طرح نگهداشت و افزایش تولید 27 مخزن

INSTALLATION, OPERATION & MAINTENANCE MANUAL

نگهداشت و افزایش تولید میدان نفتی بینک

V00	JUN.2024	IFR	Havayar Co.	M.Fakharian	M.Sadeghian	
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CHAPTER IV. ASSEMBLY, DISASSEMBLY AND MAINTENANCE

INTRO. GENERAL SAFETY PRECAUTION

● SAFETY PRECAUTIONS

The installation, operation and maintenance of compressors and auxiliary components may include certain risks inherent to this type of equipment.

The following list of safety precautions should be thoroughly read and reviewed with all personnel before working with compression equipment or systems.

The list of safety precautions is broken down into the following categories:

1) General Safety Precautions

2) Safety Precautions for Frame and Running Gear Maintenance

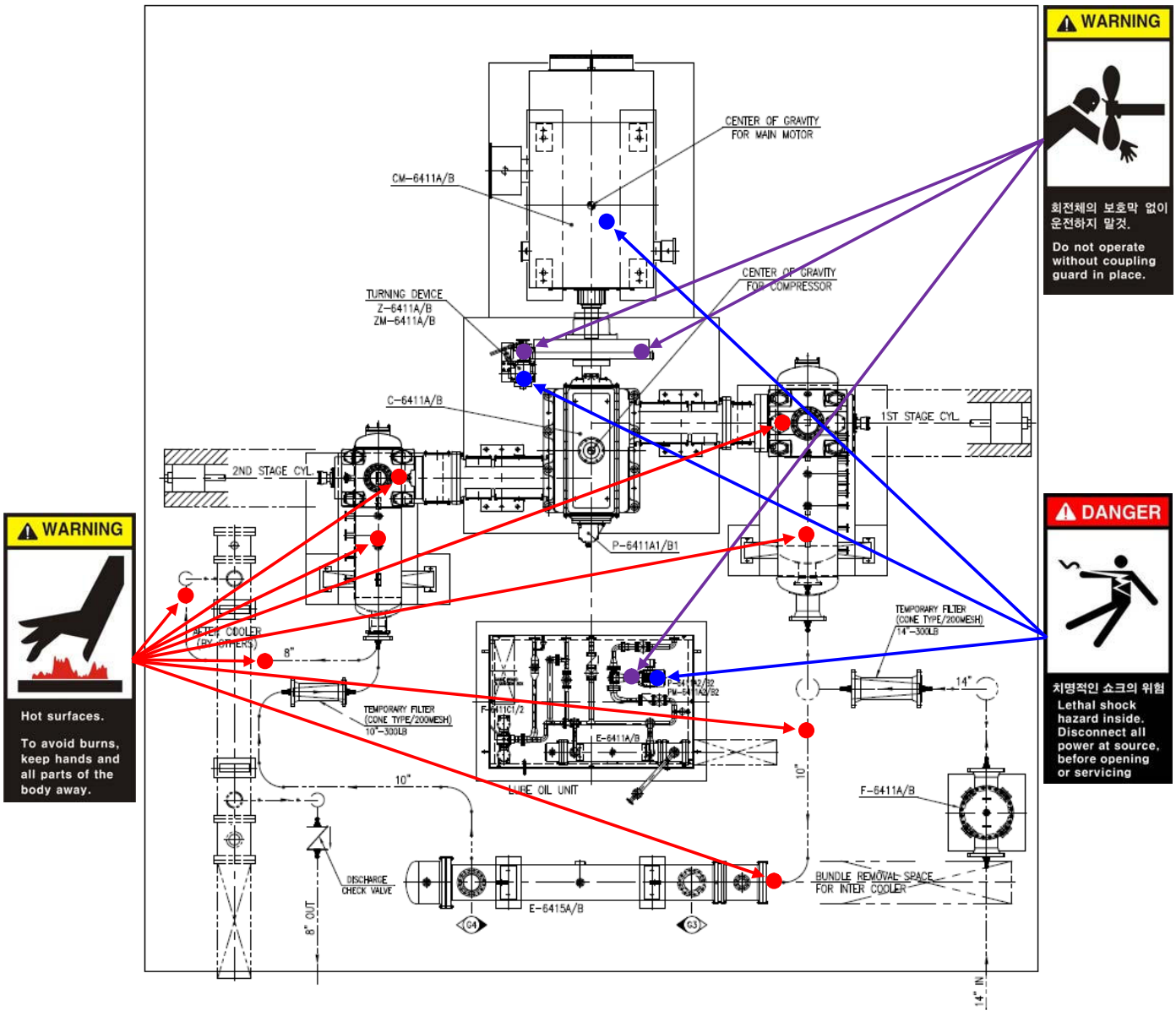
3) Cylinder Preventive Safety Measures

4) Safety Precautions for Cylinder Valve Maintenance

All employees should be aware that not all safety precautions are for specific hazards.

In addition, attention should be paid to other hazards not covered in this manual.

REFERENCE



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SAFETY PRECAUTIONS

1) General Safety Precautions

1-1) Rated Capacity,

Do not operate this equipment in excess of speed, pressure and temperature, or in excess of the conditions specified in the sales contract in accordance with the instructions contained in the "Installation, Operation and Maintenance Manual". Undesigned loads can cause serious equipment problems.

1-2) Pipes or equipment with hot or cold temperatures to which operators may come into contact must be properly protected or insulated.

1-3) Ventilation in areas and buildings with compressors handling hazardous gases must be designed to prevent recirculation or concentration of leaking or escaping gases.

