MMO

High Pressure Centrifugal Pump

TORISHIMA PUMP

PT. TORISHIMA GUNA INDONESIA

0. General

0. 1. Before Starting Initial Operation

If installed properly and operated correctly, the pump can perform its specific performance in satisfactory condition throughout a long term. Before putting the pump into initial operation, carefully read this Instruction Manual to handle, operate, and maintain the pump properly. Keep this Manual all the times where operator or maintenance personnel can have access to it easily for study any time when required.

All the pump parts and components are so manufactured under severe quality control that they can fulfil their functions to entire satisfaction. But any fault or trouble attributed to one of the causes described below shall be out of our guaranty.

(1) The ordered pump is used to handle the liquid of a different nature, density, temperature, or others than those clearly specified in the order specification, or operates outside the operating range specified therein.

(2) Pump damage is caused as a result improper handling and operation, faulty installation, the use of unsuitable material, faulty or unskilled piping, etc.

(3) Pump damage is caused by natural disaster.
When repair is required, it is recommended to repair the pump by our skilled serviceman as far as possible or to return it to our factory.

0.2 Quality Control Plan (QTC)

All inspection and test for material, dimension, performance, etc. are performed in the manufacturing process in accordance with Quality Control Plan (QTC) submitted to the purchaser when the pump was ordered. Only pumps that have fully satisfied the specified performance values upon inspection and test are allowed for shipment.

0.3 Name Plate

Any pump is provided with a nameplate. Please inform us of the followings when ordering spare parts and replacement parts.

(1) Pump type, Mfg. No. (Indicated in KH or KP), date of production, etc. (identified on the name plate) .

(2) Parts name, material, quantity, etc. described in Sectional Drawing and Spare Parts List.

0.4 Handling

When handling the pump directly coupled with the driver, hook a lifting rope on the pump and its driver as illustrated below.
(Absolutely avoid to hook a lifting rope on the eye bolt of the driver) .

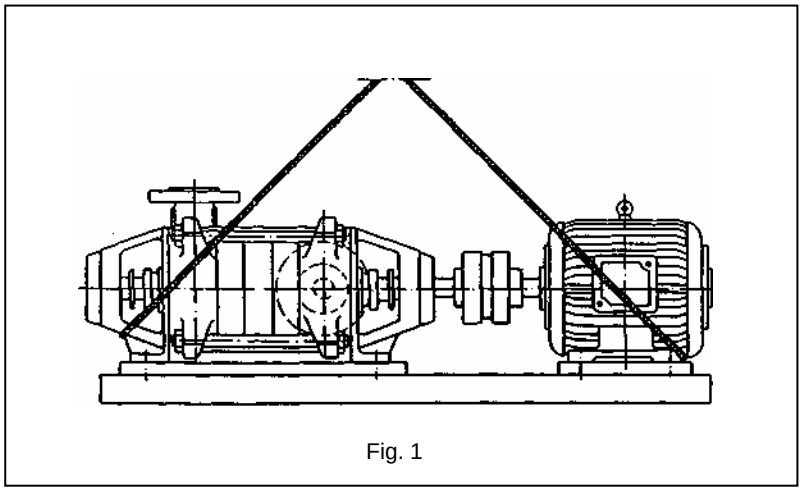


Fig. 1

1. Instalation

1. 1. Mounting

Installation and leveling of the pump should be performed by skilled workers. Improper installation and leveling/ centering would cause various troubles during the pump running.

In the case of the pump directly coupled to the driver on the common baseplate, the pump set is shipped after completely levelled and centered at our fabrication shop. However, follow the sequence given below for local installation of the common baseplate and recheck the level and centering of pump and driver.

(1) Prepare packers and leveling shims or taper liners necessary for the common baseplate installation.

(2) After complete cure-up of the foundation concrete, place and position packers along the both sides of each anchor bolt seat (if the shims are apart more than 800 mm, additional one more shim or extra shims at equi-distance between them as shown in Fig. 2) so that the common baseplate locates thereon in specific position. After each packer and shim (or taper liner) is positioned precisely, fix it by mortar application.

