270
MOBIL	Mobilux Grease No 2	Lithium	265 - 295
SHELL	Alvania R3	Lithium	220 - 250
TEXACO	Multifak EP2	Lithium	265 - 295

NLGI / ASTM - Penetration No.

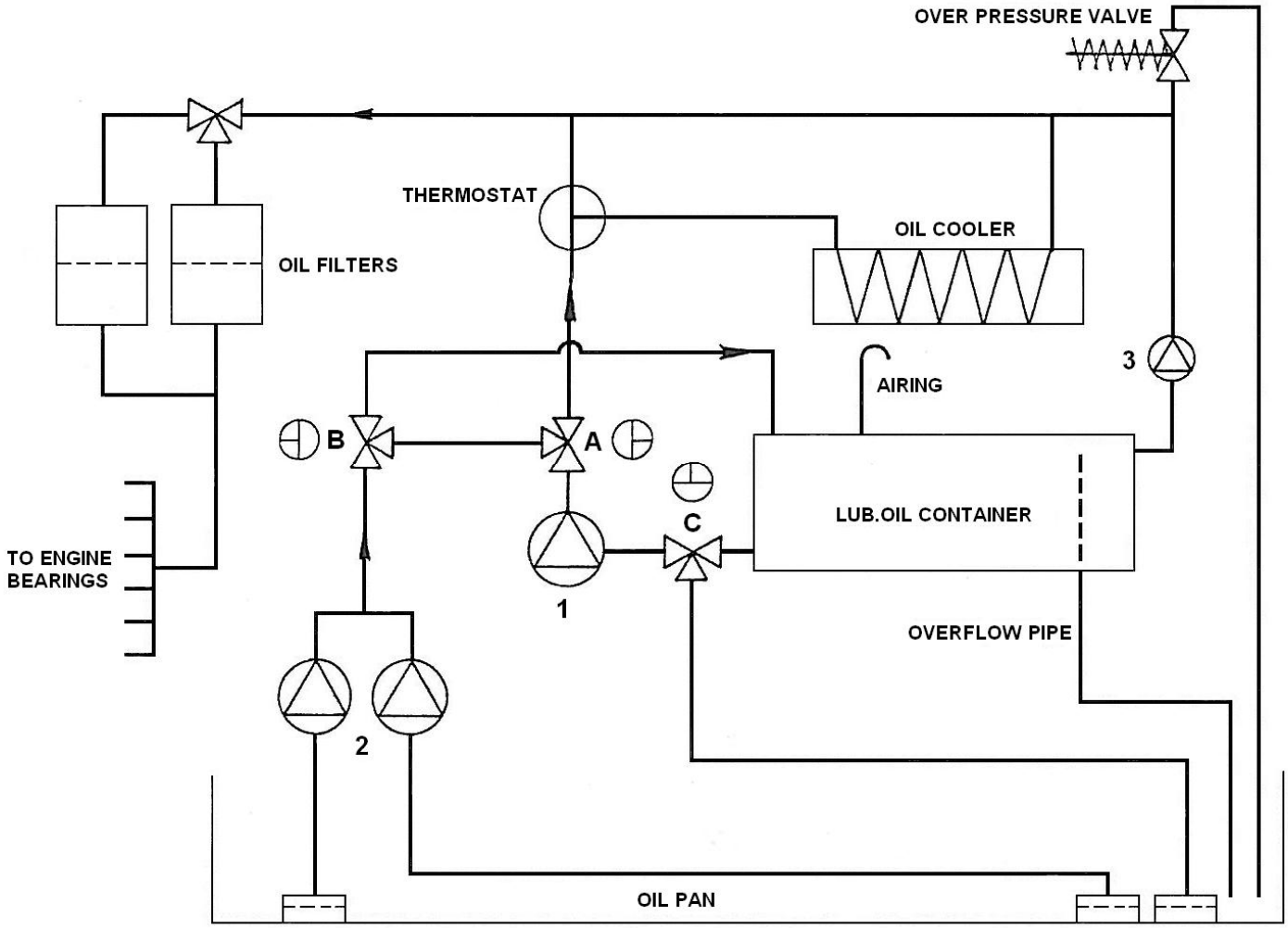
000	445 - 475
00	400 - 430
0	355 - 385
1	310 - 340
2	265 - 295
3	220 - 250
4	175 - 205
5	130 - 160
6	85- 115

Tilsvarende smøremidler fra andre anerkendte oliefirmaer kan også benyttes.

Equivalent grades of lubricants from other recognized oil companies may also be used.

Entsprechende Schmiermittel von anderen anerkannten Ölfirmen können auch benutzt werden.

LUBRICATING OIL DIAGRAMME TYPE 427



		C - D	E - F	H
1.	Forward pump - capacity m³/h	2.3	4.0	6,0
2.	Return oil pump - capacity m³/h	2.45	4.25	6.5
3.	Hand pump - capacity m³/h			

Normal drive
Usually, the engine has dry sump, and the 3 three-way cocks A, B and C must be in the positions shown in the diagramme.

Forward pump out of service
The engine must now run with wet sump and the necessary oil is led down from the oil container to the oil pan through three-way cock C. Three-way cocks A and B should be placed in a position enabling the return oil pump to send oil through both three-way cocks to the oil cooler.

Return oil pump out of service
In this case, too, the engine must run with wet sump and the oil is led from the oil container to the oil pan through cock C. When the necessary quantity of oil has been led down, cock C is placed in a position enabling the forward pump to suck direct from the oil pan. Cocks A and B remain in the positions shown in the diagramme.

LUBRICATING OIL REGULATIONS

LUBRICATING OIL
For lubrication of the engine, a good grade diesel engine oil which is highly self-purifying, a socalled D3 oil, should be used. Such an oil can be supplied by all recognized oil companies. All the year round, an oil with a viscosity corresponding to SAE 30 should be applied. It is important that the oil has a high flash point and can emulsify with water. The TBN-figure must not exceed 15, depending on the sulphur contents of the fuel.

CLUTCH OIL:
A special hydraulic oil should be used as stated below.

PROPELLER HEAD AND PULL ROD
Water-emulsifying oil, e.g. sterntube oil ESSO 460. Kinematic viscosity 400 cSt at 40ºC.

STERNTUBE GREASE
Use a thin (soft) special sterntube grease, which can emulsify with water. This grease can also be applied to the other grease cups.

OIL LUBRICATED STERNTUBE WITH "SUBLIME" PACKING GLANDS:
Same oil as the engine.

