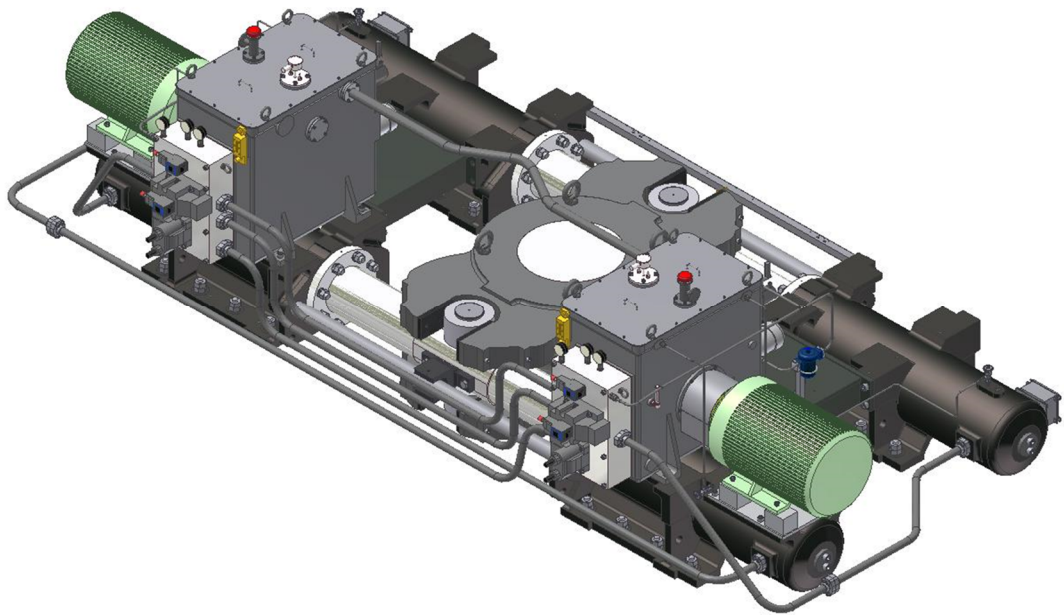


Steering Gear Maintenance Manual



Kawasaki Heavy Industries, Ltd.
Precision Machinery Business Division
Precision Machinery & Robot Company

Contact Details

(Put up your business card)

Contents

1. Overview	1
1.1 Precautions for inspection and maintenance	1
1.2 Model Description	2
2. Steering gear main body	2
2.1 Visual inspection	2
2.2 Wiring inspection	2
2.3 Ram cylinder	3
2.3.1 Inspection and maintenance for ram cylinder	3
2.3.2 Tighten V-Packing	4
2.3.3 Repair for ram scratch and rust	5
2.3.4 Inspection and maintenance for ram guide bar and guide bracket	5
2.4 Roller bearing and Hardened steel plate	6
2.4.1 Inspection and maintenance for roller bearing and hardened steel plate	6
2.5 Control equipment	7
2.5.1 Inspection and maintenance for repeat back unit and rudder angle transmitter	7
2.5.2 Inspection and maintenance for the rudder angle limit switch	9
2.6 Hydraulic equipment	9
2.6.1 Inspection and maintenance for hydraulic oil	9
2.6.2 Inspection and maintenance for solenoid valve (solenoid hydraulic valve)	11
2.6.3 Inspection and maintenance for hydraulic pump	11
2.6.4 Inspection and maintenance for brake valve	15
2.6.5 Inspection and maintenance for oil block valve	15

2.6.6	Inspection and maintenance for regulator	• • • • •	16
2.6.7	Inspection and maintenance for servo Pump	• • • • •	17
2.6.8	Inspection and maintenance for control gear	• • • • •	18
3.	Steering gear operation	• • • • •	19
3.1	Inspection for steering gear operating condition	• • • • •	19
3.2	Check operation by local steering	• • • • •	20
3.3	Check operation by NFU mode steering	• • • • •	20
3.4	Check operation by FU mode steering	• • • • •	20
3.5	Hydraulic-locking alarm test	• • • • •	21
3.6	Isolation test	• • • • •	21
4.	Inspection checklist	• • • • •	22

1. Overview

Daily inspection and maintenance are inevitable to ensure that our electro-hydraulic steering gear is used in a good condition. This manual summarizes the contents of inspection and maintenance for the purpose of preventing problems of the equipment. This manual is intended as a reference for general information, so please be sure to refer to it in conjunction with the finished plan and instruction manual, before carrying out inspections and maintenance. In addition to the inspection on board, we recommend periodic maintenance, done by our Authorized service engineer at the time of docking.

1.1 Precautions for inspection and maintenance

- Be sure to take safety precautions during inspection and maintenance work.

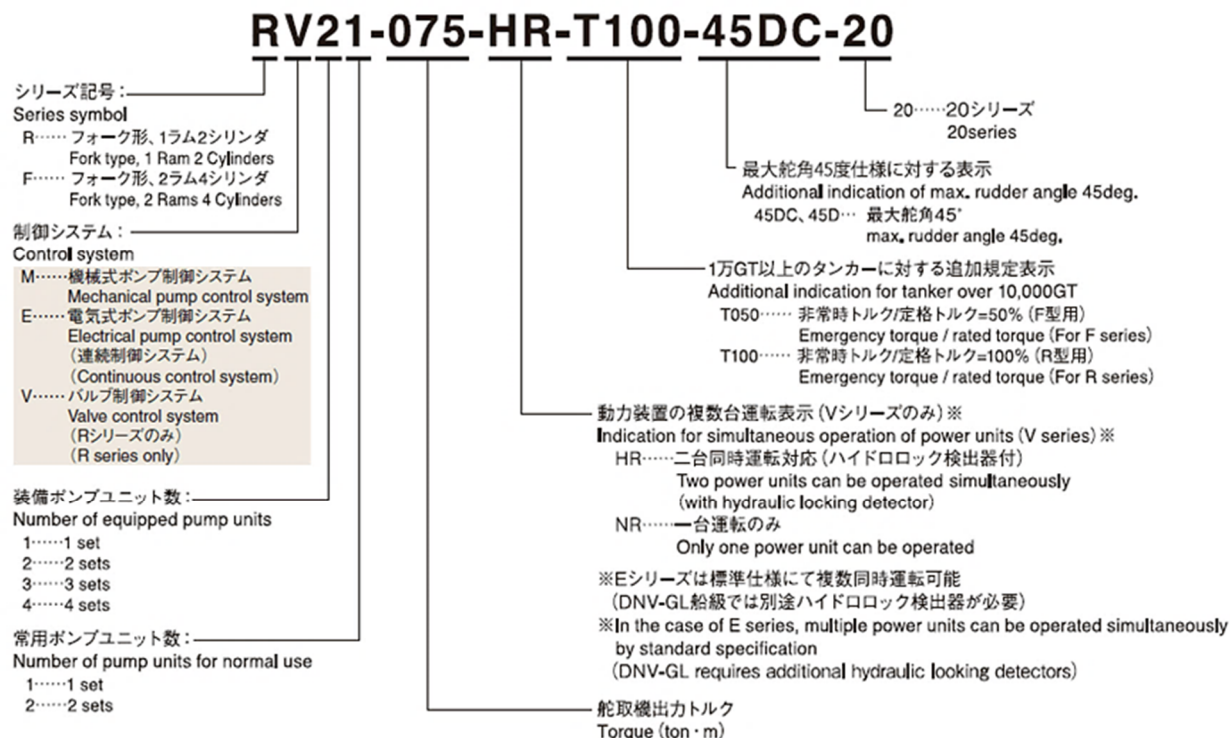
Be careful not to get caught or pinched, especially when operating the steering gear, and do not disassemble the hydraulic equipment carelessly. Also, when inspecting electrical equipment, turn off the power supply and make sure that no voltage is applied before working.

- Please use our genuine parts when you replace the parts.

If non-genuine parts including imitations are used, the functions and performance may not be satisfactory, which may lead to unexpected accidents. In addition, any trouble caused by the use of parts other than our genuine parts is not covered by our warranty.

- If disassembly or maintenance of hydraulic equipment is required, it shall be performed by our skilled service engineer.
- The corrosion of steel (rusting, etc.) may cause unexpected failures or accidents. Touch-up painting and greasing should be carried out frequently to prevent corrosion (rusting, etc.) of the steel.
- If an error occurs in the autopilot system, contact the autopilot manufacturer for advice/rectification.

1.2 Model description



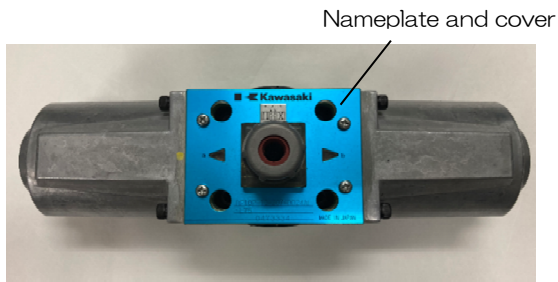
2. Steering gear main body

2.1 Visual inspection

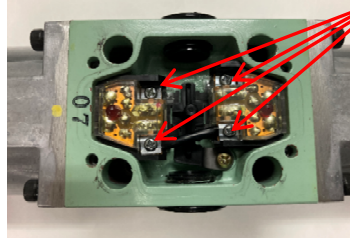
- Visually inspect the exterior of the steering gear for oil leaks or damage to the equipment. If oil leakage or damage is found, repair it immediately.
- If there is insufficient grease, grease up the parts and make sure that there is no rusting on each part.

2.2 Wiring inspection

- Check the terminals of the solenoid valve whether there are any looseness, and check the wiring whether there are any disconnection. The solenoid valve is installed in the steering gear as directional valve, shut-off valve, automatic isolation valve, and switching valve for unload device. The installation location differs depending on the model of the steering gear, so please check the finished drawings and instruction manual.



Solenoid valve



Check the terminals for looseness.
Make sure there are no
disconnection of the wiring.

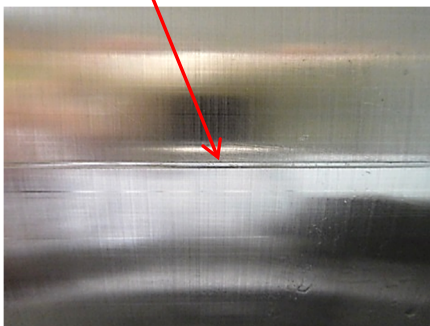
- b. Check the terminals of the electric motor for looseness, and check the wiring for disconnection.
- c. For other electrical components, such as level switches and temperature switches, check for looseness of terminals and check the disconnection of the wiring.