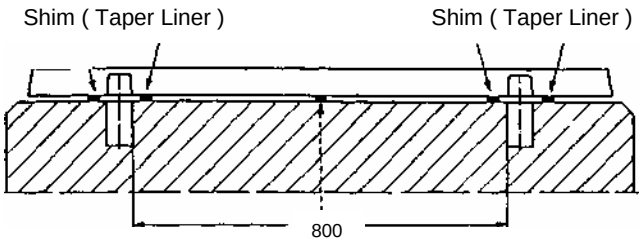


Fig. 2 Fitting the shims

(3) In this case, adjust and keep each packer horizontally using a level gauge. The height of each packer is fine-adjusted by means of shims when the common baseplate is installed. Therefore, in this stage it would be sufficient only to keep each packer right horizontal.

(4) After complete cure-up of the mortar with packer on, temporarily install the common baseplate (with the pump and driver installed thereon) onto the packers and check the center height of the pump. Furthermore, hold a level gauge on the discharge flange to make fine-adjustment of the pump horizontality in both axial and crosswise directions by inserting previously prepared leveling shims (taper liners).

For the pump that was shipped without the motor, adjust its horizontality in both axial and crosswise directions by a level gauge being held in contact with the discharge flange surface and the motor mount seat.

(5) After the pump was positioned and levelled as specified, make pre-center alignment between the pump and the driver using a centering leveling jig (refer to Para. 1.2 for the detail).

(6) After the pre-centering work, grout mortar in each anchor hole.

(7) After complete cure-up of the mortar around each anchor bolt, tighten alternately the anchor (foundation) bolts with uniform tightening torque.

(8) Grout mortar under the common baseplate until it reaches completely each corner so that any cavity does not exist in the grouted mortar.

After complete cure-up of the grouted mortar, recheck the horizontality of the common baseplate.

(9) After completion of the above works, connect both the suction and the discharge pipes to the pump.

1. 2. Alignment of pump and driver

The pump shaft and the driver shaft (motor shaft) must be centered in line.
Follow the sequence given below for the leveling and centering work.

(1) Centering and leveling can be performed easily by holding a straightedge on the flange top of the coupling set and inserting a wedge gauge between two coupling halves, as illustrated in Fig. 3.
In this case, a=ai, and b=bi, must be satisfied for the complete leveling and centering. Accordingly, equal clearance between two coupling halves along its entire periphery will show that the both shafts are completely centered and levelled.
As alternative method, a clearance gauge can be used for the checking.

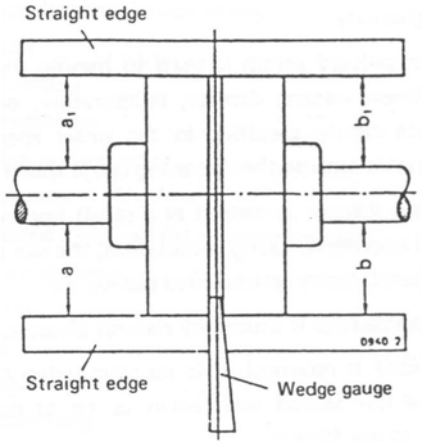


Fig. 3

(2) Furthermore, a dial gauge is used for easier and more precise centering and leveling. In this case, the clearance is measured at four points spaced with 90° while turning the coupling set, and the alignment is perfect provided that the measured deviation in clearance is within 5/100 mm in both axial and radial directions.

(3) Be sure to check the motor rotational direction before connecting the coupling halves. The correct rotational direction of the pump is arrow-marked on the both suction and delivery casings. Namely, it is clockwise viewing from the motor side.

(4) After the above check, connect the coupling halves.

1. 3. Connecting the piping

After completion of the direct coupling work, the suction and discharge pipes must be connected to the respective flanges of the pump. Perform the piping connection with good care for the following items.

(1) When connecting the suction and discharge pipes, take proper measure to prevent piping load from directly acting on the pump. Direct load to the pump by piping would cause trouble.

(2) The suction line must be installed in upward slope (about 1/50) toward the pump to prevent air pocket in the case of suction lift. And it must be installed in downward slope reversely in the case of forced suction.

(3) Take care to minimize various losses of the suction pipe and avoid sudden changes of cross-section and use of abrupt bends in the suction piping. Select the suction pipe such that the size is same or bigger than the pump suction nozzle size.

(4) When the suction pipe size is different from the pump suction nozzle size, use an eccentric tapered pipe to connect the suction pipe and pump suction nozzle and to prevent air pocket.