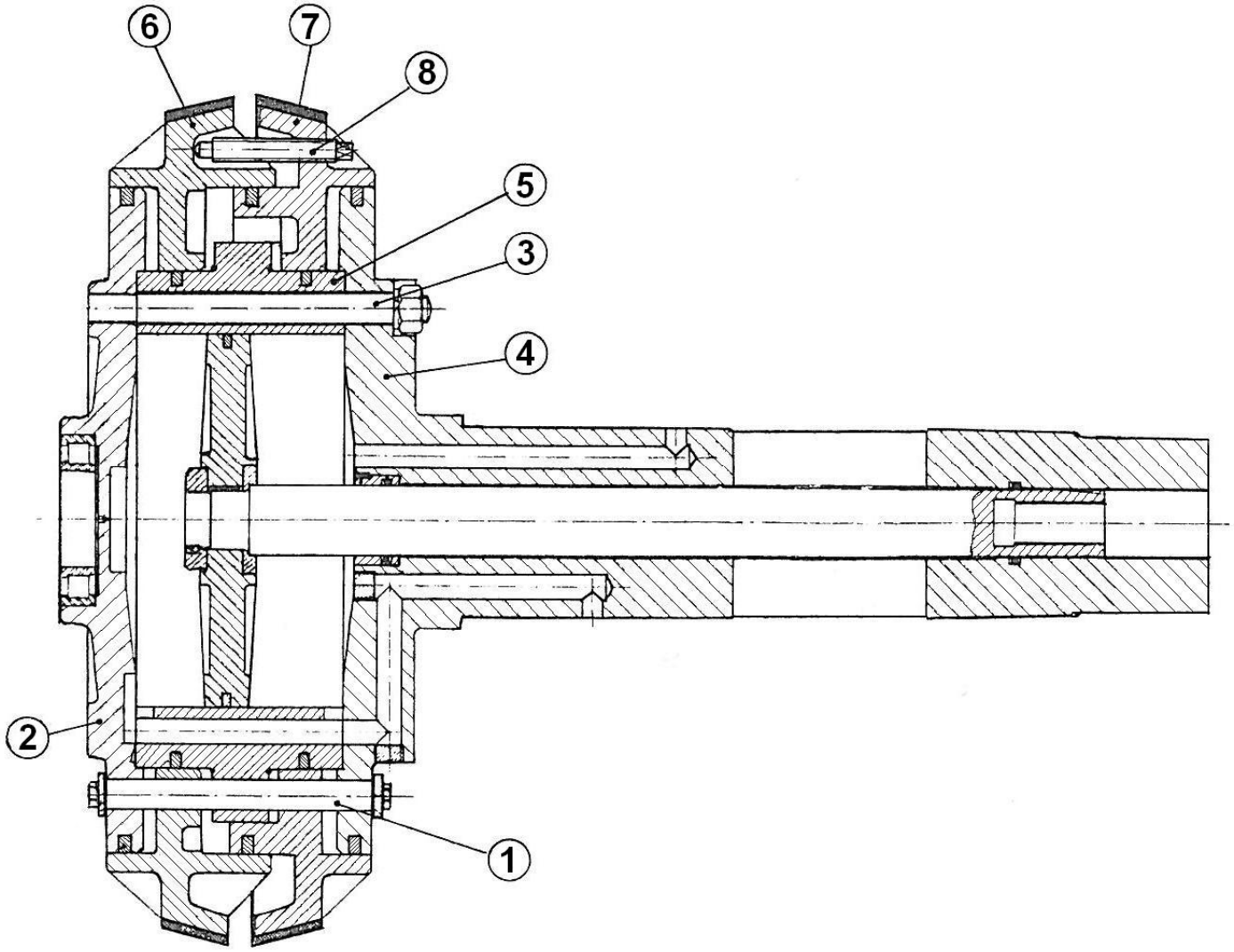
GREASE FOR AUTOMATIC GREASE GUN (DE LIMON):
As stated below.

THE FOLLOWING OILS CAN BE USED FOR CALLESEN MARINE DIESEL ENGINES (4-STROKE) TYPES 422, 425 AND 427:

MAKE	***ENGINE AND OIL LUBRICATED STERNTUBE***	***CLUTCH***
ESSO = EXXON	EXXMAR 12 TP 30	NUTO H 68
STATOIL	MARWAY 1230	HYDRAWAY HM 68
Q8	MOZART DP 30	HAYDN 68
BP	ENERGOL DS 3-103	ENERGOL HLP 68
SHELL	RIMULA 30	TELLUS 33
CHEVRON	DELO 300 SAE 30	OC TURBINE OIL 68
MOBIL	MOBILGARD 312	DTE HEAVY MEDIUM
GULF	SUPER DUTY SAE 30	HARMONY 68
TEXACO	TARO DP 30 or XD 30	REGAL (R&O) 68
CASTROL	MARINE MLC 30	HYSPIN AWH-M 68
TOTAL	DISOLA M 3015	TURBINE T 68

	TURBOCHARGER AND WOODWARD GOVERNOR	***AUTOMATIC GREASE GUN***
ESSO = EXXON	NUTO H 68	BEACON EP 2
STATOIL	HYDRAWAY HM 68	UNIWAY EP 2
BP	ENERGOL THB 68 or BARTRAN HV 68	ENERGREASE MM-EP 2
SHELL	TURBO OIL T 78	ALVANIA R 3
CHEVRON	OC TURBINE OIL 68	INDUSTRIAL GREASE HEAVY
MOBIL	DTE HEAVY MEDIUM	MOBILUX EP 2
GULF	HARMONY 68	GOLD CROWN EP GREASE 2
TEXACO	REGAL (R&O) 68	MULTIFAK EP 2
CASTROL	HYSPIN AWH-M 68	SPHEEROL AP 3
TOTAL	TURBINE T 68	CERAN WR 2

REPLACING WORN OUT CATCH BOLTS IN CLUTCH



If the catch bolts (1) and the holes, respectively, are worn out to such an extent that the oil leakage is becoming to large, the bolts have to be replaced by new oversize bolts.