2.3 Ram cylinder

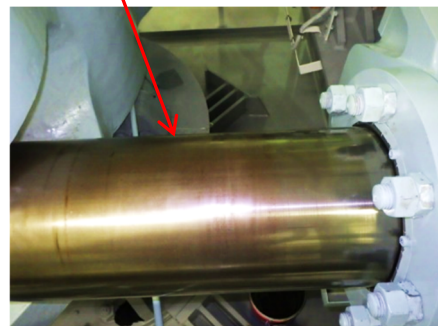
2.3.1 Inspection and maintenance ram cylinder

- a. Check the amount of oil leakage at the V-packing area whenever before leaving port/every month/during docking. If the amount of oil leakage is large, it is necessary to tighten the packing gland. If oil pan is installed, discard the hydraulic oil which has been accumulated in the oil pan.
- b. Check the condition of the ram surface whenever before leaving port/every month/during docking to make sure that there are no scratches or rust. If there are scratches or rust that catches on the nail, the sealing part of the V-Packings will be damaged by such scratches or rust edges. This will cause oil leakage, and the same must be repaired. Also, make sure that thin oil film is formed on the ram surface by hydraulic oil. If the oil film is disappeared, it may cause abnormal noise or rust.

Scratches caused by foreign material.

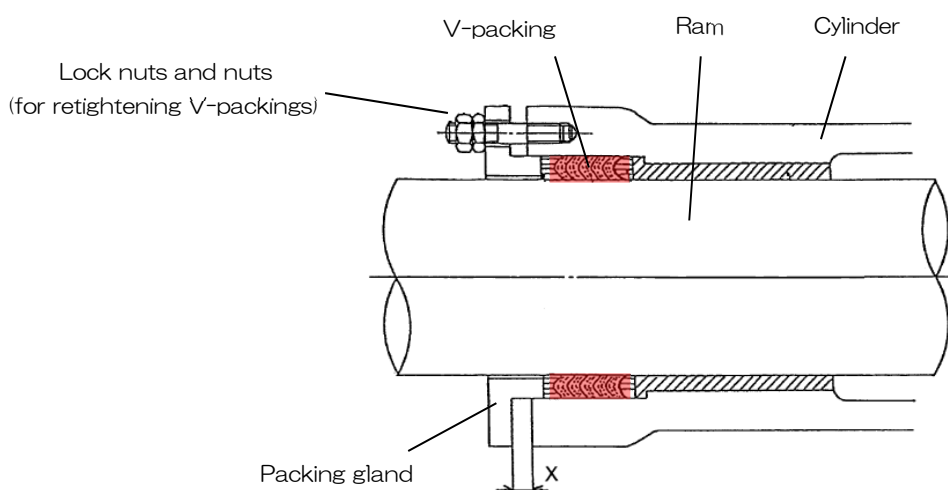


Rust caused by oil film loss.



2.3.2 Tighten V-Packing

- a. Loosen the packing gland lock nut and retighten the nut evenly, if the amount of hydraulic oil dripping is more than 2 - 3 drops, when the ram is moved back and forth for one time without load. As V-packing has the characteristic of forming a thin oil film on the ram, it may cause slight oil leakage. As excessive retightening or one-sided tightening may cause abnormal noise or rusting of the ram due to loss of oil film, please be careful. After delivery or replacement of V-packings, there may be some possibility of large amount of oil leakage, until the V-packing is acclimated. Hence, please retighten the nuts frequently.



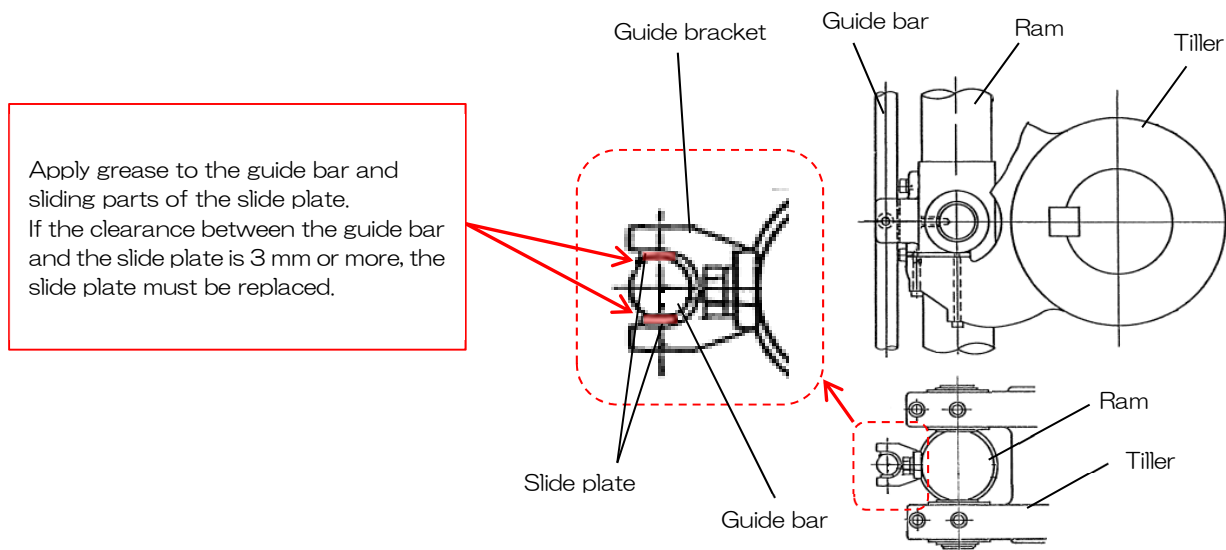
- b. Retightening is possible until the clearance X between the packing gland and the cylinder becomes 0 mm. However, further retightening is not possible. Hence, replace the V-packing before the clearance becomes 0 mm. It is also recommended to replace the V-packing every 5 years, as oil leakage may occur due to deterioration which derives from long-term use. Please refer to the instruction manual for the replacement procedure of the V-packing.

2.3.3 Repair for ram scratch and rust

- a. Scratches and rust on the ram surface should be repaired by following the steps below.
 - Cover the surface of the ram with masking tape except for the part of the scratch.
 - Remove scratches with #80 sandpaper. Polish the ram circumferentially and be careful not to polish too much not to deform the circular shape of outer diameter of the ram. If the circular shape is deformed, the contact condition between the V-packing and the ram will be poor, and oil may leak. Therefore, if scratches or rust are deep, they cannot be removed completely.
 - Polish the ram surface with #600 and #1400 sandpaper. Make sure there is no snagging on the ram surface after polishing.
 - Clean the ram surface and make sure there is no foreign materials on the ram surface.
- b. Move the ram to check whether there are any oil leakage at the V-packing area, and if the amount of hydraulic oil dripping is more than 2 or 3 drops, retighten the nut of packing gland evenly.
- c. If the oil leakage does not improve, replace the V-packing, since the damage of it is suspected.
- d. In the case of deep scratches cannot be removed, hydraulic oil may leak through the remaining scratches on the ram surface. In this case, the ram needs to be replaced.

2.3.4 Inspection and maintenance for guide bar and guide bracket

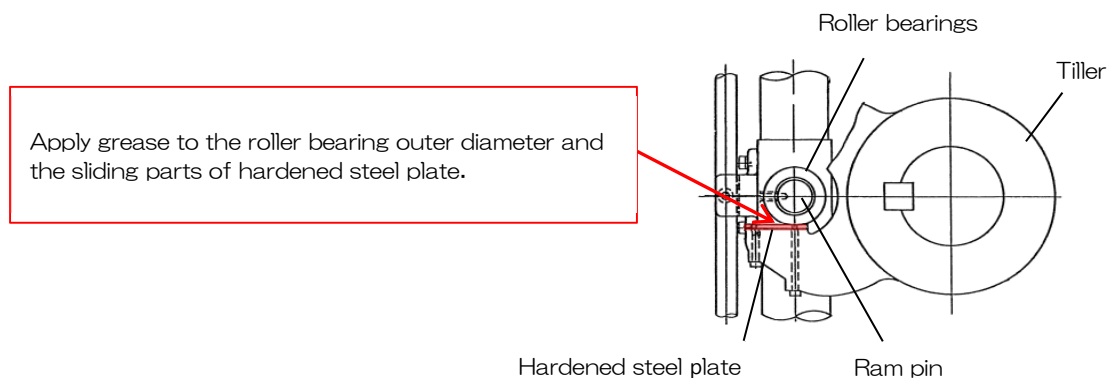
- a. Grease up the sliding parts of the slide plate every week. If the grease is insufficient, the slide plate will be worn out easily.
- b. Measure the clearance between the guide bar and the slide plate every 6 months. If the clearance between the top and bottom of the guide bar is 3 mm or more, replace the slide plate. If the clearance is too large, the rotation movement of the ram will increase, which may cause vibration and abnormal noise.



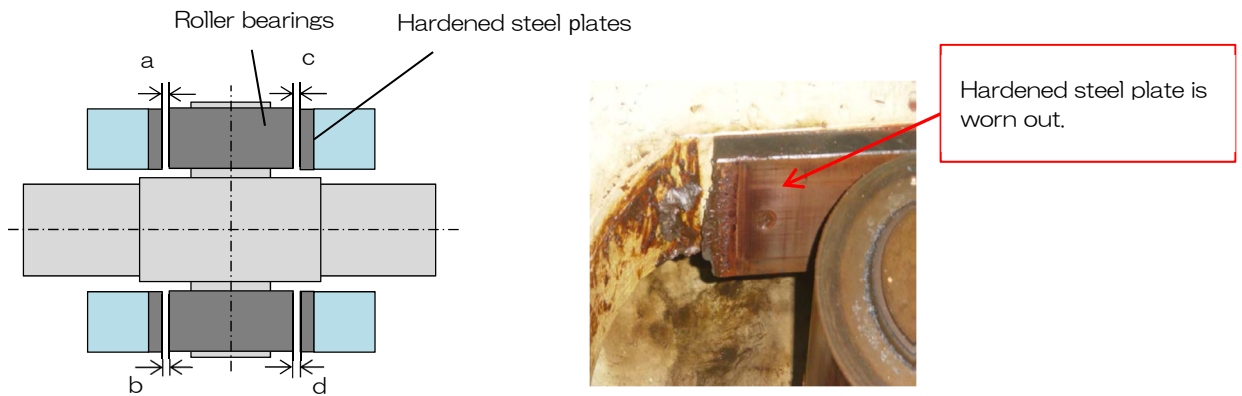
2.4 Roller bearing and Hardened steel plate

2.4.1 Inspection and maintenance for roller bearing and hardened steel plate

- a. Grease up the roller bearing outer diameter and the sliding parts of the hardened steel plate every week. If the grease is insufficient, the hardened steel plate will wear and cause vibration and abnormal noise.