(5) After completion of the piping work, recheck alignment as described in 1.2.

2. Start-up and Shut-down

2. 1. Start-up

(1) Before starting the initial operation after installation, observe the following check items and, if anything abnormal is found, take necessary corrective action in accordance with this Manual.

1) Are the pump and the suction pipe filled up with pumping liquid ?
2) Is the driver's rotating direction correct ? (Pump rotates clockwise viewing from the driver's side)
3) No abnormal in the direct coupling ?
4) No abnormal load to the pump by piping ?
5) Is the flushing pipe connected properly and the water flow rate proper ?
6) Are the suction valve fully opened and the discharge valve fully closed ?
7) Isn't the gland packing tightened irregularly or too excessively ? Also, isn't there any abnormal leakage from the gland packing ?
8) Can the pump be turned lightly by hand ? Isn't there any touch of contact in the pump ?

(2) If nothing abnormal is found upon checking the above items, turns on the driver's start switch and off it immediately to check that the pump rotates smoothly and shuts down quietly.

(3) If normal rotation of the pump is confirmed, gradually open the discharge valve up to the specific duty point, after the pump reached its specified running speed. When leakage from the gland is much, re-tighten the gland packing with equal torque for adjustment.

(4) If the pump continues running with the discharge valve fully closed, the liquid temperature in the pump will rise, causing trouble of the pump. In such case, shut down the pump immediately without fail.

(5) When starting the pump after long term shut-down, recheck the above check items (1), and (5) thru (8) to verify that the pump is abnormal-free.

2. 2. Shut-down

Follow the procedure given below for shutting down the pump.

1) Gradually close the discharge sluice valve up to full close position. However, it may be left as opened providing that a check valve is included in the discharge pipe and the back pressure is sufficient.
2) Turn off the driver's stop switch. At the same time, check that the pump rotational speed decelerates smoothly and stops quietly.
3) Stop external flushing, if any.
4) Fully close the suction valve when the pump is kept as shutdown for long time.
5) When there is a possibility of freezing in the pump, completely drain out the pumping liquid inside pump. (Complete drain of the liquid in the line is more safety) .

2. 3. Maintenance

2. 3. 1. General

The pump must run quietly and without abnormal vibration all the times. Therefore, carefully observe the following check items while the pump is in running and, if anything abnormal is found, shut down the pump immediately and search the cause.

1) Does the suction pressure fully satisfy the pump required NPSH (NPSH req.) ? .... Read the suction line pressure gauge to check it.
2) Is the specified discharge pressure satisfied ?
3) Isn't the driver in overload running ?

4) Are the both suction pipe and pump filled up with pumping liquid or the discharge valve fully opened in the pump running ?

5) Is the bearing temperature normal ? (no abnormal temperature rise ?)

6) Is leakage from the gland proper ?

7) Is the pump running with no abnormal noise and no vibration ?

2. 3. 2. Shaft Seal

The shaft seal is available in two different types of gland packing and mechanical seal. The descriptions here under covers the gland packing seal type. Refer to Chapter IV for the detailed instructions of the mechanical seal.

The gland packing insertion space in the casing cover is designed to be equivalent to either five packing rings (4610) or three packing rings plus one lantern ring (4580).

2. 3. 2. Dimensions of stuffing box compartment and no. of packing ring

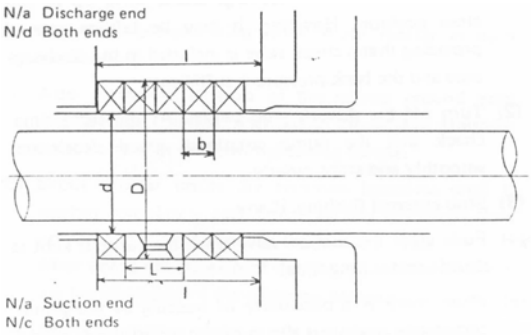


Fig. 4 Stuffing box compartment

Dimensions (in mm)

Pump sizes	Stuffing box compartment		
	d	D	l
32	34	50	45
40	34	50	45
50	39	55	45
65	45	65	55

Mode of operation	Con-struction	Pump sizes	Packing ring[1] Qty.	Packing ring[1] □b	Lantern ring Qty.
Suction lift or positive suction pressure ≦ 1 bar	N/a	32	8	8	suction end 1
		40	8	8	
		50	8	8	discharge end –
		65	8	10	
Positive suction pressure > 1 bar	N/b	32	10	8	
		40	10	8	
		50	10	8	
		65	10	10	
Vacuum (with con-densate feed)	N/c	32	6	8	suction end 1
		40	6	8	
		50	6	8	discharge end 1
		65	6	10	

1) for both shaft seals

3. Dismantling and Reassembling

3. 1. General

Before overhauling, be sure to check that the pump is in absolutely unsuitable condition.