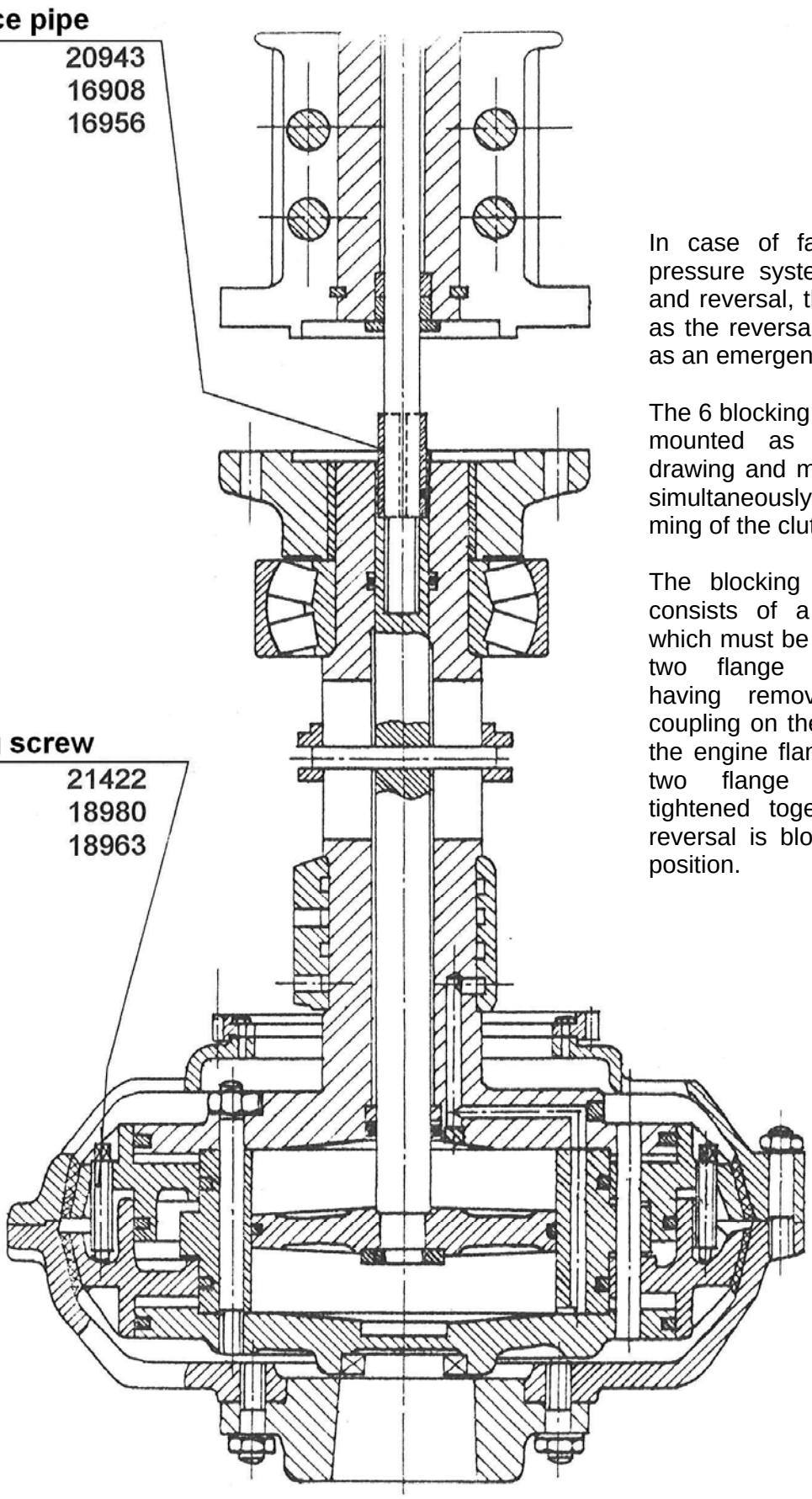
The following procedure must be used:

Cover (2), reversing cylinder (5) and clutch shaft (4) are bolted together by means of the studs (3), and the clutch cones (6) and (7) are unbolted by means of the blocking bolts (8) after having mounted only one of the catch bolts in order to control the holes in relation to each other.

Subsequently, a single hole is drilled by an oversize drill, whereafter it is reamed by an oversize reamer.

Now, an oversize bolt is put into the new hole and the next bolt can be adjusted.

BLOCKING INSTRUCTIONS FOR CLUTCH AND REVERSAL

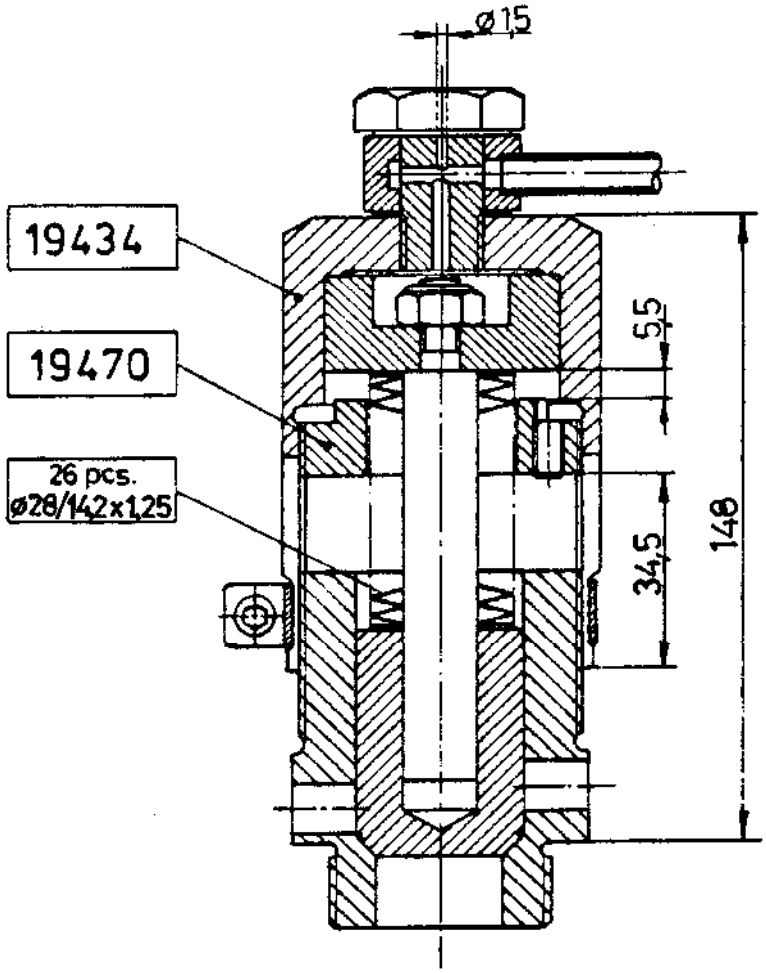


In case of failure of the oil pressure system in the clutch and reversal, the clutch as well as the reversal can be blocked as an emergency arrangement.

The 6 blocking screws are to be mounted as shown on the drawing and must be tightened simultaneously to avoid jamming of the clutch cones.

The blocking of the reversal consists of a two-piece pipe which must be laid between the two flange couplings after having removed the flange coupling on the sternshaft from the engine flange. When these two flange couplings are tightened together again, the reversal is blocked in "Ahead" position.