- b. Measure the clearance between the roller bearing outer diameter and the hardened steel plate with a feeler gauge every three months, while the rudder is stopped in the midship position. If $a+c$, $b+d$ of the following is 0.5mm or more, the hardened steel plate needs to be replaced. If the clearance between the roller bearing and the hardened steel plate is too large, it may cause vibration or abnormal noise.

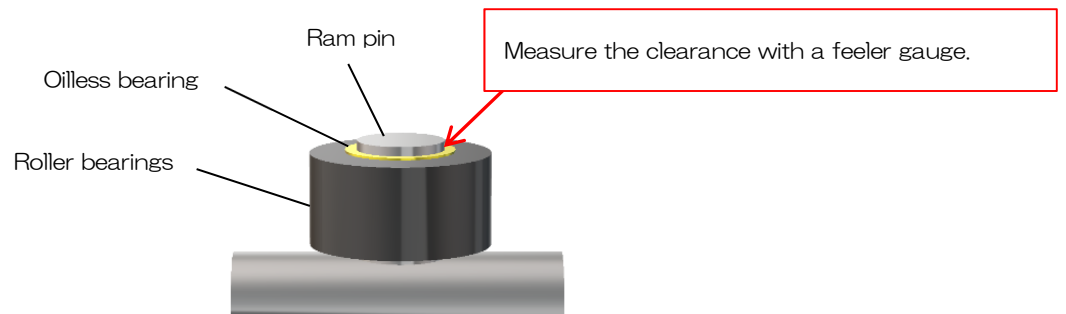


- c. Measure the clearance between the roller bearing inner diameter (Oilless bearing) and the ram pin with a feeler gauge every three months, while the steering gear is stopped in the midship position.

(Remove the upper stop ring before taking the measurement.)

If the clearance is more than 0.5mm, the roller bearing or ram pin needs to be replaced. If the clearance between the inside diameter of the roller bearing and the ram pin is too large, it may cause vibration or abnormal noise.

It is not necessary to grease the Oilless bearing.

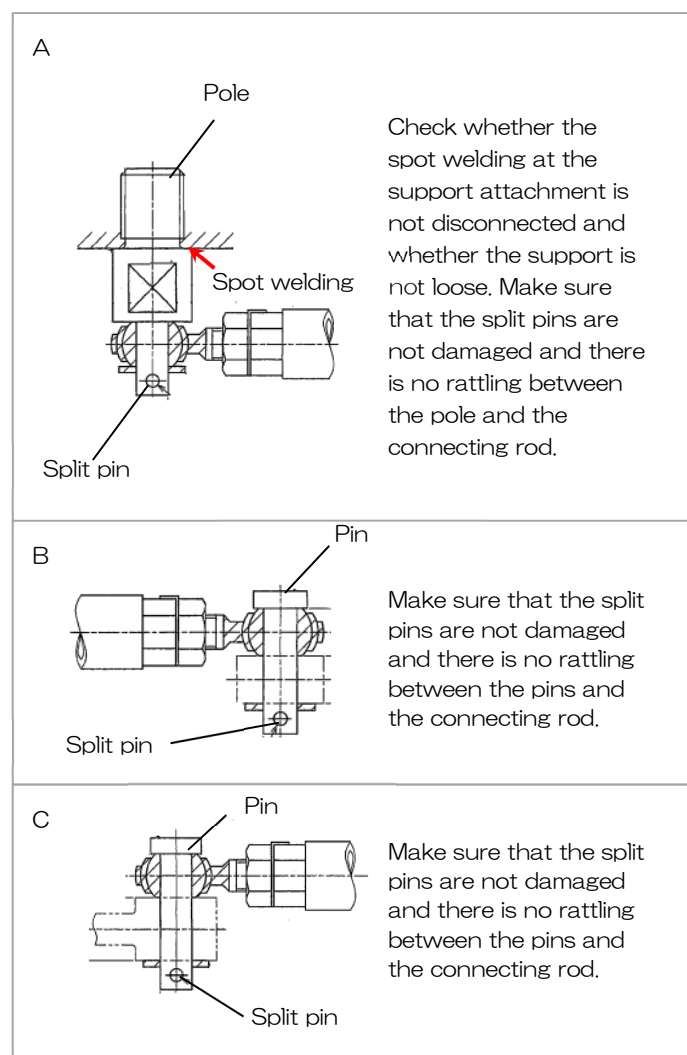
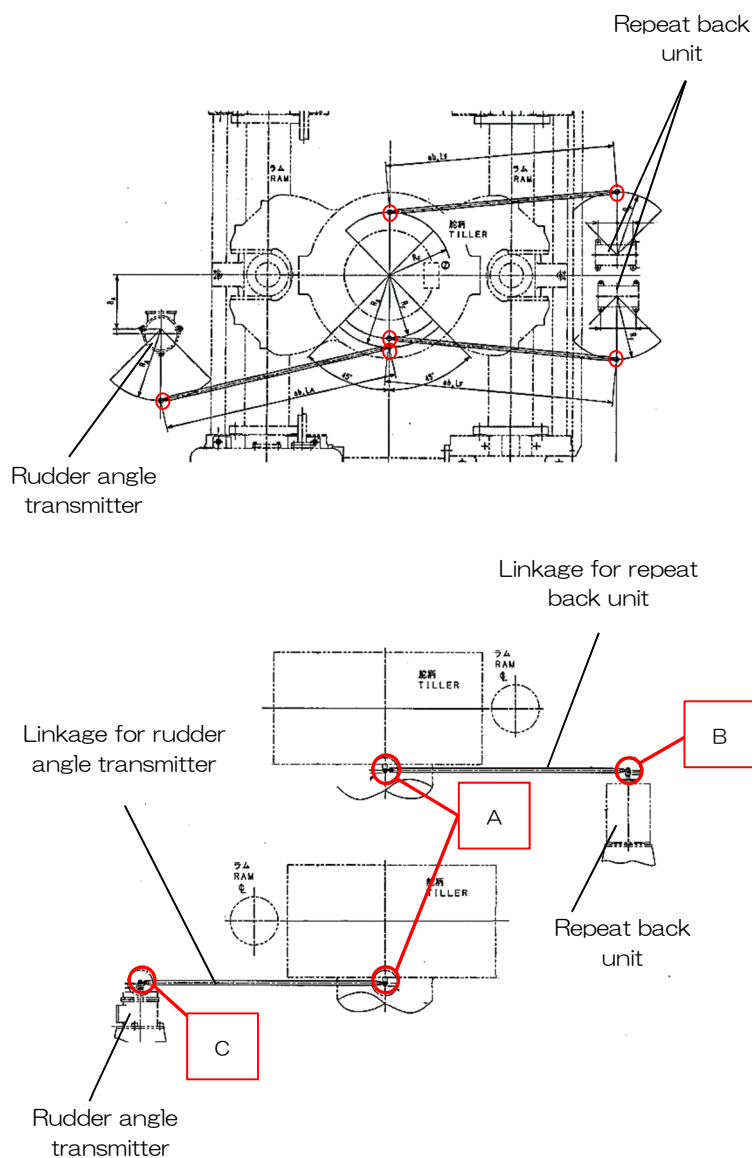


2.5 Control equipment

2.5.1 Inspection and maintenance for repeat back unit and rudder angle transmitter

- a. Before leaving port, check that there is no looseness or dropout in the linkage of the linkage for repeat back unit, and apply greasing. If the linkage rod of the repeat back unit has slip off or if the rattling of the linkage is too large, the steering gear may not operate properly in response to the order signal.

- b. Before leaving port, check that there is no loosening or dropout of the linkage for rudder angle transmitter, and apply greasing. If the linkage of the rudder angle transmitter has slip off or if the rattle of the linkage rod is too large, the rudder angle indicator in the steering room may not operate properly.



In some cases, repeat back unit and rudder angle transmitters are out of our scope. In such case, please check finished plan.

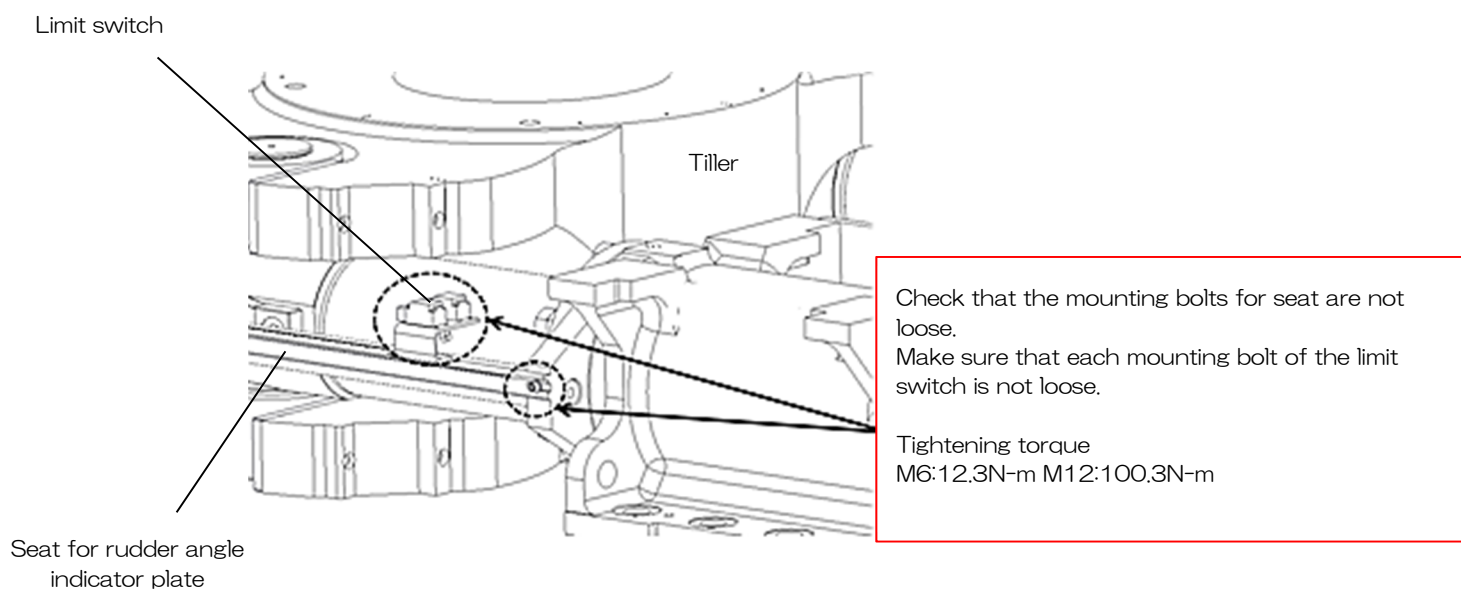
2.5.2 Inspection and maintenance for the rudder angle limit switch

- a. FU mode on the autopilot stand and make sure that the steering gear can stop normally at the maximum steering angle position (approx. 36 degree).