In addition, check without fail that the both suction and discharge line sluice valves keep full-close position, the pump casing is normal in its temperature and no pressure is loaded to the pump casing (that is, the casing is empty).

When overhauling, maximum possible effort must be made to avoid accidental trouble. Also, good care must be exercised to protect the pump components/parts from impact and flaw in handling of them.

3. 2. Dismantling

For dismantling the pump, follow the disassembling sequence given below with reference to 3. 6 " Exploded View ”and parts names listed therein.

Also, keep all the overhauled parts in order of overhaul so as to smooth the reassembling work without any error.

(1) Remove any small pipings if any.

(2) Remove the coupling guard.

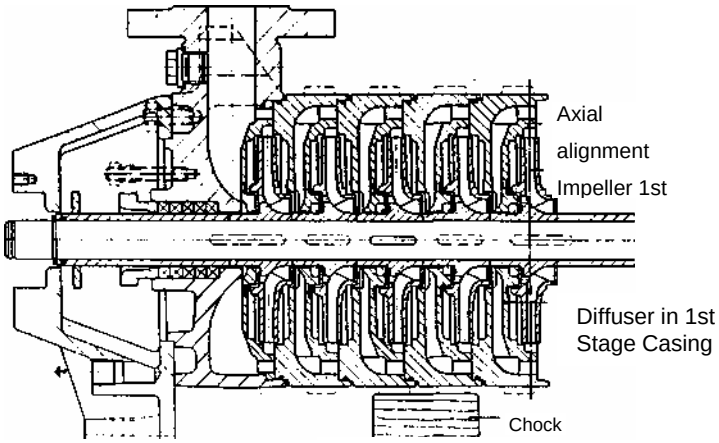
(3) Remove the coupling bolts and then remove the prime mover from the common baseplate.

(4) Pull out the pump side coupling half from the pump shaft.

(5) Chock up the stage casings before proceeding with dismantling to prevent them from falling down when the bearing housing is removed. (Refer to Fig. 5)

(6) Begin the overhauling from the discharge side.

(7) Remove the end cover and then take off the circlip and the spacer ring.



(Wedge or Frame)

(8) After unscrewing off the bolts fixing the discharge side bearing housing to the baseplate and the casing nuts from the casing, pull out the bearing housing together with the ball bearing from the pump shaft.

(9) Dismantle the spacer ring, circlip, delivery side shaft protecting sleeve and gland in sequence.

(10) Unscrew off each tie bolt nut from the discharge side, and dismantle the discharge casing and the last stage impeller.

(11) Dismantle the stage casings and impellers in sequence of every stage.

(12) Dismantle the suction casing and the gland.

(13) Draw out the pump shaft from the bearing housing.

(14) When the ball bearing is replaced, take it out from the bearing housing using a pipe or the like.

(15) Inspect each part carefully and repair or replace it when deemed as necessary.

(16) When the part is hard to be removed after long term operation of the pump, apply the penetrant to the part or use a special jig for removal. In any case, do not hit it.

3. 3. Reassembling

Reassembled the overhauled components and parts in the reverse sequence of the overhauling with reference to " Exploded View ". For normal running of the pump, specially follow the precautions given below.

(1) Clean adequately each pump component/parts. Prevent adhesion of dust on the connections and joint portions.

(2) When replacing the ball bearings, use the designated bearing No. without fail (See 3.4).

(3) Take good care not to damage each O-ring and the sealed contact surface of each parts.

(4) When replacing the rotating assembly (shaft, impeller, sleeve), determine the dimension (Y-X) of the casing side spacer ring in the discharge side bearing housing in accordance with the procedure shown in Fig. 6. In this case, move reciprocally the rotating assembly from the discharge side to the suction side and vice-versally and determine the dimension of spacer ring based on the center position of the rotating assembly.