TWO-STEP OVERFLOW VALVE



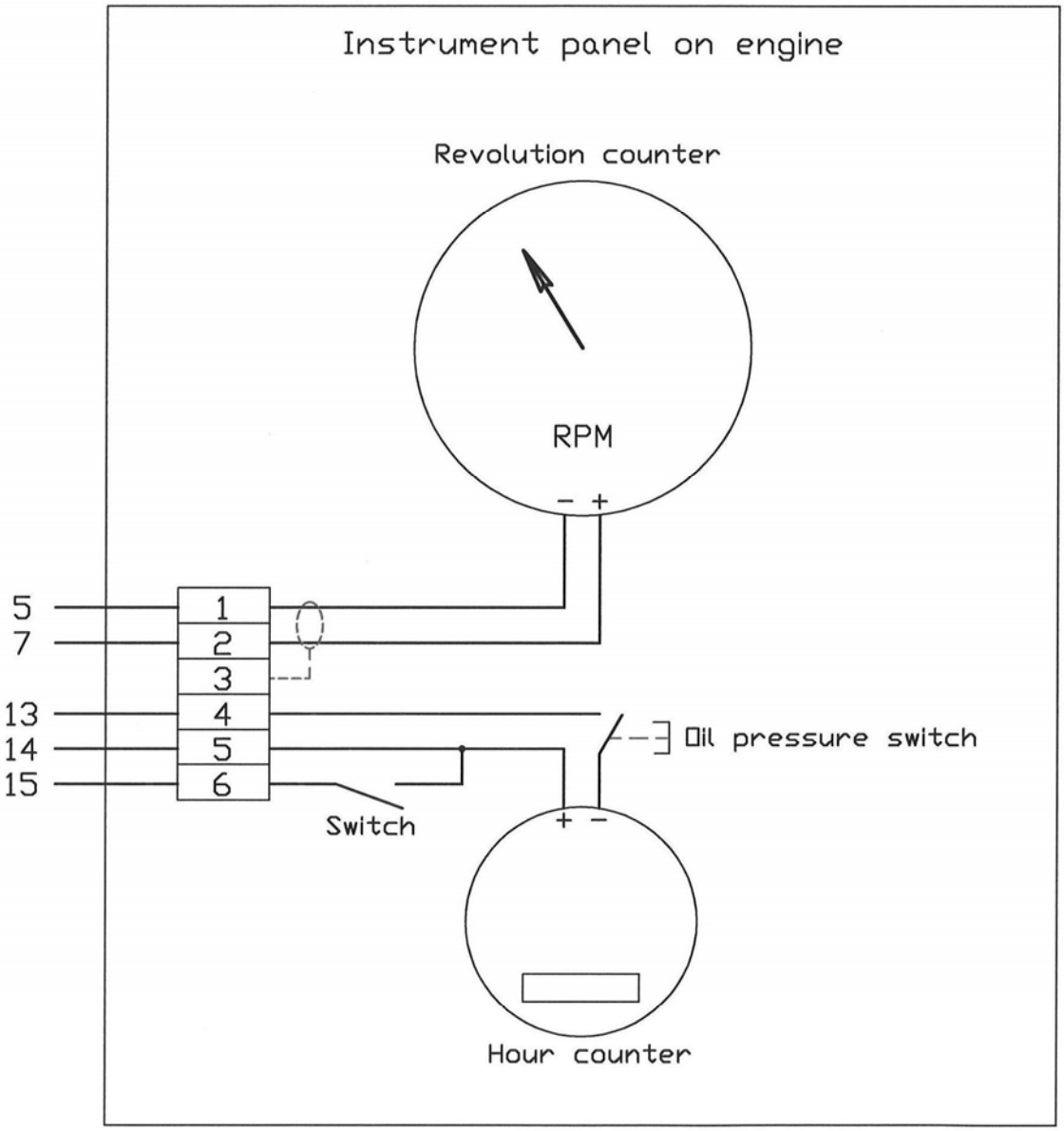
Mode of Operation

The valve is a two-step overflow valve. It is functioning by means of the pressure available in the hydraulic system which rises when the oil is fed into the cylinder head. This is done during the reversing manoeuvre.

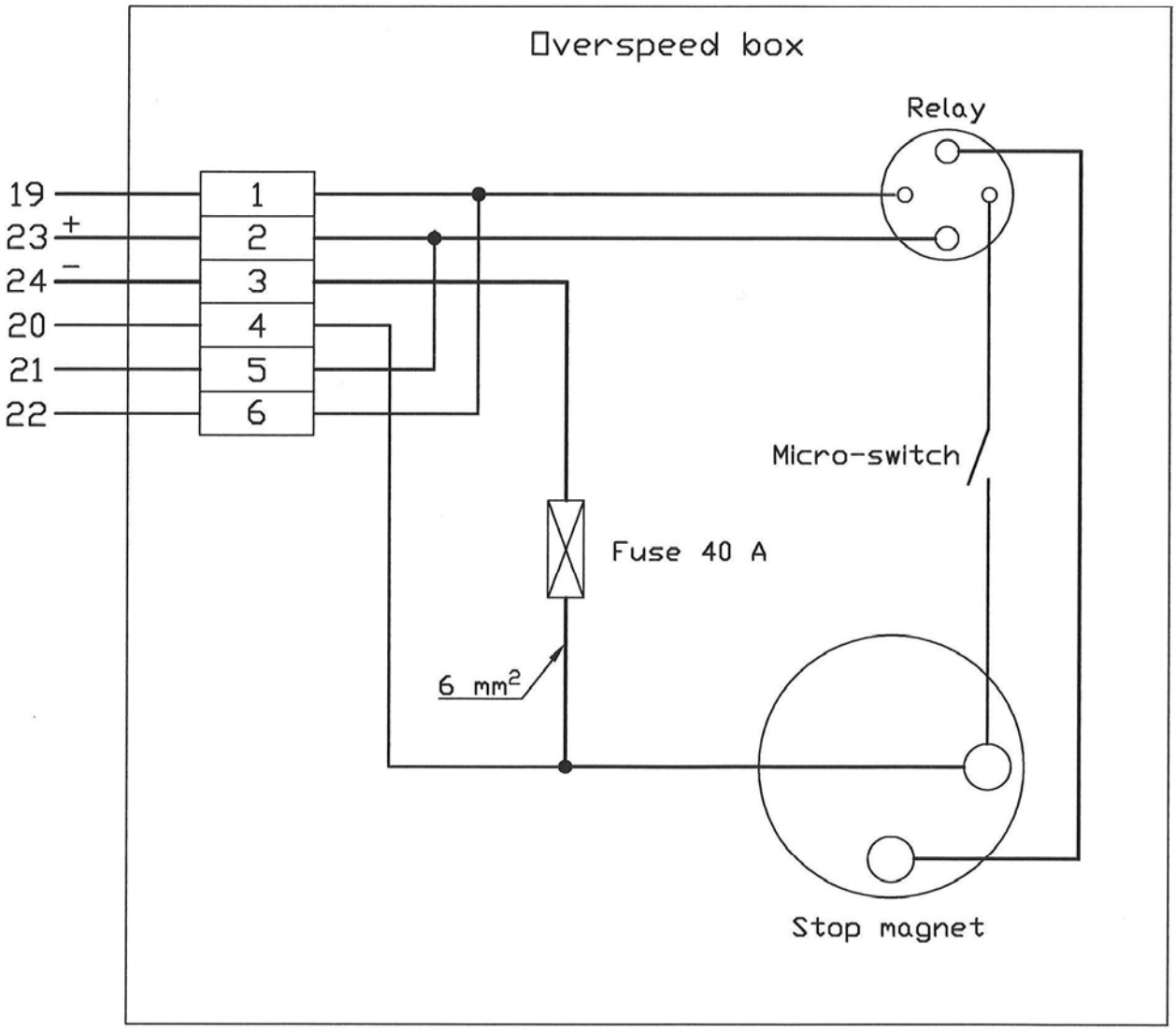
Step 1 is used to supply the clutch with oil, and the pressure is dimensioned to be able to hold the clutch. The pressure should be 9 kp/cm². Step 1 is adjusted by turning the cylinder 19434.