In the case of (-45DC) which has the maximum steering angle as 45 degree, limit switch will activate when the angle is 35 degree and maximum steering angle position (approx. 46 degree).

Make sure that the steering speed slows down at 35 degree and it stops normally at the maximum steering angle.

There are two types of limit switches: such as ones built into the repeat back unit and another mounted on the seat. If the limit switch is mounted on the seat, make sure that the bolts for seat and the limit switch are not loose. If the limit switch slip off from the steering gear, steering may impossible. Also, make sure that there are no looseness or failures in the wiring.



2.6 Hydraulic equipment

2.6.1 Inspection and maintenance for hydraulic oil

- a. Make sure that the oil level in the oil tank is within the visible range of the oil level gauge every day. (If it is within the visible range, it is normal.)

- b. Sampling of hydraulic oil from the hydraulic cylinder and oil tank should be conducted every 6 months to check the deterioration level by visual inspection.

- Check whether the oil is discolored to dark brown.
- Check whether there are no abnormal/simulative odor from the oil.
- Check whether there are no impurities/foreign object in the oil.
- Check whether there are no emulsification in the oil.

If foreign objects, such as metal fragments, are found in the hydraulic oil, please contact us, since the internal parts of the hydraulic equipment are suspected to be damaged

- c. Sampling of hydraulic oil from hydraulic cylinders and oil tanks shall be carried out every year, and the hydraulic oil manufacturer should analyze the results and advise whether the oil can be used or not.

Deterioration of the hydraulic oil will affect the operation and life time of the hydraulic equipment. Therefore, please replace the hydraulic oil when it exceeds the criteria mentioned in the following table.

When replacing the hydraulic oil, clean the inside of the tank, by passing it through a filter of 200 mesh or more, and refill the tank so that no foreign matter can enter the tank.

Hydraulic oil replacement standard

Item	Changes resulting from deterioration and pollution	cause	Working limit (changing rate)
specific gravity	Increase	Deterioration	+0.05
flash point	Decrease	Deterioration	-60° C
Color	Darken	Oxidation, mixture of worn powder	+2 (Union)
Viscosity	Increase (decrease)	Deterioration	±10%.
Acid value	Increase	oxidation	+0.4mgKOH/g
Humidity	Increase	-	+0.05%

- d. Foreign material in the hydraulic oil will affect the operation and shorten the life of the hydraulic equipment, and should be controlled at the following contamination levels.

ISO 4406 -/20/17

- e. Make sure that the temperature of the hydraulic oil is within 80°C while the steering gear is in use. If the steering gear is operated with high oil temperature, it will deteriorate seal parts and hydraulic oil.

2.6.2 Inspection and maintenance for solenoid valve (solenoid hydraulic valve)

- a. Solenoid valves (solenoid hydraulic valves) are used in steering gear for the following applications. Please refer the finished plan for the installed location.
 - V series : Directional valve, shutoff valve (-NR/-HR),
automatic isolation valve (-T050)
 - E series : Solenoid valve for Unloading device,
automatic isolation valve (-T050/-T100)
 - M series : Solenoid valve for Unloading device,
automatic isolation valve (-T050/-T100)
- b. Make sure that there is no oil leakage from the solenoid valve (solenoid hydraulic valve). As oil leakage may occur at the mounting part or solenoid part due to aging deterioration of seals, overhaul maintenance is recommended every 5 to 7 years.
- c. Check the operating condition of the solenoid valve (solenoid hydraulic valve) every week. If the valve can be operated manually with push rod or push button, move it manually, then check whether it can be operated normally.

2.6.3 Inspection and maintenance for hydraulic pump (Attachment 1 and 2)

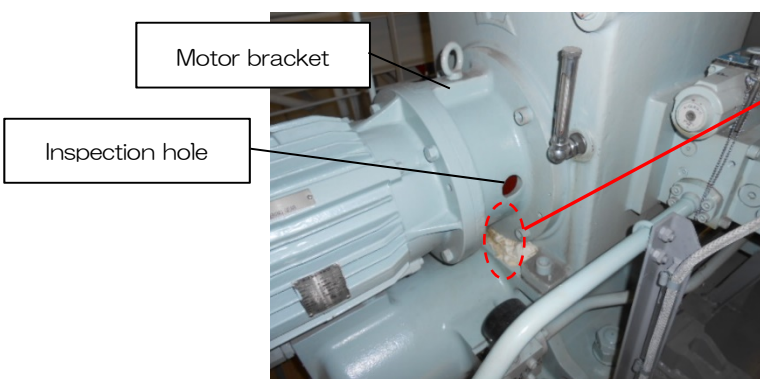
Hydraulic pump type

- | | |
|---|---|
| <ul style="list-style-type: none"> • V series : RV2*-010~027 <li style="padding-left: 40px;">RV2*-032~086 • E series : RE2*-***/FE*-*** • M series : RM2*-***/FM*-*** | <ul style="list-style-type: none"> • • • LVP017 • • • LV-030/LV-060 • • • LV-030~LV-500 • • • LV-030~LV-500 |
|---|---|

- a. Check whether there are no unusual noise or abnormal vibration from the hydraulic pump when the steering gear is running, every day.
- b. Make sure that there is no oil leakage from the oil seal part of the hydraulic pump.

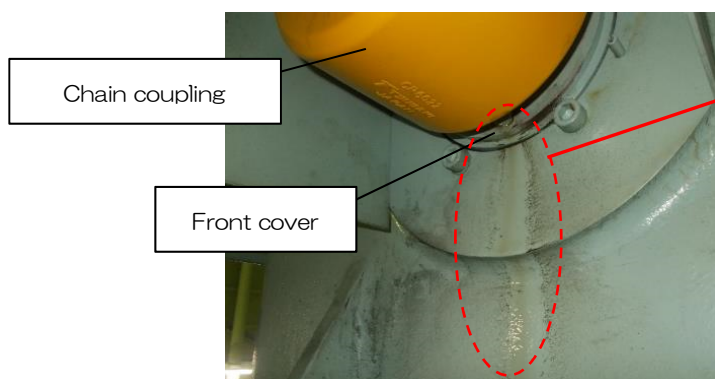
The oil seal of the hydraulic pump may seep slightly depending on the operating conditions. If there is seepage, observe the progress. If hydraulic oil continues to seep and drip, the oil seal needs to be replaced.

Oil leakage from the oil seal section is generally caused by aging, enter of dust of steering room, or enter of foreign object in the hydraulic oil. Keep the steering room clean and maintain the cleanliness of the hydraulic oil.



LVP017 Tank unit

For the LVP017 tank unit, the coupling part is covered by motor bracket. Check whether there is no hydraulic oil adhering to the lower part of motor bracket. Check the inside through the inspection hole to make sure whether there is no oil leakage. If there is hydraulic oil adhering to the lower part of the motor bracket, degrease it once and check whether oil leakage occurs continuously.

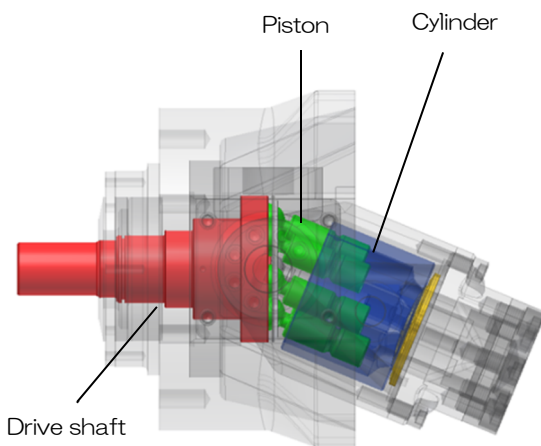


LV-030~050 Tank unit

Hydraulic pump: Check whether there is no hydraulic oil near the front cover. If there is hydraulic oil adhering, degrease it once and check whether oil leakage occurs continuously.

- c. The internal sliding parts of the hydraulic pump will wear gradually due to sliding action during operation. As the internal parts wear, internal leakage increases and performance decreases, which may result in slower steering speed.

If it is used for a long period of time without maintenance, the hydraulic pump may be damaged due to an increase of the clearance between piston and cylinder or the aged deterioration of bearings. In addition, oil leakage may occur due to deterioration of sealing parts including oil seals. Therefore, we recommend that LV-030 to LV-500 to be overhauled by our authorized service engineer every 5 to 7 years.



LV-030~050



[Bad Example]

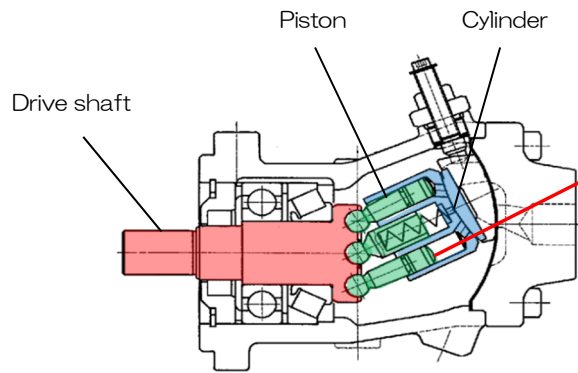
Piston seized in cylinder and piston connecting rod is broken.



[Bad Example]

Piston is seized and stuck to cylinder.

As for LVP017, the piston and cylinder are manufactured and assembled with the condition that requires adjustment of clearance at site. Therefore, it is recommended that our service engineer to replace the complete assembly every 5 to 7 years, because each part cannot be replaced.



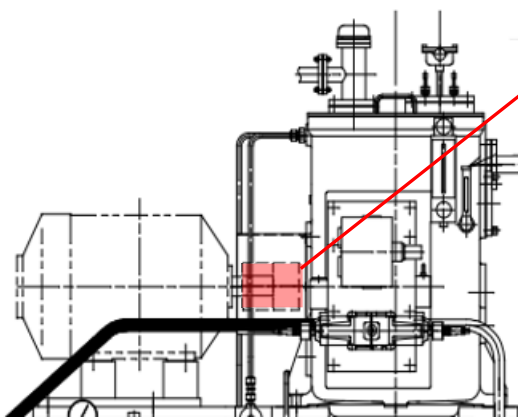
LVP017

Since the product is manufactured and assembled with the condition that requires adjustment of clearance at site, the whole assembly shall be replaced at the time of the maintenance. .

- d. Inspect the coupling every three months to check whether there are no rattling or damages.

If there is any rattling, the coupling needs to be replaced.

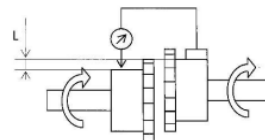
For steering gears which use chain couplings, check the centering at each dock and adjust it if it is out of the criteria.