1-4) Compressors must be equipped with safety valves to limit the discharge and stage-to-stage pressure to a safe minimum.

1-5) Safety valves should be tested for the set pressure at least once a year and more often in extreme conditions with appropriate bench testing.

1-6) If the safety valve bursts during operation, stop the device immediately, investigate the cause, and discard the nonconforming product.

1-7) Pressure relief devices venting to the atmosphere should be connected to the vent, avoiding the operator position where possible.

1-8) Rotating equipment must not operate without proper protection for rotating parts.

1-9) Machine maintenance should always start with floor cleaning, machine inspection and outside cleaning of the machine to remove any oil that could cause the maintenance personnel to slip.

1-10) Volatile flammable liquids should not be used as cleaning agents for compressor parts. Prior to assembly, use a safety solvent and dry parts thoroughly.

1-11) Before operating the compressor, ensure that “all pressure” has been released from the gas passages, frame and piping.

1-12) If overheating is suspected due to signs such as a frame breather or other smoke, the crankcase upper cover should not be opened until sufficient time has been given to cool down.
Opening the crankcase prematurely on an overheated machine can cause the crankcase to explode.

1-13) Do not open the compressor cylinder or any other part of the compression system until you have first completely relieved all pressure inside the system and take necessary precautions to prevent accidental recompression of the system.

1-14) Use a movable base for maintenance and/or inspection of out of reach areas in accordance with the instructions on safety precautions.

1-15) Use a suitable stand for operation of vents and other valves in elevated positions.
Do not work on plumbing, etc.

1-16) After installation is complete, remove the lifting lugs protruding from the passage.
If possible, bend the ground lug to avoid damage to the safe side.

1-17) Operate each stop valve in the proper position, taking into account the valve handle.

2) Safety Precautions for Frame and Running Gear Maintenance

2-1) Make sure the main driver is locked so there is no possibility of the driver starting.

2-2) Close the suction and discharge line valves and remove any residual pressure in the compressor cylinder and frame.

2-3) Install a block or brace under the crankshaft web, or block the crosshead so that the shaft cannot turn while working inside the unit.

2-4) Machine repairs should always begin with cleaning of the floor, workbench and exterior of the machine to remove any oil that could cause the maintenance personnel to slip.

2-5) Compressors handling toxic or flammable gases should be isolated from process piping through blinds or double valves and bleeders when major maintenance is required.

Equipment must be purged or emptied before opening these compressors. Adjustments and maintenance can be carried out if appropriate precautions, such as pressure reduction, are taken to protect the operator. Check valves should not be used for compressor isolation.

2-6) Volatile flammable liquids should not be used as cleaning agents for compressor parts. Use a safe solvent and dry parts thoroughly before assembly.

3) Cylinder Preventive Safety Measures

3-1) Eliminate the possibility of accidentally restarting the compressor.
The equipment must be marked with the warning "WORK IN PROGRESS-DO NOT START".

3-2) Close the suction and discharge line valves and relieve any pressure that may be in the cylinder. Take necessary precautions to prevent accidents due to re-pressurization of the system.

3-3) Compressors handling toxic or flammable gases should be isolated from process piping through blinds or double valves and bleeders when major maintenance is required.
Equipment must be purged or emptied before opening these compressors. Adjustments and maintenance can be carried out if appropriate precautions, such as pressure reduction, are taken to protect the operator. Check valves should not be used for compressor isolation.

3-4) Install a block or brace under the crankshaft web, or block the crosshead so that the shaft cannot turn while working inside the machine.

3-5) Volatile flammable liquids should not be used as cleaning agents.

3-6) Incorrect placement of the suction and discharge valves on the compressor cylinder can lead to extremely dangerous situations.
Please refer to “OPERATION AND MAINTENANCE MANUAL (Chapter IV-1-6. COMPRESSOR VALVE)” before installing the valve.

4) Safety Precautions for Cylinder Valve Maintenance

4-1) Observe all safety precautions before removing the compressor valve.

It is especially important that all pressure is released from the cylinder passages and piping before opening the valve cover.

4-2) Whenever the compressor valve is removed, it is very important to properly reinstall the intake and discharge valves on the cylinder.

Improper installation of the cylinder's suction and discharge valves can lead to extremely dangerous situations.

◈ CAUTION : Installing a suction valve in the discharge valve port or installing the discharge valve upside down may cause an explosion.