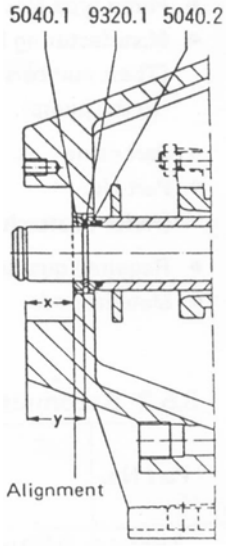


Fig. 6 Correctly sized spacer ring

(5) Follow the table below for the tie bolt tightening torque.

(Unit : kgf)

Pump Size	32	40	50	65
Tie bolt tightening torque	7	8	10	10

Table 2. Torque tightening tie bolt.

(6) After the reassembling work, check the condition of the coupling set in the procedure given in Para. 1. 2 and start the pump pursuant to Para. 2. 1.

3. 4. Bearing

(1) Bearing spesification – Single row deep groove ball bearing.

Pump Size	32	40	50	65
Bearing No.	$6305C_3$		$6306C_3$	$6307C_3$

Table 3. Bearing No.

Further, the bearing used are of contact rubber sealed type.

Example : Makers NSK DDUC3
NTN LLUC3/2A
KOYO 2RS

(2) Bearing replacement interval.

Replace the bearing with new ones either every about 5000 running hours or every two year's running.

3. 5. Spare Parts

3. 5. 1. Order for spare parts

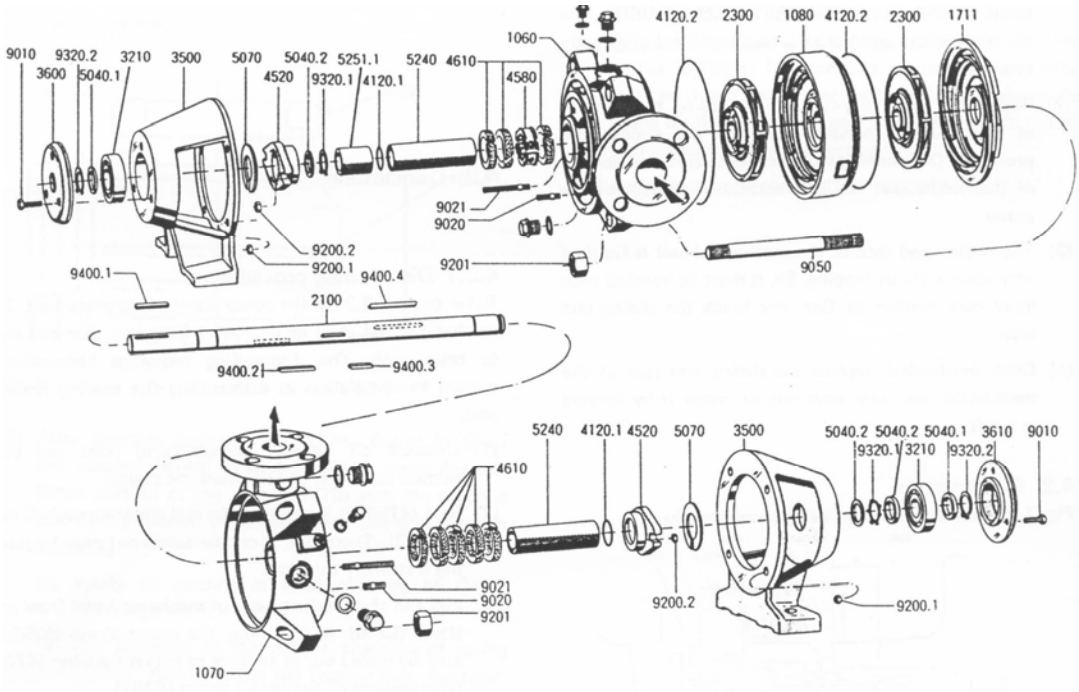
When ordering spare parts, let us have the following information without fail.

- Pump type No. and size
- Manufacturing No.
  (These numbers are identified on the name plate attached to the pump)
- Part name.
- Part No.
  (Refer to attached List of Components)
- Required quantity.
- Material code.

3. 5. 2. Recommended List of Spare Parts for 2 Year's Operation.