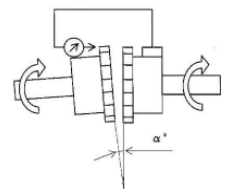
For LV-030 ~ 050

Chain Coupling

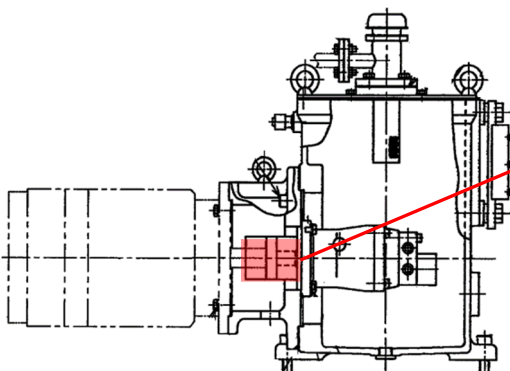
- Check the sprockets whether there are no wear and damage.
- Check the chain is not stretched or rattling.
- Replace the grease of the coupling case every three months.
- Check the centering at each dock.



Parallel error within
0.15mm or less



Tilt error within 0.5
degrees



For LVP017

Rotex Coupling

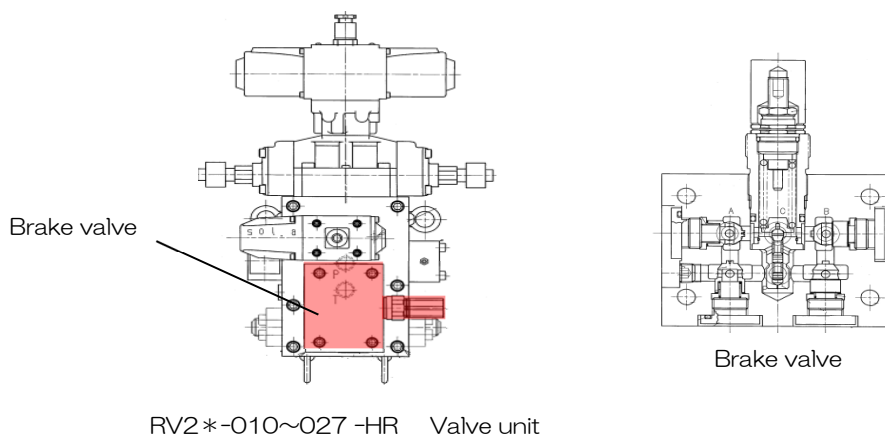
Check that the spider (rubber coupling) is not damaged.
If it will be used while the spider is damaged, the coupling will be damaged also.

- e. The electric motor is out of our scope, but please make sure that there is no abnormal noise or vibration during operation.

In some cases, electric motor is out of our scope. In such case, please check finished plan.

2.6.4 Inspection and maintenance for brake valve

- a. The brake valve is used for the following models of steering gears. Please refer to the finished plan for installed location.
- V series : RV2*-010~027
RV2*-010~027 -H / -HR / -NR
RV2*-032~086
RV2*-032~086 -H
- b. Check whether there is no oil leakage from the brake valve. Oil leakage may occur due to aged deterioration of seals. If the brake valve malfunctions, the steering speed may slow down or the oil tank level may fluctuate which result in to overflow, etc. Therefore, it is recommended to carry out overhaul of brake valve every 5 to 7 years.



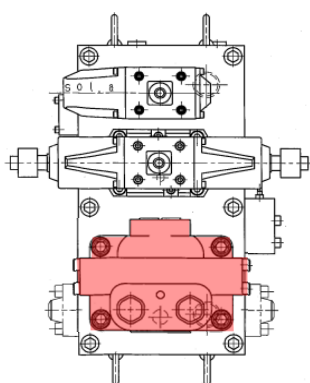
2.6.5 Inspection and maintenance for oil block valve

- a. The oil block valve is used for the following models of steering gears. Please refer to the finished plan for installed location.
- V Series : RV2*-032~086 -HR / -NR
 - E Series : All models
 - M Series : All models

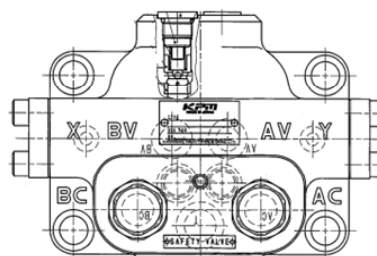
- b. Check whether there is no oil leakage from the oil block valve. Oil leakage may occur due to aged deterioration of seals. If the oil block valve malfunctions, it may cause the following.

- malfunction of the steering gear
- slowing down of the steering speed
- overflow due to fluctuation of the oil tank level
- reversal of the hydraulic pump in the stop unit

Therefore, it is recommended to carry out overhaul in every 5 to 7 years.



RV2*-032~086-HR Valve unit

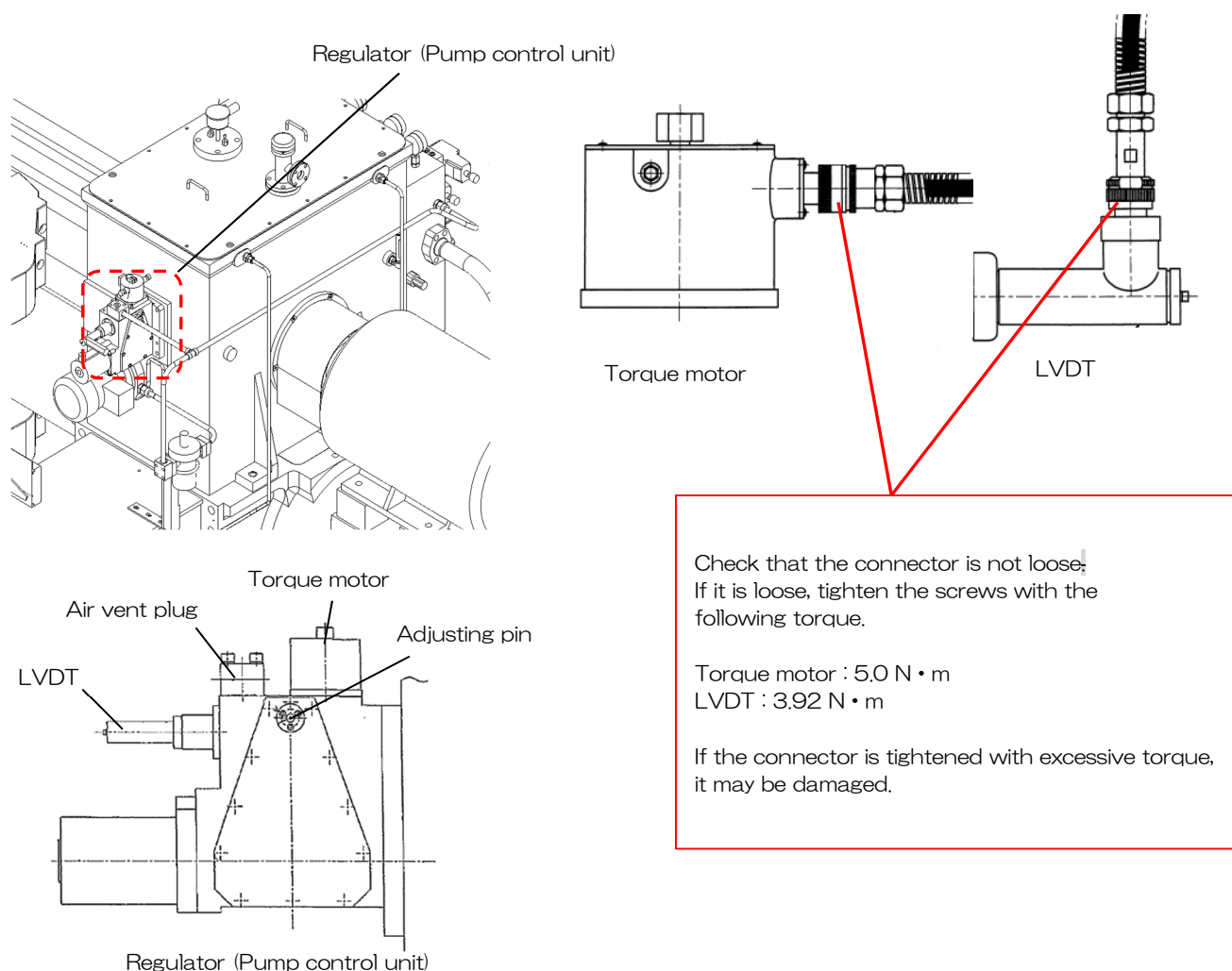


Oil block valve

2.6.6 Inspection and maintenance for regulator (For E series)

- Start up the pump one by one with NFU mode, and check that the ram does not move more than 0.5° /min in the stopped situation. If the ram moves more than 0.5° , neutral adjustment (zero point adjustment) is required. For the adjustment procedure, please refer the instruction manual. If the value cannot be adjusted within the allowable range after the above mentioned neutral adjustment, the internal parts of the regulator are suspected to be worn out. In such case, the regulator needs to be replaced or overhauled.
- If the regulator is behaving unstable, open the air release plug gradually to bleed air while operating the control knob of the torque motor.
- Check that the torque motor temperature is within $+30^{\circ}$ C of room temperature, during operation of the steering gear. Check the connectors for looseness every three months.
- Check the LVDT connector for looseness every three months; if

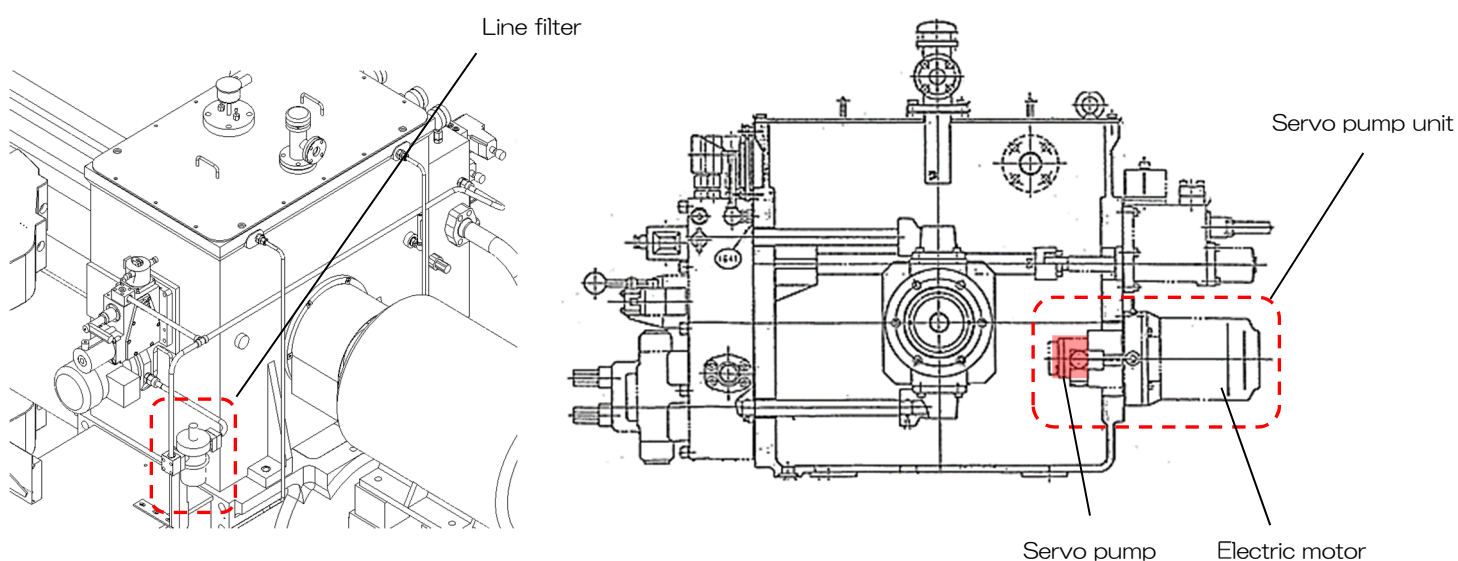
the LVDT is in abnormal condition, the pump control status will not feedback properly to the autopilot system, which may cause an error to the autopilot system.