CHAPTER Ⅰ. SPECIFICATION OF GAS COMPRESSOR

* Attach. 1-1. Reciprocating Compressor Data Sheet

RECIPROCATING COMPRESSOR DATA SHEET

DOC. NO.	VP-23006-026	REV.	D
PAGE NO.	1 OF 3		

1	CUSTOMER	**HAVAYAR INDUSTRIAL GROUP**								PREPARED BY :			
2	PJT. NAME	Binak Oil Field Development Project								PREPARED BY :			
3	M/O NO.	**SR23006**		ITEM NO.	**C-2101A/B/C & C-2102A/B/C**					REVIEWED BY :			
4	SERVICE	Sour Gas Compressor								REVIEWED BY : J.Y.KIM			
5	NO. REQ'D	WORKING 2		STAND-BY 1		TOTAL 3				APPROVED BY :			
6	**(OPERATION CONDITIONS)**												
7	NO. OF STAGE (S)			TWO (2)									
8	GAS HANDLED			Sour Gas (Details of Gas Composition)									
9	ATMOSPHERIC PRESSURE	(mmHg)		760									
10	CAPACITY	(kg/hr)		8935.5						8343.5 (7585*1.1)			
11		(Nm^3/hr)		8162.9 (7918/0.97)						8668.6			
12		(Am^3/hr)		**1613.1**									
13	**(SUCTION CONDITIONS,CYLINDER FLANGE SIDE)**												
14	STAGE	(Two)		(1ST / SUMMER)		(2ND / SUMMER)				(1ST / WINTER)		(2ND / WINTER)	
15	PRESSURE	(kg/cm2.G)	(barg)	4.90	4.805	17.19	**16.856**			4.90	4.805	17.19	**16.856**
16	TEMPERATURE	(℃)		36.8		59.9				18.9		59.9	
17	RELATIVE HUMIDITY	(%)		SATURATED		SATURATED				SATURATED		SATURATED	
18	MOLECULAR WEIGHT	(g/mol)		24.52		24.52				21.56		21.56	
19	Cp/Cv	(K1)		1.245		1.278				1.280		1.295	
20	COMPRESSIBILITY	(Zs)		0.975		0.936				0.977		0.951	
21	**(DISCHARGE CONDITIONS,CYLINDER FLANGE SIDE)**												
22	PRESSURE	(kg/cm2.G)	(barg)	18.31	17.956	55.98	54.898			18.31	17.956	55.98	54.898
23	TEMPERATURE	(℃)		129		148				116		**149**	
24	Cp/Cv	(K2)		1.245		1.278				1.280		1.295	
25	COMPRESSIBILITY	(Zd)		0.964		0.923				0.970		0.948	
26	INTER STAGE PRESS. DROP	(kg/cm^2. G)		**1.122**		0.000				**1.122**		0.000	
27	COMPRESSION RATIO	(Rc)		3.260		3.129				3.260		3.129	
28	BHP OF EACH STAGE	(kw)		441.0		463.0				435.0		481.3	
29	TOTAL BHP	(kw)		903.9						916.3			
30	ROTATIONAL SPEED OF COMP'R (rpm)			420				(PSV Setting : 963.9 kW @ 63.22 kg/cm2.G)(62.0 barg)					
31	**(OTHER CONDITIONS)**												
32	COMP'R TYPE	□ "D" TYPE	□ "Y" TYPE	□ "L" TYPE	□ "C" TYPE	■ BALANCED OPPOSED TYPE (2-THROW)							
33		□ NON-LUBRICATED	■ LUBRICATED										
34		■ WATER COOLED	□ AIR COOLED										
35	DRIVER	□ V-BELT	TYPE :	PCS :	LENGTHS : C =	mm),	inch.						
36			COMP' PULLEY DIA. :	mm	MOTOR PULLEY DIA. :	mm.							
37		■ DIRECT BY COUPLING (FLEXIBLE DISC)	FLY WHEEL DIA. :	1940	mm								
38	COMP'R ROTATION (view comp'r pulley side)	■ CW	■ BARRING DEVICE : ELECTRIC TYPE (MANUFACTURE'S STD)										
39	ELECTRIC MOTOR SPEC.	TYPE	Exe. II T3 (IP55)	MANUFACTURER	LATER								
40		SPEC.	**1070 kw**	11000 volts	3 phase	50 Hz	14 poles	420 rpm					
41		STARTING METHOD	■ DIRECT ON LINE START	□ Y-△	□ REACTOR								
42		INSULATION CLASS	■ B(temp)	■ F	LOCATION	□ INDOOR	■ OUTDOOR						
43	CAPACITY CONTROL	■ SUCTION VALVE UNLOADER : FINGER	■ REVERSE (AIR TO LOAD / FAIL SAFE), I/A : 4~8.5 barg)										
44		■ START-STOP	■ 5-STEP (0,25,50,75,100%)	■ BY-PASS CONTROL SYSTEM (BY HAVAYAR)									
45		□ BY FINAL PRESSURE	■ FIXED CLEARANCE POCKET : 25% (HEAD SIDE)										
46	COMP'R LOCATION	□ INDOOR	■ OUTDOOR	□ AMBIENT : (MAX.50~5)℃ / R.H : (0~100)%									
47	ELECTRIC AREA	□ NON-HAZARDOUS	■ HAZARDOUS	□ ZONE 2, GR.IIB, T3									
48	CONTROL POWER	■ AC 110 volts	1 phase	50 Hz									
49	PAINTING COLOR(Munsell No.)	■ MANUFACTURER'S STANDARD	■ JOB SPEC.										
50	APPLICABLE CODE	■ MANUFACTURER'S STANDARD	■ API 618(5th)	■ ANSI, ASME, NACE MR-0175									
51	REMARKS	1) The Lubricator applies a Motor driven Type **(Electric Motor and Lubricator Heater by Manufacture's Scope)**											
52		**2) The Hydraulic tension tools to be in Manufacturer's scope**											
53													
54													

RECIPROCATING COMPRESSOR DATA SHEET

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CUSTOMER	HAVAYAR INDUSTRIAL GROUP	ITEM NO	C-2101A/B/C & C-2102A/B/C	
PJT. NAME	Binak Oil Field Development Project	M/O NO.	SR23006	
SERVICE	Sour Gas Compressor			

(CYLINDER DATA)