Part No.	Part designation		No. of pumps (including standby pumps)						
			1 and 2	3	4	5	6 and 7	8 and 9	10 and over
			No. of sets						
2100	Shaft with keys		1	1	2	2	2	3	30%
2300	Impeller		1	1	1	2	2	3	30%
3210	Deep groove ball bearing		1	1	2	2	3	4	50%
4120.1	O-ring		1	1	2	2	3	4	50%
4120.2	O-ring		1	1	2	2	3	4	50%
4610	Gland packing (set of rings)		2	2	3	3	3	4	50%
5240	Shaft protecting sleeve		1	1	2	2	3	4	50%
On pumps with mechanical seals									
4000	Gasket	Part nos.	2	3	6	8	8	10	50%
5241	Seal sleeve	4610 + 5240	2	2	2	3	3	4	40%
4330	Mechanical seal	are not fitted	2	2	4	5	6	7	50%
Coupling									
	Elastic transmission elements		2	2	3	3	3	4	50%

3. 6. Exploded View and List of Components



Part No.	Part Designation	Part No.	Part Designation	Part No.	Part Designation
1060	Suction casing	4120.2	O-ring	9021	Gland bolt
1070	Discharge casing	4520	Stuffing box gland	9050	Tie bolt
1080	Stage casing	4580	Lantern ring	9200.1	Hex. nut
1711	Final stage diffuser	4610	Stuffing box packing	9200.2	Hex. nut
2100	Shaft	5040.1	Spacer ring	9201	Threaded plug
2300	Impeller	5040.2	Spacer ring	9320.1	Circlip
3210	Deep groove ball bearing	5070	Thrower	9320.2	Circlip
3500	Bearing housing	5240	Shaft protecting sleeve	9400.1	Key
3600	Bearing cover	5251.1	Spacer sleeve	9400.2	Key
3610	Bearing end cover	9010	Hex. head bolt	9400.3	Key
4120.1	0-ring	9020	Stud	9400.4	Key

4. Mechanical Seal

4. 1. General Caution

(1) The mechanical seal service life is significantly shortened by impurities if included therein. Therefore, clean the mechanical seal and the pump internals when reassembling and prevent invasion of such impurities into the mechanical seal from the flushing line during pump running.

(2) Absolutely avoid dry-running (including the running at seal chamber pressure less than the atmospheric pressure). Dry-running would cause seizure and damage of the mechanical seal and occasional damage of the pump.

(3) The sliding end face of the mechanical seal is finished very accurately by lapping. So, it must be handled with good care neither to flaw nor break the sliding end face.

(4) Once overhauled, replace the sliding end face of the mechanical seal with new one or repair it by lapping as a rule.

4. 2. Construction

Fig. 7 Illustrates the mechanical seal construction.

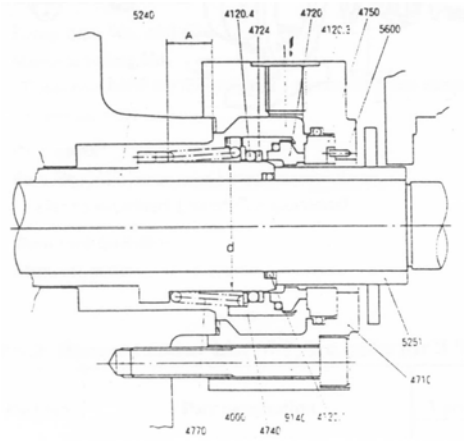


Fig. 7 Construction of Mechanical Seal

Part No.	Part Designation	Materials	Pcs.
4000	Flat gasket	Valqua #1500	2
4120.3	O-ring	Viton	2
4120.4	O-ring	Viton	2
4710	Seal cover	FC20	2
4720	Washer	Carbon	2
4724	Back up ring	SUS304	2
4740	Stopper	SUS304	2
4750	Seat	SiC	2
4770	Spring	SUS304	2
5241	Seal sleeve	FC2O+HCr plated	2
5251.2	Spacer sleeve	FC20	2
5600	Pin	SUS316	4
9140	Hex. bolt	SUS420J2	8

4. 3. Dismantling

4. 3. 1. Dismantling Procedure

Refer to paragraph. 3.2 for the pump dismantling procedure. The mechanical seal shall be dismantled from one side and then to other side. The dismantling sequence hereunder is subject to completion of dismantling the bearing housing unit.