2.6.7 Inspection and maintenance for servo pump (for E series)

- Check the pressure of the servo pump every day.
Check whether it is within the range of 1.8 to 2.0 MPa and there is no swing/fluctuation in the pressure. If the needle of the pressure gauge swings/fluctuates too much, bleed the air. Also, check that there is no abnormal noise or vibration from the servo pump and electric motor.
- Check the line filter indicator and check whether it is not clogged.
Inspect the line filter element every three months and clean it if it is clogged.

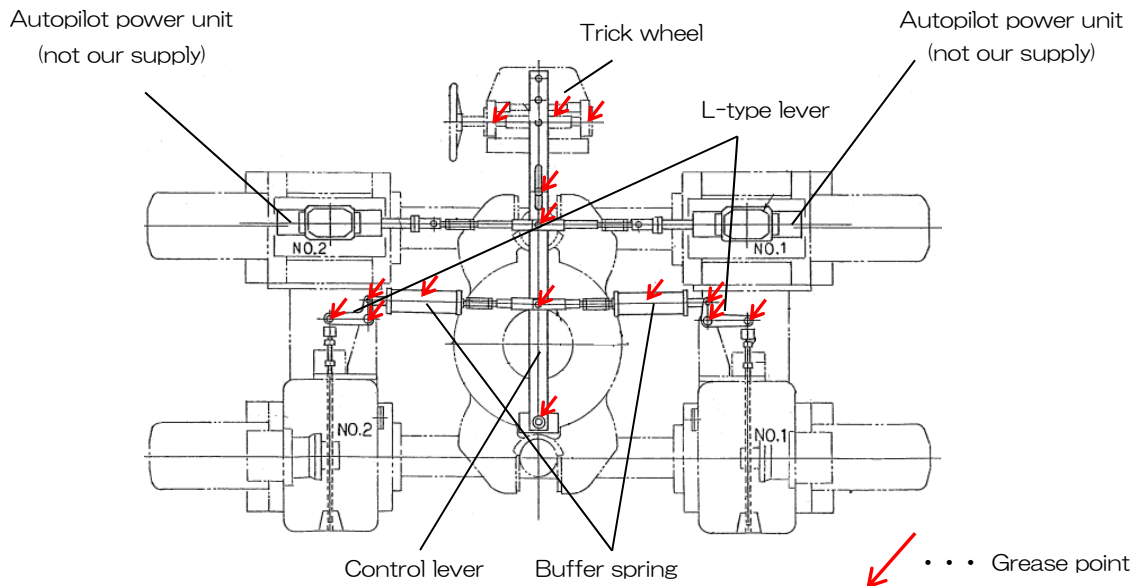
- c. The internal sliding parts of the servo pump will wear due to aged deterioration by sliding actions during operation. If the internal parts wear out, the performance will deteriorate and the steering gear may not be able to operate properly. In addition, oil leakage may occur due to aged deterioration of the seal parts. Therefore, we recommend to have our service personnel to replace the complete pump every 5 to 7 years.



2.6.8 Inspection and maintenance for control gear (for M-series)

- a. Grease the link part of the control gear every week. For buffer spring, refill the grease from the grease insert hole every three months,

If there is adhere due to lack of grease or rattling due to wear, the steering gear may not operate properly in response to commands. Also, check whether there is no looseness in the threaded parts of the turnbuckle, etc. and make sure that anti-looseness measures have been taken.



- b. Although the L-type lever uses a DU bush and washer, it is recommended to replace the bush and washer every 5 years as they will wear out due to aged deterioration. If adhere is observed, make the pin smooth with sandpaper, etc. and apply grease as an emergency measure.
- c. Move the steering gear by NFU mode and local steering and check that the movement of the control lever is smooth.

3. Steering gear operation

3.1 Inspection for steering gear operation

- a. Before leaving port, operate the steering gear in the FU mode and check that the steering gear operates normally against the commanded angle.
- b. Check that the commanded angle and the actual angle are correct.
- c. Check whether there is no abnormal noise or vibration during steering. If the steering gear does not move smoothly during steering, turn off the autopilot system and check the operation of the steering gear by local steering. If the steering gear does not move smoothly, there is a possibility that air is mixed in the hydraulic circuit. In such case, bleed the air. For details of how to

bleed air, refer the instruction manual. After bleeding air, make it sure to close the air release valve of the cylinder. If the air release valve is not completely closed, the steering speed will be slow.

3.2 Check operation by local steering

- a. Check the operation of the steering gear by the local operation every week, when the ship is at standstill condition. The method of operation differs depending on the model. Therefore, refer the instruction manual.
- b. Operate the regular pumps (number of pump normal use) and make sure that the steering speed is within 65 degrees/28 seconds.
PORT35 degrees → STBD30 degrees
STBD35 degrees → PORT30 degrees
- c. Make sure that the cylinder pressure is not at high pressure when turning. Depending on draft and the condition of the rudder carrier, the cylinder pressure will become around 1 to 2.5 MPa (reference value) when the ship is at standstill condition.

3.3 Check operation by NFU mode steering

- a. Check the operation of the steering gear by NFU mode operation every week, when the ship is at standstill condition.
At this time, make sure there are no errors in the autopilot system.
- b. Operate the regular pumps and make sure that the steering speed is within 65 degrees/28 seconds.
PORT35 degrees → STBD30 degrees
STBD35 degrees → PORT30 degrees

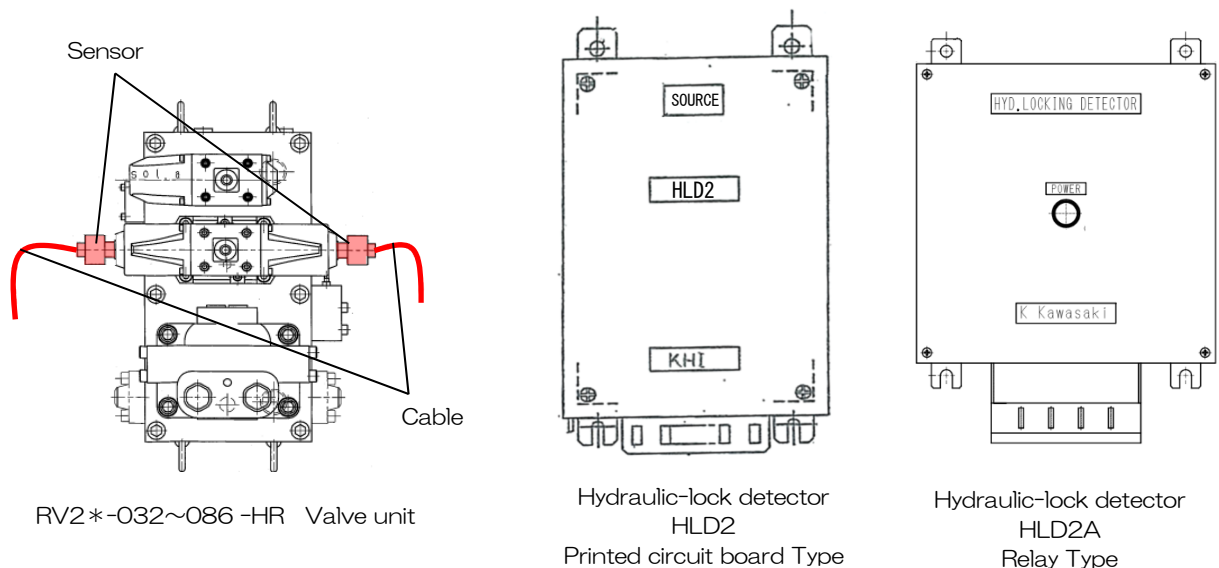
3.4 Check operation by FU mode steering

- a. Check the operation of the steering gear by FU mode operation every week, when the ship is at standstill condition.
At this time, make sure there are no errors in the autopilot system.

- b. Operate the regular pumps and make sure that the steering speed is within 65 degrees/28 seconds.
PORT35 degrees → STBD30 degrees
STBD35 degrees → PORT30 degrees

3.5 Hydraulic-locking alarm test (for -H / -HR)

- a. Check whether the LED light in the hydraulic-lock detector lights up properly by moving the steering gear in a NFU mode operation while standstill condition.
- b. Make it sure that the hydraulic-locking alarm is not occurred at the alarm panel.
- c. If the steering gear is operating normally and there is an abnormality in the LED lamp lighting status or hydraulic-locking alarm, please contact us. In such case, damage of the sensor, cable, or board/relay in the hydraulic-lock detector are suspected.



3.6 Isolation test (for -T050 / -T100)

- a. Start the electric motor while standstill condition, push the system test bar (LOW) on the top of the oil tank, and confirm that the automatic isolation valve switches normally.

- b. Push the system test bar (LOW-LOW) and check that the starting pump stops, the automatic isolation valve switches again, and the stop pump starts automatically.