Step 2 is used during the reversing process, and the pressure should be 16 kp/cm². The pressure can be adjusted by turning the nut 19470.

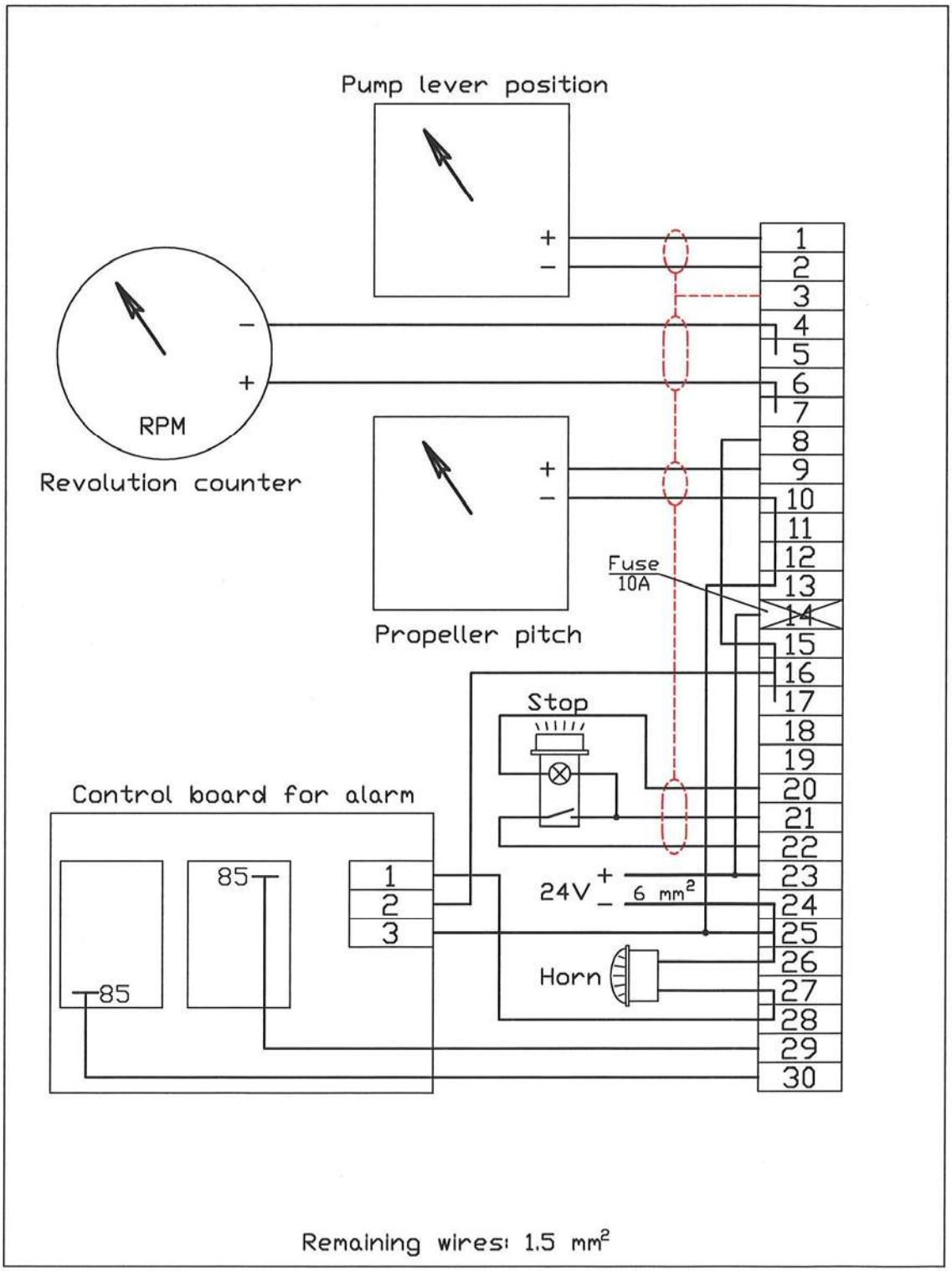
EL-DIAGRAM FOR INSTRUMENT PANEL ON ENGINE