STAGE	(1ST)	(2ND)	-	-
NO. OF CYLINDER PER STAGE	1	1		
SINGLE / DOUBLE ACTING	DOUBLE	DOUBLE		
CYLINDER LINER YES / NO	YES	YES		
CYLINDER LINER WET / DRY	DRY	DRY		
OUTSIDE DIA. LINER (mm)	505	310		
BORE (mm)	475	280		
STROKE (mm)	250	250		
PISTON DISPLACEMENT (m^3/hr)	2192.71	735.77		
VOLUMETRIC EFFICIENCY (%)	73.57	76.71		
NO. OF PISTON RING PER STAGE	5PCS	7PCS		
NO. OF RIDER RING PER STAGE	4PCS	4PCS		
NO. OF SUC. / DIS. VALVE PER STAGE	4/4PCS (Φ200)	4/4PCS (Φ160)		
TYPE OF VALVES	PLATE	PLATE		
PISTON SPEED (m/s)	3.500	3.500	(Max.4.0)	
ROD DIAMETER (mm)	90	90		
ROD LOAD-C (kg)	24075	24980	(Max. 40,000)	
ROD LOAD-T (kg)	22598	20325	(Max. 40,000)	
DESIGN PRESS. (kg/cm2.G) (barg)	24.983 24.5	63.222 62.0	(GAS SIDE)	
DESIGN TEMP. (℃)	180	180	(GAS SIDE)	
HYDRO. TEST PRESS. (kg/cm2.G) (barg)	37.475 36.8	94.834 93.0	(GAS SIDE)	
SUCTION FLANGE SIZE	10"	6"	(CYLIN. SIDE)	
RATING / FACING	ANSI 300LB FF	ANSI 600LB FF	(CYLIN. SIDE)	
DISCHARGE FLANGE SIZE	10"	6"	(CYLIN. SIDE)	
RATING / FACING	ANSI 300LB FF	ANSI 600LB FF	(CYLIN. SIDE)	
TYPE OF MAIN BEARING	☐ SPHERICAL ROLLER B/R		■ SLEEVE B/R	

(COMPRESSOR MATERIALS)

CYLINDER (S)	A395 Gr. 60-40-18	VALVE SEAT (S)	A276 Type 420
CYLINDER LINER (S)	A278 CL.NO.40	VALVE GUARD (S)	A276 Type 420
PISTON (S)	A395 Gr. 60-40-18	VALVE PLATE (S)	PEEK (Non-Metallic)
PISTON RING (S)	Filled PTFE	VALVE SPRING (S)	B637 (Inconel X-750)
RIDER RING (S)	Filled PTFE	CRANK SHAFT	A668 CL.D
DIAPHRAGM (S)	FKM	CROSS HEAD/SHOE(S)	A216 Gr.WCB/ A278CL.NO.35 "Wj2"Coating
PISTON ROD (S)	A564 Type 630 "Tc" Coating	CONNECTING ROD (S)	A668 CL.D

COMP'R PACKING	■ LUBRICATED	■ BUFFER GAS PURGE SYSTEM (N2)	
	■ WATER COOLED	■ PACKING CASE MATERIALS : A276 Type 316L	
	■ Filled PTFE	☐ BRONZE ☐ CARBON ☐ METALLIC ☐ TBM	
DISTANCE PIECE	☐ STANDARD ☐ EXTRA LONG SINGLE COMPARTMENT "B" ■ TWO COMPARTMENT "C"		
LUBRICATION	☐ SPLASH SYSTEM		
	■ PRESS. SYSTEM	OIL PUMP DRIVEN	
		■ COMP'R SHAFT FOR MAIN PUMP	
		☐ ELECTRIC MOTOR FOR AUX. PUMP	
		☐ MANUAL FOR START	
	CRANK CASE OIL CAPACITY 350 (ℓ)	■ ISO VG #100	
	☐ ELECTRIC HEATER (W/THERMOSTART)	☐ STEAM	

REMARKS

RECIPROCATING COMPRESSOR DATA SHEET

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1	CUSTOMER	**HAVAYAR INDUSTRIAL GROUP**	ITEM NO.	C-2101A/B/C & C-2102A/B/C
2	PJT. NAME	Binak Oil Field Development Project	M/O NO.	SR23006
3	SERVICE	Sour Gas Compressor		

(ACCESSORIES)

☐ PULSATION DAMPER (CS)
TYPE ☐ VOLUME BOTTLES ☐ ASME DESIGN
Q'TY: ☐ SUCTION ☐ DISCHARGE
☐ EACH STAGE SUCTION & DISCHARGE

☐ SUCTION LINE FILTER (TEMPORARY TYPE)
TYPE ☐ DRY ☐ SS ☐ 80 mesh ☐ OUTDOOR
☐ 8" ANSI 300LB SO.RF
Q'TY:

☐ UNLOADER SYSTEM
☐ SOLENOID VALVE ☐ FILTER & REGULATOR
☐ MANUAL TYPE ☐ PRESSURE TRANSMITTER

■ LUBRICATION
■ LUBRICATOR(MOTOR DRIVEN) ☐ CHECK VALVE
■ LEVEL GAUGE ■ OIL STRAINER
■ GEAR PUMP (MAIN) ☐ OIL COOLER
☐ OIL FILTER (DUAL) ☐ INTER PIPING (SS)
☐ OIL DRAIN VALVE ☐ PRESSURE TRANSMITTER
☐ GEAR PUMP (AUX.) ☐ RELIEF VALVE

☐ SUCTION K.O DRUM / DEMISTER
TYPE : Q'TY : SET(S)
MAT'L : ☐ LEVEL TRANSMITTER
VOLUME : m3 ☐ LEVEL GAUGE
SIZE : ☐ DRAIN CONTROL VALVE