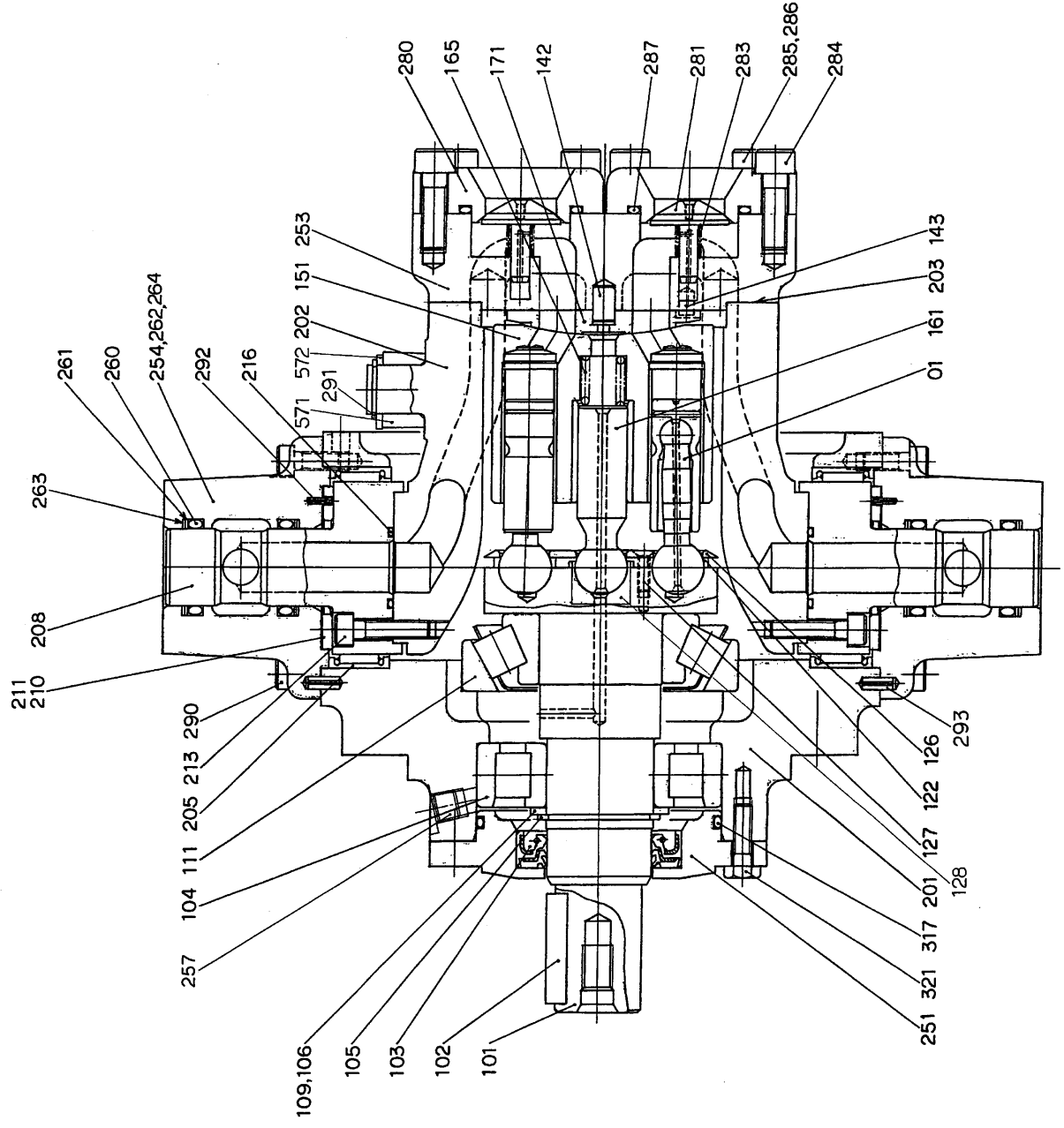
For details on test methods, operating sequences, etc., please refer the instruction manual.

4. Inspection checklist

Check/inspect the entire steering gear every three months in accordance with the inspection checklist in this document, and keep the results/record to ensure the maintenance of the steering gear.

Please refer to Attachment 4 for the checklist.

ITEM NO. 符号	NAME OF PART	名 称
01	PISTON SUB	ピストンサブ
101	DRIVING SHAFT	駆動軸
102	KEY	キー
103	OIL SEAL	オイルシール
104	ROLLER BEARING	円筒コロ軸受
105	STOP RING	ストップリング
106	INNER SHIM	内輪シム
109	INNER SPACER	内輪スベーサ
111	TAPERED ROLLER BEARING	円錐コロ軸受
121	CONNECTING ROD	コンロッド
122	SET RING	セトリング
123	PISTON	ピストン
126	SET PLATE	押え板
127	SET SCREW	止めネジ
142	PIN 1	ピン1
143	PIN 2	ピン2
151	CYLINDER	シリンダ
161	CENTER ROD	センターロッド
165	CYLINDER SPRING	シリンダスプリング
171	VALVE PLATE	バルブプレート
201	BEARING CASING	軸受ケーシング
202	CYLINDER CASING	シリンダケーシング
203	COPPER PACKING	銅パッキン
205	NEEDLE ROLLER BEARING	針状コロ軸受
208	SUPPORTING AXLE	傾転支持軸
210	THRUST PAD	スラストパッド
211	SHIM	ライナー
213	SOCKET BOLT	六角穴付ボルト
216	O-RING	O-リング
251	FRONT COVER	フロントカバー
253	VALVE COVER	バルブカバー
254	PIPE FLANGE	パイプフランジ
260	O-RING	O-リング
261	BACK-UP RING (1)	バックアップリング(1)
262	PO PLUG	POプラグ
263	BACK-UP RING (2)	バックアップリング(2)
264	O-RING	O-リング
280	SUCTION VALVE COVER	吸入弁カバー
281	POPPET	ポペット
283	SPRING	スプリング
284	SOCKET BOLT	六角穴付ボルト
285	SOCKET BOLT	六角穴付ボルト
286	SOCKET BOLT	六角穴付ボルト
287	O-RING	O-リング
290	SOCKET BOLT	六角穴付ボルト
292	SPRING PIN	スプリングピン
293	SPRING PIN	スプリングピン
317	O-RING	O-リング
321	HEXAGON HEAD BOLT	六角ボルト

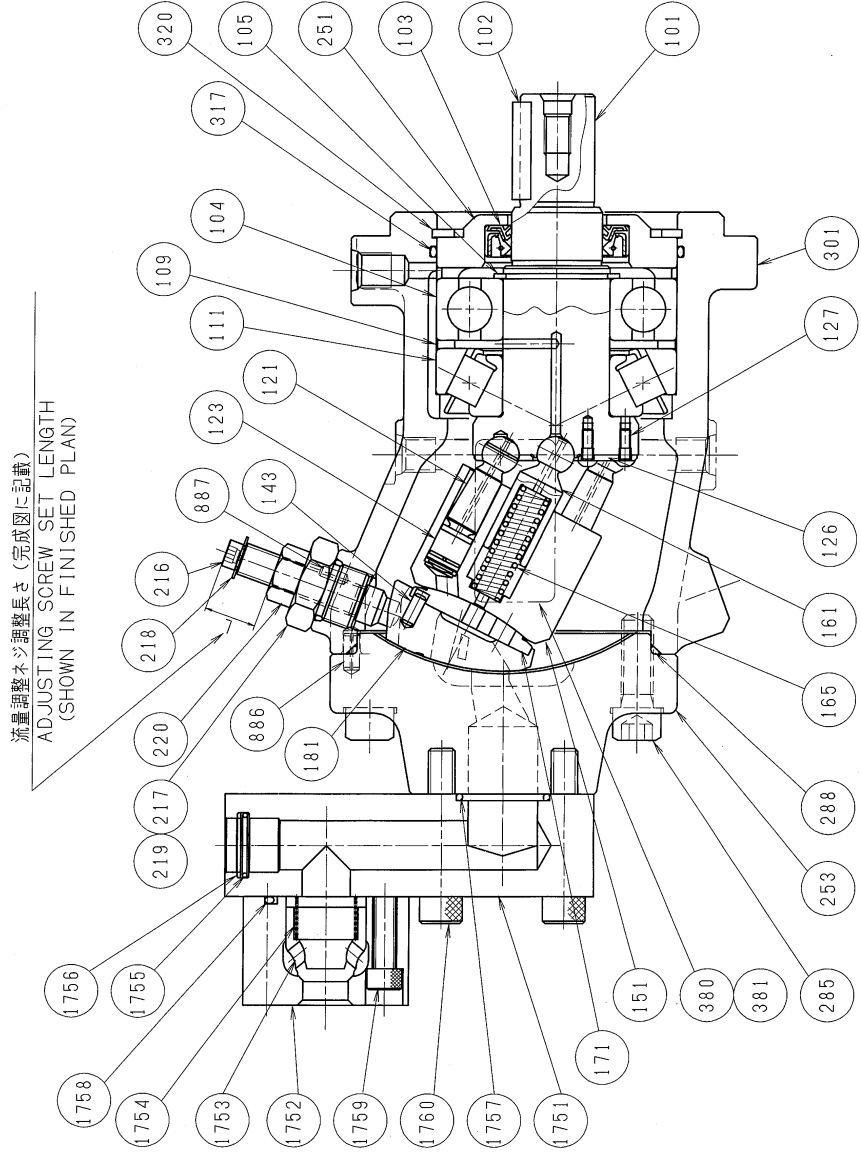


ボルト・プラグ・ナット・ネジの締付トルク

TIGHTENING TORQUE

部品番号 NO.	ネジサイズ THREAD SIZE	締付トルク TIGHTENING TORQUE N・m [kgf・cm]
220	M12	57±6 580±58
217	M22	137±14 1400±140
285	M12	98±10 1000±100
127	M4	3.4±0.4 35±4
1759	M8	29±4 300±45
1760	M10	57±5 580±87

ITEM NO. 符号	NAME OF PART	名称	REF. 備考
101	SHAFT	駆動軸	
102	KEY	キー	
103	OIL SEAL	オイルシール	
104	BALL BEARING	玉軸受	
105	STOP RING	ストップリング	
109	SPACER	スペーサー	
111	TAPERED ROLLER BEARING	円錐ころ軸受	
121	CONROD	コンロッド	
123	PISTON	ピストン	
126	PLATE	押え板	
127	SCREW	止めネジ	
143	PIN	平行ピン	
151	CYLINDER	シリンダ	
161	CENTER ROD	センターロッド	
165	CYLINDER SPRING	シリンダスプリング	
171	VALVE PLATE	バルブプレート	
181	SLIDER	スライダ	
216	ADJUSTING SCREW	流量調整ネジ	M12
217	PLUG	調整プラグ	
218	RETAINING RING	E型止め輪	
219	O-RING	O-リング	P20
220	LOCK NUT	ロックナット	
251	FRONT COVER	フロントカバー	
253	VALVE COVER	バルブカバー	
285	SOCKET BOLT	六角穴付ボルト	M12-35
288	O-RING	O-リング	G110
301	CASING	ケーシング	
317	O-RING	O-リング	G90
320	LOCKING RING	ロックキングリング	
380	NAME PLATE	銘板	
381	PIN	打込みピン	
886	SPRING PIN	スプリングピン	
887	SPRING PIN	スプリングピン	
1751	SUCTION VALVE BODY	補給油弁ボディ	
1752	SUCTION VALVE CASING	補給油弁ケーシング	
1753	VALVE CONE	バルブコーン	
1754	SPRING	スプリング	
1755	O-RING	O-リング	P20
1756	BACK-UP RING	バックアップリング	
1757	O-RING	O-リング	G30
1758	O-RING	O-リング	P40
1759	SOCKET BOLT	六角穴付ボルト	M8-40
1760	SOCKET BOLT	六角穴付ボルト	M10-55