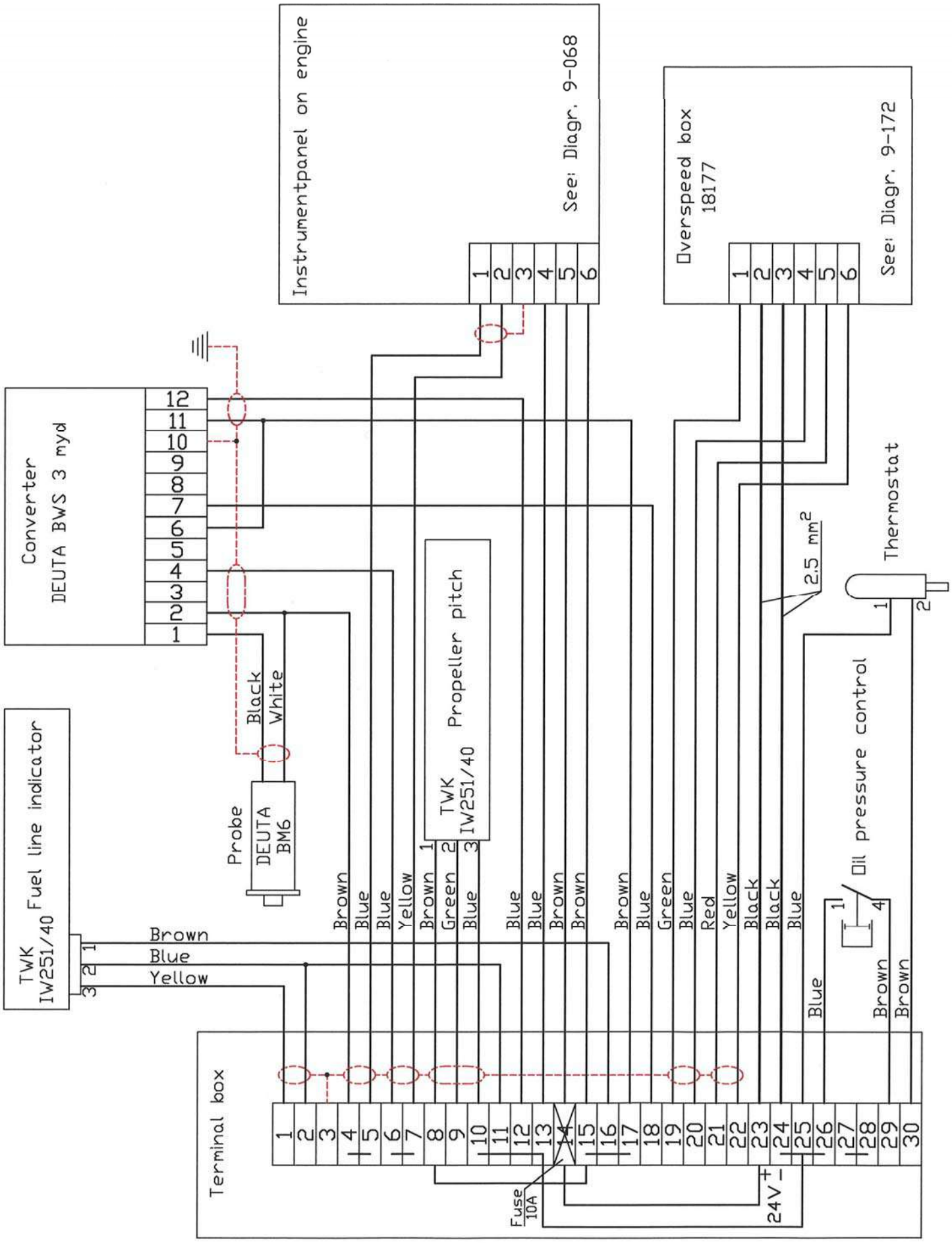
EL-DIAGRAM FOR OVERSPEED STOP



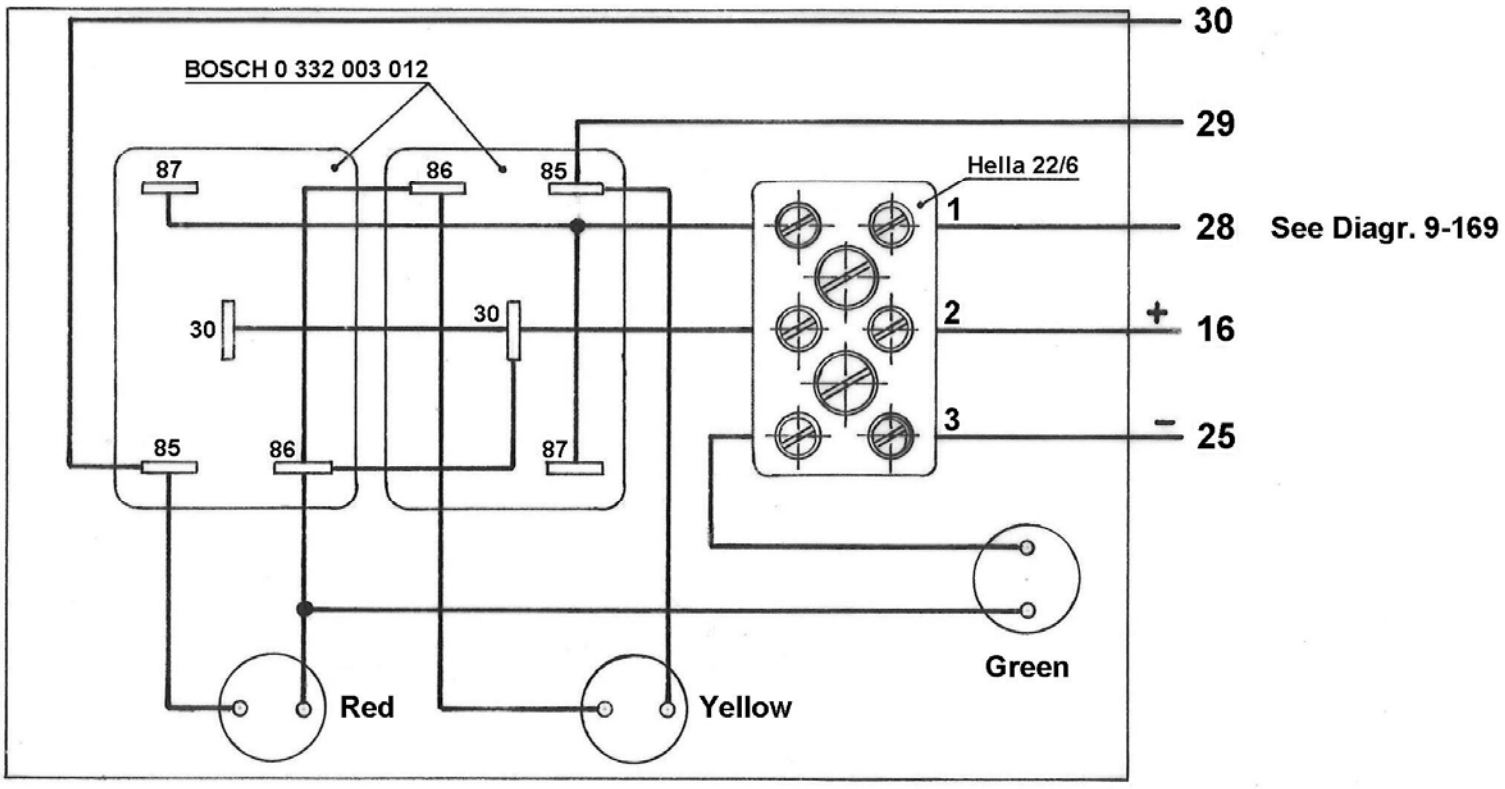
EL-DIAGRAM FOR TERMINAL BOX



CONNECTION-DIAGRAM



Alarm device



Wires: 1.5 mm^2

CHECKING THE ADJUSTMENT OF THE FUEL PUMPS

1. Dismount the Bosch pumps and the pump lever guide (18101) with lever (17190). Check the Ona bearing 3264-1; It must be absolutely without backlash. At the same time, check the cam face while the engine is turned. The surface must be undamaged.