☐ WATER COOLER (AIR-COOLED)
TYPE : Q'TY : SET(S)
FIN DIA. : HEAD MAT'L :
TUBE SIZE (OD x L x TH'K) X X
TUBE MAT'L : TUBE Q'TY : PCS

☐ INTER COOLER (AIR COOLED)
TYPE : Q'TY : SET(S)
FIN DIA. : HEAD MAT'L :
TUBE SIZE (OD x L x TH'K) X X
TUBE MAT'L : TUBE Q'TY : PCS

☐ AFTER COOLER (AIR-COOLED)
TYPE : Q'TY : SET(S)
FIN DIA. : HEAD MAT'L :
TUBE SIZE (OD x L x TH'K) X X
TUBE MAT'L : TUBE Q'TY : PCS

☐ OIL COOLER (TEMA-C)
TYPE : Q'TY : SET(S)
SHELL DIA. : SHELL MAT'L :
TUBE SIZE (OD x L x TH'K) X X
TUBE MAT'L : TUBE Q'TY : PCS

☐ CHECK VALVE
TYPE Q'TY : SET(S)
SIZE ☐ 4" ANSI 300LB SO.RF

☐ BED
FOR ☐ COMMON BED Q'TY : SET(S)
☐ MOTOR SLIDE BED Q'TY : SET(S)

☐ GUARD (NON-SPARKING)
FOR ☐ V-BELT Q'TY : SET(S)
☐ DIRECT COUPLING Q'TY : SET(S)

☐ PROCESS & UTILITY PIPING
☐ SUCTION ☐ INTER STAGE
☐ DISCHARGE (up to check valve) ☐ N2 GAS LINE
☐ COOLING WATER ☐ OIL ☐ INSTRUMENT AIR

■ THE OTHERS ☐ ANCHOR BOLT & NUT ☐ COUNTER FLANGES ■ NAME PLATE

(SAFETY VALVE)

LOCATION	☐ 1ST DISCH.LINE	☐ 2ND DISCH.LINE	☐ LUBE. OIL LINE	☐ N2 PURGE LINE
SIZE				
SET POINT (kg/cm^2. G)				
Q'TY :				

(CONSUMPTION OF COOLING WATER)

SERVICE	CYLINDER(1ST)	CYLINDER(2ND)	AFTER COOLER	OIL COOLER	PACKING CASE
CAPACITY (ton/hr)	**5.3**	**9.6**			**0.4**
INLET TEMP. (℃)	**63**	**63**	**<- Havayar Commented. ->**		**63**
OUTLET TEMP. (℃)	**70**	**70**			**70**
PRESSURE (kg/cm^2. G)	3.0	3.0			3.0
TOTAL (ton/hr)	**15.3**				

(ELECTRIC SERVICE)						**(ALARM & SHUT DOWN)**		
	kw	volts	phase	Hz	poles	☐ LUBE OIL PRESS. LOW	☐ ALARM	☐ SHUTDOWN
MAIN DRIVER	1070	11000	3	50	14	☐ LUB. OIL PRESS. LOW.LOW	☐ ALARM	☐ SHUTDOWN
LUBE. MOTOR	**0.4**	**400**	**3**	**50**	**4**	☐ SUCTION PRESS. LOW	☐ ALARM	☐ SHUTDOWN
AUX. OIL PUMP						☐ DISCHARGE PRESS. HIGH	☐ ALARM	☐ SHUTDOWN
OIL HEATER						☐ DISCHARGE TEMP. HIGH	☐ ALARM	☐ SHUTDOWN
BARRING DEVICE	2.2	400	3	50	4	☐ COOLING WATER FLOW LOW	☐ ALARM	☐ SHUTDOWN

REMARKS :

CHAPTER Ⅱ. INSTALLATION

Ⅱ-1. GENERAL

1) Locate the compressor in an area that is clean, well lighted, and well ventilated, with sufficient space for safe and proper inspection and maintenance.
2) The compressor is capable of operating in an ambient temperature up to 40°C (or as specification on data sheet) provided that the area is well ventilated.
3) If air in the area where the compressor is to be installed is acid-laden, or dust-laden, the compressor intake should be piped to the outside.
4) The compressor must not be installed closer than required space on general Arrangement drawing to a wall or to another compressor to allow ample circulation of air across the compressor cylinders and head, and through the coolers if they are part of the system.
5) Additional safety can be achieved by location the pulley or coupling drive system, with the guard, if supplied, on the wall side.
6) Do not install the compressor in a boiler room, paint spray room or area where sand-blasting is carried out.
7) If air in the area where the compressor is to be installed is acid-laden, or dust-laden, the compressor intake should be piped to the outside.

Ⅱ-2. STORAGE

If the compressor is to be stored at any time and it is not resting on a foundation, it must be supported the full length to prevent any possible sag or distortion. It will also be necessary to protect the unit from the weather, either in a building or by a tarpaulin or similar covering.

Protection for longer than 6 month storage period can be provided as an equipment option. This additional protection is normally selected to suit the particular storage

requirements and environmental conditions.

When a lubricated compressor cylinder is shipped, the main bores and gas passages are coated with a rust preventative oil. This oil should not be removed or wiped out of the cylinder until actual starting of the compressor. All of the cylinder openings must be completely closed so that dirt, rain or dust cannot be blown into them.

Non-lubricated compressor cylinders are preserved at the factory by ;

(1) Blowing out bores and gas passages with compressed dry air

(2) Charging dry nitrogen or dry air

(3) Hang desiccant bag one per M3 of the box

(4) Covering the unit with vinyl

(5) Finally, pull out air and charge dry air or nitrogen inside of the vinyl and then tightly closing all openings.