< Inspection of Hyd.Lock Detector >

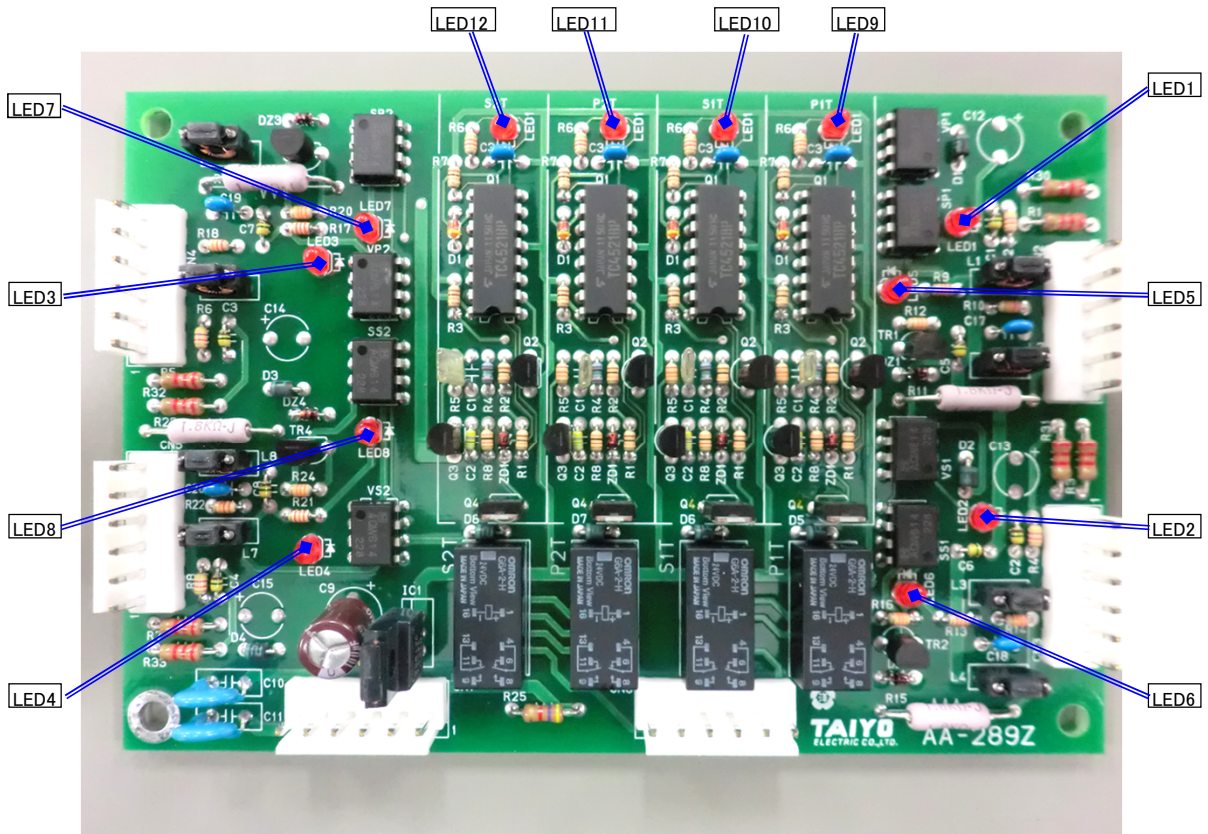
Kawasaki V-type electro hydraulic Steering Gaer
(with Hydraulic-locking alarm system)
Hyd.lock DETECTOR
(shown the normal condition.)

O...LED ON, X...LED OFF

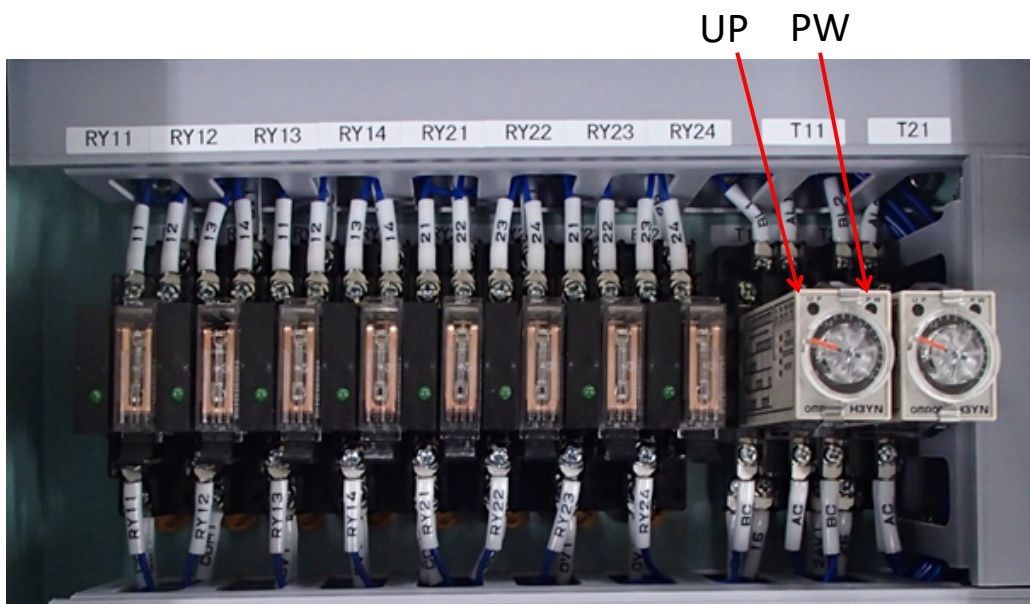
Inspection of Hyd.Lock Detector		HLD SYSTEM											
		No.1				No.2				No.1		No.2	
		Order signal		Position sensor		Order signal		Position sensor		Timer		Timer	
		P	S	P	S	P	S	P	S	T11(PW)	T11(UP)	T21(PW)	T21(UP)
LED name	HLD2 CIRCUIT BOARD	LED1	LED2	LED3	LED4	LED5	LED6	LED7	LED8	LED9	LED10	LED11	LED12
	HLD2A RELAY CIRCUIT	RY11	RY12	RY13	RY14	RY21	RY22	RY23	RY24	T11(PW)	T11(UP)	T21(PW)	T21(UP)
No.1 Running unit(s)	NOR	X	X	O	O	X	X	O	O	X	X	X	X
	Steering to PORT	O	X	X	O	X	X	O	O	X	X	X	X
	Steering to STBD	X	O	O	X	X	X	O	O	X	X	X	X
No.2	NOR	X	X	O	O	X	X	O	O	X	X	X	X
	Steering to PORT	X	X	O	O	O	X	X	O	X	X	X	X
	Steering to STBD	X	X	O	O	X	O	O	X	X	X	X	X
No.1&2	NOR	X	X	O	O	X	X	O	O	X	X	X	X
	Steering to PORT	O	X	X	O	O	X	X	O	X	X	X	X
	Steering to STBD	X	O	O	X	X	O	O	X	X	X	X	X

- When failure of change-over valve occur at No.1 unit, Timer T11(UP) is activated 2 seconds later after turning on T11(PW).
- When failure of change-over valve occur at No.1 unit, Timer T21(UP) is activated 2 seconds later after turning on T21(PW).
- In steering, LED PW of T11 and T21 is turned on for a moment.

HLD2 CIRCUIT BOARD



HLD2A RELAY CIRCUIT



Inspection checklist.

Ship's name :

Date :

	Check Item	Result	memo
Steering Gear Main body (2)	Visual Inspection (2.1)		
	Wiring Inspection (2.2)		
	Ram Cylinder (2.3)	Oil leakage	
		Condition of ram surface	
		Oil film on the ram surface	
		Grease up the slide plate	
	Roller bearing and Hardened steel plate (2.4)	Clearance between the top and bottom of the guide bar allowable value : 3mm	
		Grease up the roller bearing outer diameter and the hardened steel plate	
		Clearance between the roller bearing outer diameter and the hardened steel plate allowable value : a+c, b+d 0.5mm	
		Clearance between the roller bearing inner diameter and the ram pin allowable value : 0.5mm	
	Control equipment (2.5)	Inspection of linkage for rudder angle transmitter	
		Grease up linkage for rudder angle transmitter	
		Inspection of linkage for repeat back unit	
		Grease up linkage for repeat back unit	
		Inspection of rudder angle limit switch	
		Terminals of limit switch	
		Wiring of limit switch	
		Mounting bolt of limit switch	
		Mounting bolt of rudder angle indicator plate	
		Oil level of oil tank	
	Hydraulic equipment (2.6)	Condition of working oil	
		Operating condition of solenoid valve (solenoid hydraulic valve)	
		Oil leakage from solenoid valve	
		Operating condition of hydraulic pump (solenoid hydraulic valve)	
		Oil leakage from oil seal	
		Condition of coupling	
		Oil leakage from brake valve/oil block valve	
		Neutral adjustment of regulator 0.5° /min (For E series)	
		Torque Motor and LVDT Connector (For E series)	
		Pressure of servo pump (1.8~2.0MPa) (For E series)	
		Condition of line filter (For E series)	
		Grease up linkage of control gear (For M series)	
		Operating condition of control gear	
		Operating condition in FU mode	
		Check agreement between the commanded rudder angle and the actual rudder angle	
		Abnormal noise, vibration	
Steering gear operation (3)	Inspection of steering gear operation (3.1)		
	Check operation by local steering (3.2)	Rudder turning speed (65 degrees/28 seconds)	
		Pressure of cylinder	
	Check operation by NFU mode steering (3.3)	Rudder turning speed (65 degrees/28 seconds)	
		Pressure of cylinder	
	Check operation by FU mode steering (3.4)	Error of autopilot system / occur, not occur	
		Rudder turning speed (65 degrees/28 seconds)	
	Hydrolock alarm test (for +H / +HF) (3.5)	Pressure of cylinder	
		Error of autopilot system / occur, not occur	
	Isolation test (for -T050 / -T100) (3.6)	Lighting status of LED lamp	
		Alarm / occur, not occur	
		Operation status of automatic isolation valve at "LOW" level	
		Operation status of automatic isolation valve and pump (on/off) at "LOWLOW" level	

First edition : October 2021

Kawasaki Heavy Industries, Ltd.

Marine CS Section

Industrial & Marine Machinery Sales Dep., Marketing & Sales Group

Precision Machinery Business Division

Precision Machinery & Robot Company