   Remount pump lever and guide. Check the height of the elevating screw (16121) above the upper side of the crank case. The height should be 5.5 mm when the cam is at its lowest position.

   It is absolutely necessary to keep the 5.5 mm, which must not be changed for adjustment purposes.

   The index pointer of the pumps must be adjusted on test bed to secure the same pumping volume, unless the pumps have been delivered ex works, where adjustment has been made.

   Now the pumps can be mounted. The connecting rods between the pumps are mounted before tightening. Newer engines are supplied with one through connecting rod in front of the fuel pumps. When tightening, take care that the pump is not twisted which will result in sticking governing rods. These rods must work absolutely free.

2. ***Checking the timing***
   The best way to check the timing is by means of a drip pipe. Instead of the fuel pipe, a bent pipe - sharpened so that the drops can be counted - is mounted and the valve cone and the pressure valve spring are removed. On the suction side of the pump a small container holding approx ½ litre is mounted. When watching the dropping from the drip pipe, you will see when the cutting-off takes place. Correct adjustment is about 6-10 drops per minute. For various specifications of adjustment - please refer to sheet 7-45.

   Adjust the fuel cam by loosening it from the cam unit. Take care that the two halves of the fuel cam are pressed firmly together before tightening the bolts. After having tightened the bolts, check that there is no gap between the cam halves. Normally, the cams for inlet and exhaust valves must not be loosed from the cam shaft. Adjustment of the cam valves will influence the adjustment of the fuel cam, which must then be readjusted.

   When the cam shaft cover is mounted again, apply a "form gasket" (outside the bolt holes) to prevent leakage. This gasket should be of the silicone rubber type, e.g. Permatex. Do not apply too thick a layer as this may cause superfluous sealing to drop down into the engine before it has dried up.

   After adjustment and mounting, test the engine and measure the ingition pressure. The ignition pressure should be between 63 and 65 atm. (Check the fuel injectors, which must be flawless. Opening pressure 240 atm. Compression pressure 58 - 60 atm.)

   As a guide, 2 mm on the face of the flywheel equals approx 1 atm. at a possible readjustment.

ADJUSTMENT OF REVOLUTIONS FOR TYPE 427 C-E

See fig. 8 page 11 in the spareparts manual showing a sectional drawing of the hydraulic governor.

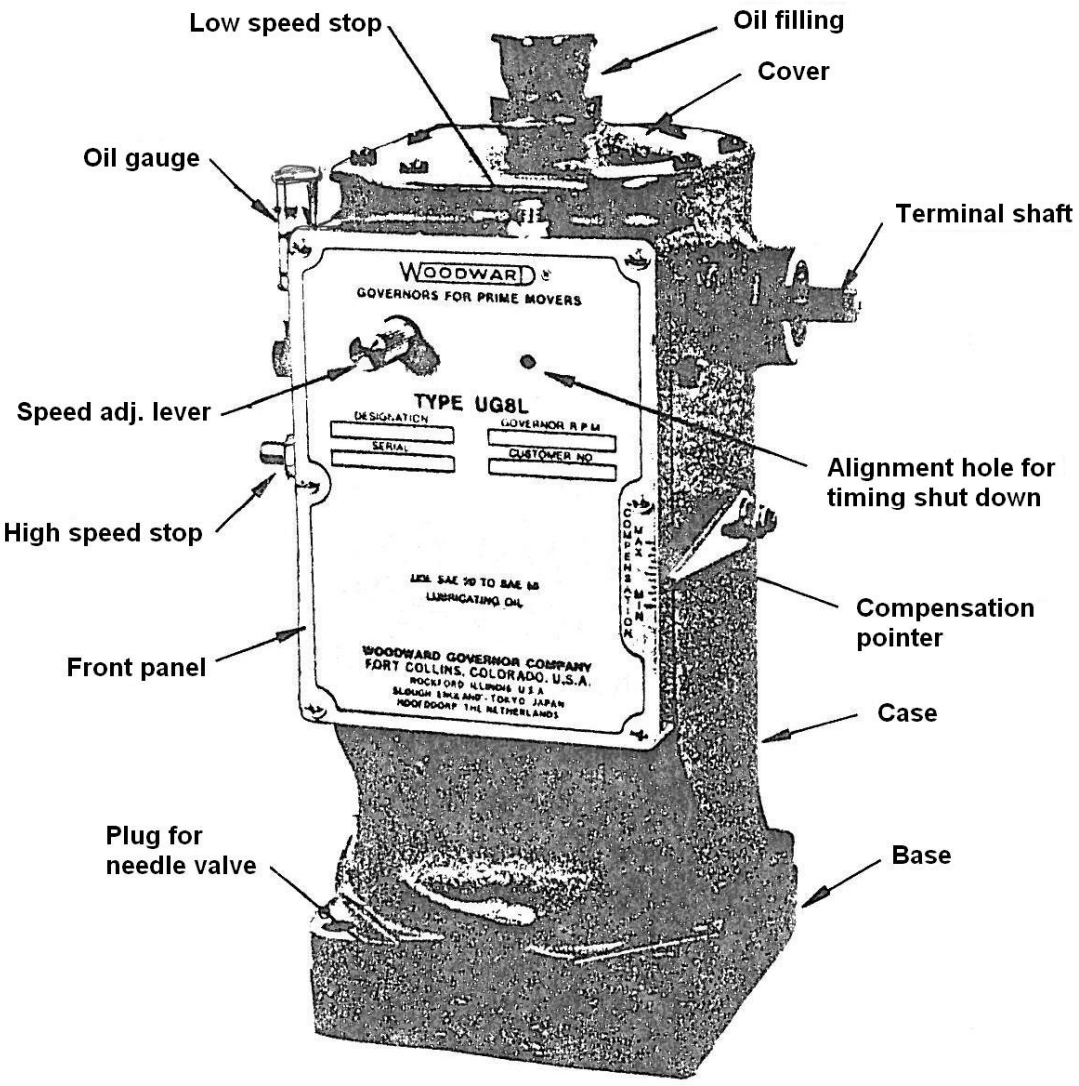
The engine is adjusted to run 225 r.p.m. at idle speed by means of the ¼" x 75 mm screw which pushes against the end of the piston (17115). If the screw is turned clockwise the revolutions will be increasing.The adjusting screw ¼" x 65 mm at the top of the bracket (17114) is not allowed to touch the traverse (20164).