Before storing the unit, it is important to check inside as well as outside the machine to be sure all finished surface and all exposed surfaces subject to corrosion are adequately protected.

During storage, periodically remove covers and check inside of the unit for condensation and for adequate protection of all internal surfaces. This should be done at least once a month and more often if conditions warrant it.

Ⅱ-3. LOCATION AND BUILDING

Where possible select a site for the compressor installation where the soil under and around the foundation will be firm and dry at all times. Inadequate soil conditions require special compensating measures in designing and constructing the foundation.

Before making a final decision on the compressor site, study the foundation plan, installation drawings and piping diagrams.

It is normally a customer option as to whether or not the compressor is placed in a building and the building should then be designed to suit the particular installation. Generally, a building is intended to provide adequate protection against the weather for the operators, compressors and auxiliary equipment. It may be partially or completely enclosed, depending on the site requirements.

The building should be of ample size to provide sufficient working space around each unit. Refer to the compressor layout plan for minimum clearances required to remove compressor pistons and other parts. An overhead hoist, arranged so that it can be moved to a position over any parts of the compressor or driver, will greatly facilitate maintenance work requiring the removal of parts. Select a hoist with enough capacity to lift the heaviest part that may be removed during normal maintenance.

Good lighting is essential for proper operation and care of these units. In addition to daylight and overhead electric lights, outlets should be provided for drop light and extensions convenient to each machine.

Adequate ventilation is essential to safety in any compressor room. Pockets or areas any escaping gas can collect must be avoided. Remember that even the spark from a nail in a shoe can start a fire in a flammable atmosphere. Good ventilation around any compressor is of prime importance to the comfort and morale of the operators.

Ⅱ-4. FOUNDATION SIZE AND DESIGN

Foundation requirements can vary from one installation site to another and will depend upon the soil condition, the gas to be handled, the forces to be absorbed and, in some cases, the climate. The KWANGSHIN, therefore, can suggest only general foundation design criteria to be adapted to the local conditions. So, have to consult with civil engineer who knows well as local foundation condition

1) GENERAL RULES FOR FOUNDATION DESIGN

A few general rules may aid in the design of a foundation Keep the height of the foundation block as low as possible. The greater the height of the block the greater the rocking effect will be consequently, the greater the chance of excessive vibration.

When two or more compressors are to be installed, it is preferable to arrange the units with the crankshaft parallel (not in line) and to have one continuous reinforced mat under all compressor foundation block.

2) FOUNDATION CONSTRUCTION

Build the forms for pouring the foundation so that the top of the foundation will be at the proper to allow for grout placement under the compressor base or skid the recommended grout thickness is shown on the foundation drawing. Be sure that the forms provide for any pockets or depressions in the foundation.

The foundation bolts must be located according to the plan supplied for the unit. To hold the bolt accurately in the position while the foundation is being poured, build a skeleton wood template with holes for the bolts to correspond to the bolt layout plan. Foundation for reciprocating compressors require adequate steel reinforcement. Cracks which would cause little or no concern in ordinary concrete construction are serious in foundation of this type, where they are subject to stresses which can cause the cracks to grew.

A good concrete mixture for compressor foundations are consists 1:2:4 parts of cement : sand(clean and shape) : crushed stone.
If crushed stone is not available, gravel may be substituted, using one part cement to four parts gravel together with the sand. Make sure that the sand, gravel and stone are clean and contain no loam or clay. Impurities will weaken the foundation and may result in an expensive repair later.

After a final check on the location and height of all foundation bolts, the concrete can be poured up to the bottom of the template ; leave the top surface rough to assure a good bond for the grout. After pouring the foundation, cover it with burlap and wet it down twice a day to prevent its drying too rapidly. Allow three or four days to elapse before removing the forms and at least 3 weeks between pouring the foundation and operating the compressor.

II-5. SETTING AND LEVELING UNIT

The following procedure for setting and leveling the compressor can be applied to both block-mounted and skid-mounted units.

1. Roughen the top of the concrete foundation with a star chisel or chipping hammer to remove the surface layer of material which has a low strength ; the roughened and cleaned surface provides a better bond for the grout. Clean the surface of oil. grease, dirt and loose particles.

2. Prepare enough leveling pad plates to allow one being placed near each foundation bolt. The leveling pad plate must be thick enough to allow the recommended grouting space between the top of the foundation and the bottom of the unit.

   Note : Skid-mounted units are leveled by means of setscrews provided in the skid base. A steel leveling plate made from 100mm circular with 25mm thick steel plate, or equal material should be placed under each leveling setscrew to keep it from digging into the foundation and affecting level adjustments.
   (Refer to Attach. 2-1. Compressor GA Drawing, Foundation Drawing and Loading Data)