(1) Unscrew off hexagon socket head bolts and then remove seal cover (4710) from the casing.

(2) Seat (4750) is inserted in the seal cover through O-ring (4120.3). Therefore, it can be taken out only by pushing it strongly by hand.

(3) Pull out the rotating parts of mechanical seal from seal sleeve (5240). At this time, the spacer sleeve (5251.2) may be pulled out in advance to prevent washer (4720) from contacting the spacer sleeve (5251).

4. 3. 2. Inspection and adjustment of dismantled parts.

(1) Inspect the wear state of the sliding surface of the seal.

(2) As a rule, the mechanical seal once used, must be replaced with new one irrespective of the running hours. However, stopper (4740), back-up ring (4724) and spring (4770) are available for further re-use unless they are flawed. In addition, if the wear degree of seat (4750) and washer (4720) is small, these parts also are available for further re-use by lapping-repair.

(3) Inspect the presence or non-presence of flaw on the portion of seal sleeve (5240) to insert the O-ring (4120.4).

(4) Check the presence or non-presence of flaw on the contact surface of seal cover (4710) and the seat (4750).

(5) After the above inspection, clean adequately each part in washing oil.

4. 4. Reassembling

(1) Insert O-ring (4120.3) in Fig. 8 in the seal cover after thin oil coating (turbine oil or machine oil) was applied thereto. Then, apply same oil coating to the peripheral surface of the seat and insert it in the seal cover, with its lapped surface upside. At this time, pay special attention to the positions of the notch for seat locking and lock pin (5600). After insertion, check for inclination of the seat.

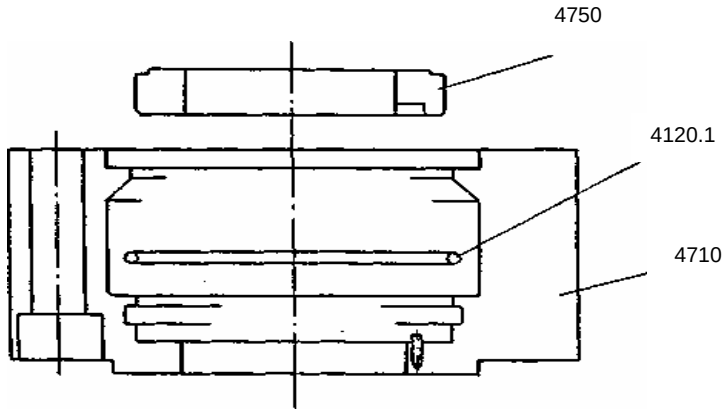


Fig. 8

(2) After inserting back-up ring (4724), O-ring (4120.4) and stopper (4740) in washer (4720), insert the projected portion of the spring (4770) into the notched hole of the washer. In this case, pay special care to the following.

(a) Apply oil coating in small quantity to O-ring (4120. 4).

(b) Pay attention to the coiling direction of spring (4770). Viewing from the suction side, the right-hand coiled spring is for the suction side use and the left hand coiled one for the discharge side use. (Refer to Fig. 9) Reverse fitting of these springs would cause them to break during the pump running. Therefore, fit them at the specified side without fail.

Right-hand coiled spring　　Left-hand coiled spring

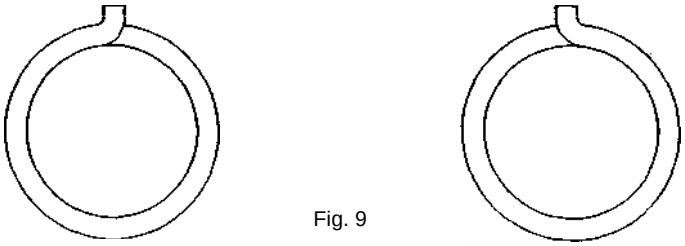


Fig. 9

(3) Insert seal sleeve (5240) in the shaft and then insert O-ring (4120. 1) in the seal sleeve after thin oil coating applied thereto.

(4) After applying oil coating to the seal sleeve, insert the rotating portion of the mechanical seal on the seal sleeve in alignment of the spring rear projection with the notched hole of the seal sleeve. And push the sliding surface of the washer in the spring compression direction two or three times to check the O-ring followability.

(5) Insert the spacer sleeve (5241. 2) in the shaft.