If you want the engine to run faster when idling, e.g. 230 r.p.m., you just have to turn the ¼" x 65 mm screw further down.

The maximum position of the fuel oil pump is adjusted by means of the 5/16" x 32 mm pointed screw which is placed in the governor lever (16132). You can get to it by removing the little cover on the side of the governor cover. If the screw is turned clockwise the load will be reduced. The screw is secured by a wire and sealed by the factory.

The blockings of the governor and the toothed rods of the fuel pumps should never be altered. If the lead seals are broken, the factory‘s guarantee will cease to be valid. The adjustment has been made so by the factory that the engine can perform about 5% above normal load.

WOODWARD GOVERNOR



Description

The Woodward UG8L governor is a mechanical-hydraulic governor for controlling diesel engines. The governor is mechanically linked through a damper to the fuel racks. The maximum work output of the governor is 1.1 kpm over the full 42° travel of its output shaft; however, recommended travel of the output shaft is 30°.

Normally, the governor operates isochronously (constant speed) regardless of the load on the engine.

Mounting instructions
Make sure the governor drift shaft rotates freely before installing the governor. Mount and fasten the governor squarely on its mounting pad on top of the gearbox, taking care that the connection between the governor and the prime mover drive is in order. It is most important to make sure that there is no binding, excessive side loading of the drive shaft or looseness in the coupling. There must be no force pushing the drive shaft into the governor. Improper alignment, or too tight a fit between any of the parts can result in excessive wear or seizure and may also couse undesirable "jiggle" in the governor output.

When mounting the remote control to the wheelhouse (Teleflex), be sure that the motion on the Teleflex tower is corresponding with the deflection on the governor lever. First, you should start the engine and block up at idling (220 rpm) and maximum number of revolutions (425 rpm) before the Teleflex connection is made.

A lever with a slotted hole, in which the telescope link is fastened, is mounted on the output shaft, i.e. that shaft which is connected with the governor shaft of the fuel pump. The lever is fastened so that the shaft is turned to impact at the same time as the fuel pumps stand on 0. If necessary, you could adjust further on the connecting rod after the telescope link.

First, place the telescope link in the outer slot and then follow the instructions below.

If the hunting cannot be stopped, you can try to change the lever proportion by moving the bearing journal a little against the shaft, approx 1 mm at a time, until steady running is achieved.

IMPORTANT! Before the engine is started, make sure that the lever on the output shaft can move enough for the fuel pumps to go to 0, or there is a risk of the engine bolting.

Oil supply
Fill the governor with oil to a level between the lines on the oil gauge sight glass. We recommend a lubricating oil with a viscosity between SAE 10 and SAE 50, depending on the temperature, in which the governor is operating. Recheck the oil level after the engine is started and at operating temperature; then add oil if necessary.

Compensation adjustments
Even if it seems to be running satisfactorily at constant speed, the governor may need adjustment. High overspeed and underspeed after load changes and slow return to normal speed, indicate the need for compensation adjustment.

After the oil temperature of engine and governor has reached its normal operating values, make the following compensation without load on the prime mover to make sure that the governor gives optimum control:

1. Loosen the nut holding the compensation adjusting pointer enough to set the pointer at its extreme upward position for maximum compensation.

2. Remove the plug and open the compensating needle valve 3 to 5 turns anti-clockwise with a screw driver. Be sure that the screw driver fits into the shallow slot of the compensating needle valve - **not into the deep slot** - located at right angles to the shallow screw driver slot. Allow the prime mover to hunt for about 30 seconds to bleed trapped air from the governor oil passages.

3. Move the compensation pointer to the minimum compensation position and gradually close the needle until the hunting just stops. Make sure that the needle valve is max. 1 turn short of closing. Then the valve is opened again at its previously noted position where the hunting stopped.

   Check the governor stability by manually disturbing the governor speed setting. The compensation adjustment is satisfactory when the governor returns to speed with only a slight over or under shoot.

   The needle valve must not be closed completely, normal position is between 1/3 and 3/4 turn open.

If the hunting does not stop, open the needle valve again and move the compensating pointer up by two marks on the panel front indicator scale. Again, gradually close the needle valve till the hunting stops. If not, repeat the resetting of the compensating lever upward by two marks and retest.

It is desirable to have as little compensation as possible. Closing the needle valve further than necessary makes the governor slow to return to normal speed after load change.

HYDRAULIC MOUNTING OF HUBS

In principle the method is as follows: At a very high oil pressure, approx 3000 atm, the hub is expanded so that the hub can be drawn up on a conical shaft with a slim cone (1:50) by a small axial pull .

This method can be used both when mounting and when dismounting the hub.

As mentioned the shaft has a slim cone with oil distribution traces and oil distribution channels as well as a threaded hole where a drawbolt can be placed.

To obtain the pressure an SKF oil pressure pump with built-in oil reservoir and relief valve is used. Use a clean engine oil SAE 30.

To reduce friction during mounting, a thrust bearing has been placed between drawbolt and pressure disc.

Mounting

Before assembling the parts, which are to be pumped together, it is important to make sure that traces and channels are in connection and the the parts are **absolutely clean and free of burrs**.

Before placing the auxiliary tools according to the sketch, the parts are lubricated with oil to prevent friction during mounting. When pumping, take care that oil is running out at both ends before you tighten the nut.

When the hub has been pulled into its place, the drawing tool should be kept on the shaft for approx 15 minutes so that the oil can leak out. Do not load the connection during the first 4-6 hours.

Dismounting

The same method is used. However, the drawing tool is used as holder-on as a lot of power is set free. Do not use a thrust bearing. There must be a distance equalling the shrinking length (approx 17 mm) between the hub and the pressure disc so that the hub can move freely this length.

WARNING!

Repeated hydraulic mountings and dismountings, or if the hub is drawn too high up on the shaft cone by mistake, may result in permanent shape changes of the hub. Consequently, the connection may not be able to transmit the projected torque. In that case the hub (flange coupling) will have to be replaced.

FUEL OIL SYSTEM TYPE 427 C-F