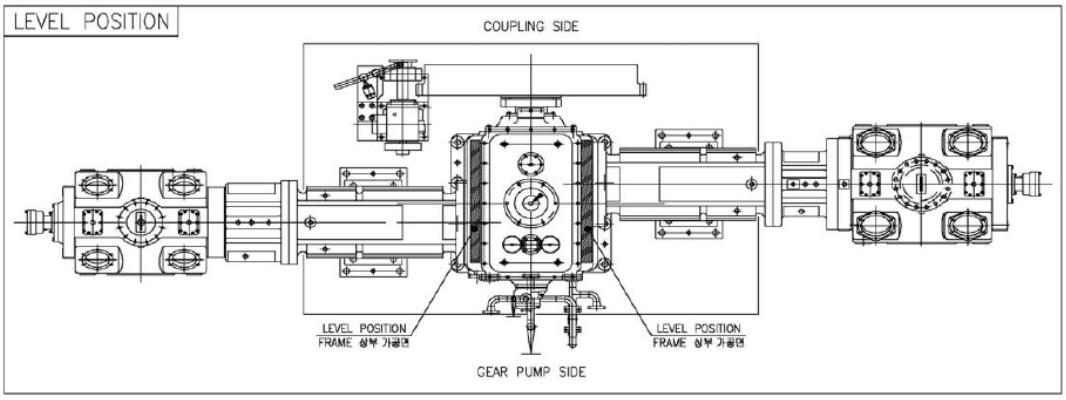
3. Lower the compressor frame over the foundation bolts and onto the leveling pad plates.

4. Adjust the compressor frame is at its desired elevation and is level both longitudinally and transversely.

5. On block-mounted units, adjust the wedges under the distance piece support and outboard cylinder support(if used) so that these supports are carrying the distance piece and cylinder weight but are not placing an upward strain on the frame-to-distance piece or distance piece-to-cylinder bolting. In its final position, the weight of the compressor should be evenly distributed on the leveling pad plates.

6. When the unit is level, place washers and nuts on the foundation bolts and snug them evenly against the frame base flange to hold the final position. At the same time, check with the level to make certain the machine does not shift on the wedges. Do not attempt to level the unit by tightening the foundation bolt/nuts as this can distort the skid base.

7. Recheck the equipment to be sure it is properly aligned and leveled.
   With the unit properly aligned, and with the foundation bolt & nuts pulled down only enough to hold the unit in position, grout in the machine.



◎ Compressor installation and leveling

1. Check the horizontality of the pad plate around the anchor box.
   (Standard value: 0.15mm/m)
2. Loosen the compressor body fastening bolt and disassemble the upper cover.
   When the upper cover is opened, be careful not to let dust enter into the crank case.
3. Measure the X-Y horizontal direction level based on the upper processing surface of the frame. (Standard value: 0.05mm/m)
   Perform calibration work within the standard value using SIM PLATE.

◎ API STANDARD 618

3.5.1.2.2 The upper surface of mounting plates shall be machined flat and parallel to all other mounting surfaces within 0.15 millimeter per meter.

II-6. GROUTING

There are numerous grouting materials and techniques that will provide satisfactory result. The following instructions describe the commonly used sand and cement grout mixture and may require modification when a commercial grouting material is being used.

Note : Commercial grouts include the non-shrink cement grout mixtures and the epoxy grouts. Epoxy type grouts in particular have received increased usage because of their oil resistance, high compressive strength and exceptional bonding characteristics. The final selection of a particular grouting material is the responsibility of the customer or his contractor.

1) The foregoing instructions for preparing the top of the foundation and for setting and aligning the equipment must be closely observed before grouting the unit.
2) Build a temporary dam of boards around the top of the foundation about 50mm higher than the bottom of unit. This will provide a sufficient head on the grout so that it will flow under the compressor frame or skid members and fill voids on the underside of the equipment.
3) Mark the locations of the level wedges, if used, so that they can be removed after the grout has started to set.
4) For proper bonding of the grout to the surfaces being grouted, it is particularly important that these surface be clean and free of all paint, oil and rust. Sand blasting of these surface is preferred ;
   however, properly performed wire brushing can be adequate. After sand blasting or wire brushing, thoroughly clean surfaces with solvent. For best results, complete the surface preparation just before grouting.
5) Before starting to grout, be sure that there are sufficient materials and help available so that the grouting can be completed without interrupt. Keep the top of the foundation wet for 6 to 8 hours prior to the time the actual grouting is started. Then, blow off the excess water with an air hose, paying particular

attention to the foundation bolt holes. It is important that any puddles of water are removed.

6) If Portland cement grout is used, a good mixture is one part normal Portland cement to two parts of clean, sharp, well-ground sand. (It is important that the sand is free from silt or clay) To lessen shrinkage, use as little water as possible.

Note : The strength of a cement grout is reduced, and shrinkage is increased, as larger amounts of water are used.

7) Crumbling grout affords poor support for a compressor installation.
If low temperatures are likely to be encountered before the grout has thoroughly set, precautions must be taken to prevent freezing.

8) Place the grout quickly and continuously to avoid the undesirable effects of overworking. Pour the grout from one side only to assure complete filling of the space to be grouted and to avoid entrapping air.

9) When the grout placement is completed, have a batch of thoroughly mixed dry sand and cement (2 parts sand to 1 part cement) ready to pack in around the edges of the unit.

10) If the installation site is dry and warm, cover the exposed grout with wet burlap bags or similar material and wet thoroughly every few hours to keep it from drying too rapidly and developing surface cracks.

11) The distance piece support, cylinder support and driver are grouted in a similar manner.

12) After the grout has hardened sufficiently, remove the forms.

13) When the grout has set at least 24 hours, remove the leveling wedges and patch.

Caution : It is important that the compressor is supported by the grout and not by the leveling wedges or setscrews.

14) After the grout has thoroughly set (usually about 5 days), pull the foundation bolts down tight. Recheck all leveling points to be sure that the machine was not disturbed during the grouting period. If the unit does not show the level, remove it from foundation, chip off the grout and start over again.