(6) Wipe off the sealing end face of the seat and the washer in finger for complete removal of dust. After that, joint the seal cover with gasket (4000) to the casing by tightening hexagon socket head bolts (9140) with uniform tightening torque.

This completes the mechanical seal reassembling.

5. Trouble Shooting

When repair is required to eliminate fault or defect, the portion to be repaired must be checked using a proper instrument. Accordingly, inspect and calibrate the instrument before the use.

5. 1. Discharge capacity down

Possible Cause	Remedy / Corrective Action
1. Too high back pressure.	The actual required head is to high as compared with the initial design head. Accordingly, consider of the increase in no. of revolutions, the use of larger impeller, or the increase in no. of stages.
2. Insufficient exhaust from pump or piping.	Exhaust carefully once more. Repair the piping when deemed as necessary and add an exhaust valve and an exhaust pipe.
3. Blocked suction pipe or blocked impeller.	Clean the pipe and take out the impeller for inspection and cleaning when deemed as necessary.
4. Too low suction head.	Check the water level in feed water tank. Also, be sure to check that

	all the suction line valves are kept fully opened. In addition, inspect the suction pipe to check for poor fluid flow or great flow resistance. Clean well the strainer if provided.
5. Reverse rotational direction.	Interchange the wiring connection to the motor terminal. Should the pump rotate reversely, check the packing sleeve and retighten it as necessary.
6. No. of revolutions (rotational speed slower than the specified).	Check voltage and frequency.
7. Wear of pump component.	Overhaul the pump to check the wear degree of parts and replace worn parts with new one(s) if necessary.

5. 2. Overload of driver (electric motor)

Possible Cause	Remedy / Corrective Action
1. Pump back pressure lower than the specified.	Clean the discharge sluice valve up to the specified pressure point.
2. Handling of fluid with greater specific gravity or at lower temperature than that specified in specification.	Where it is not impossible to keep specific gravity and temperature indicated in the specification, but the discharge capacity to the allowable rate of the driver. When good effect cannot be obtained even after that, be in touch with our Technical Departement.

5. 3. Excessive discharge pressure

Possible Cause	Remedy / Corrective Action
1. Excessive rotational speed.	Check the rotational speed (no. of revolutions) carefully. In the event of failure in speed down, be in touch with our Technical Departement for further instruction. In such case, it will be necessary to either reduce the number of stages or to cut the impeller diameter.
2. Too low discharge temperature or too large specific gravity.	When the pump running in such conditions is required, be in touch with our Technical Departement for further instruction.
3. Too high force head.	Investigate carefully the forced head. If the change of this pipeline is impossible, be in touch with our Technical Departement.

5. 4. Leak from pump (leak from other than gland)

Possible Cause	Remedy / Corrective Action
1. Insufficient tightening torque of mounting bolts.	Retighten them with uniform tightening torque after complete shutdown internal pressure drop and complete cool-down of the pump.
2. O-rings.	Retighten the bolts.If fluid still leaks even after retightened, replace O-ring with new one.
3. Rapid change of fluid temperature.	Rapid temperature down would cause eventual leak from the pump. Accordingly, check whether or not fluid leaks from the pump even after the temperature rises up to normal degree. If still leaked, it will show fault of O-ring. When fluid still leaks even after the bolts retightened, take corrective action in the above item-2.

5. 5. Leak from gland packing

Possible Cause	Remedy / Corrective Action
1. Wear or imperfection or improper insertion of packing rings.	Re-insert the packing rings.
2. Damage of packing sleeve caused by over-clamped or irregularly clamped gland.	Re-polish or replace the sleeve. After replacement of the packing, tighten carefully the gland nut.
3. Unsmooth rotation of pump, so called, swing of the shaft.	Unsmooth rotation of the shaft cause leak from the gland. In such event, check carefully gap in the bearing and replace it with new one if necessary. If fluid still leak even after replacement, overhaul the pump to find out faulty part.

5. 6. Overheat of bearing

Possible Cause	Remedy / Corrective Action
1. Imperfect centering of pump and driver (motor).	Check the centering and leveling state.
2. Abnormal piping load acts on the pump.	Modify properly the piping to remove abnormal load on the pump, and make re-centering.
3. Inaccurate clearance between coupling halves.	Adjust it to the value shown in the drawing.
4. Damage of bearing or deterioration of grease.	Replace the bearing or grease with new one.

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