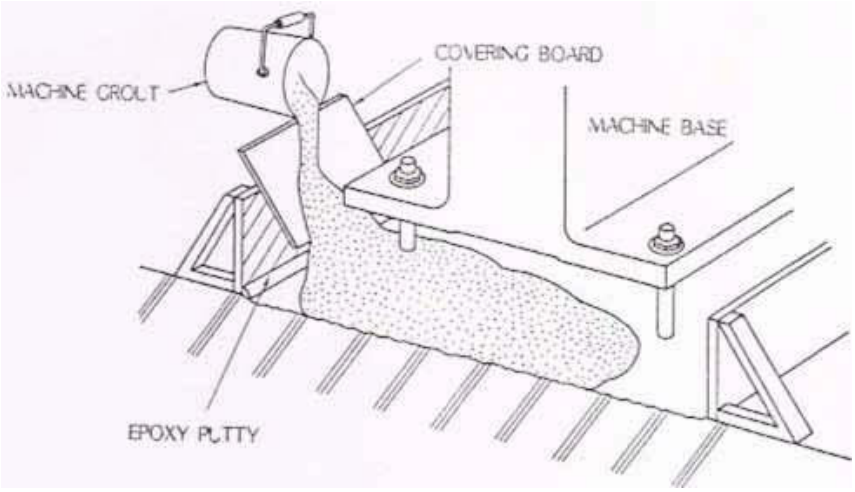
(Refer to Chapter IV-7. General Bolt Conclusion Torque)

15) Before starting the compressor, be sure the grout is thoroughly set and hard and then paint the whole foundation with a good waterand oil-resistant paint. Be careful to make a good paint seal between the unit and the grout so that any oil spilled cannot creep under the equipment to soften the grout. If any oil works its way into the grout, the alignment of the entire machine can be affected as the grout softens. Epoxy type paints are recommended because of their oil resistance and bonding characteristics.

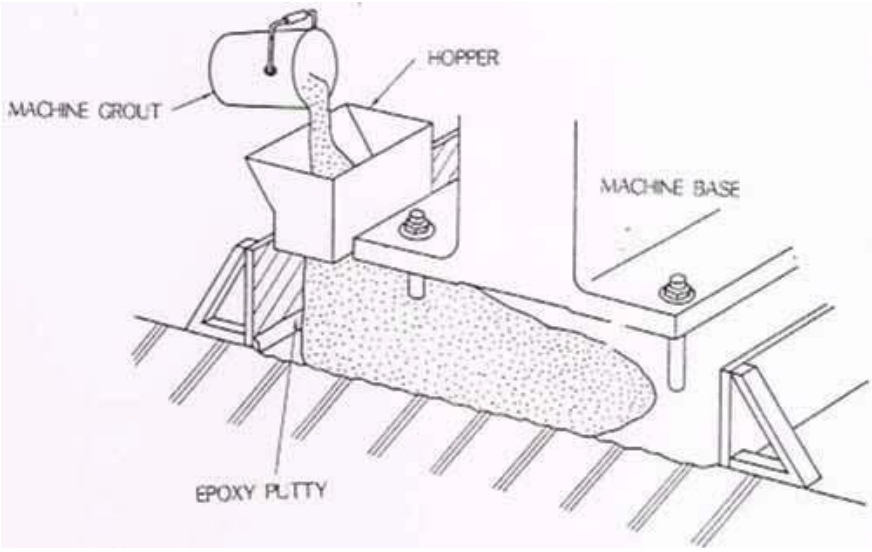
Caution : Do not operate the compressor until the foundation has thoroughly hardened.

1. Pour

Place grout quickly and pour continuously until it flows from one place to another (opposite side) by filling with its own weight (head pressure method).



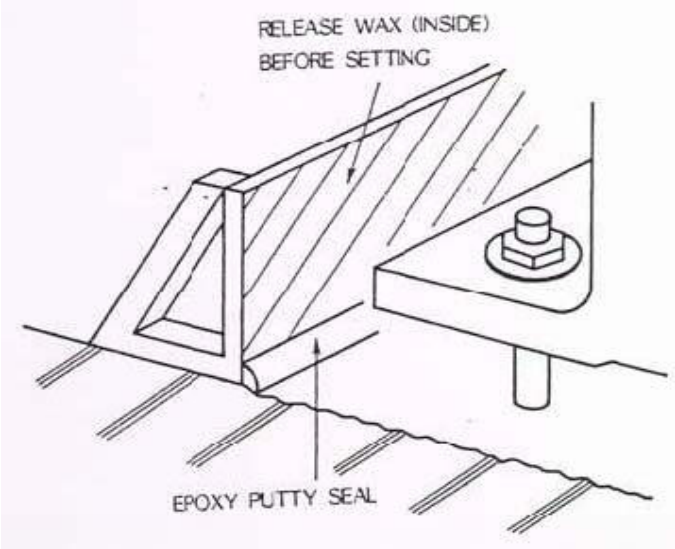
Example 1) Method of direct injection using a base plate, board, etc.



Example 2) Method of direct injection using a hopper

2. Installation of the mold

1) Please the mold has a structure that pours the grout in one place and flows it out to another place (the opposite side), and fix it after installing it firmly so that the grout does not leak or deform the mold during construction.
2) Please assemble the mold 100 ~ 150mm away from the end of the base plate (about 1 ~ 1.5 times the thickness of the grout) and 500mm or more high from the pour level.
3) Apply a releasing agent (wax for FRP) enough to the inner surface of the mold before installing the mold.
4) After installing the molds, the joint between the molds. Seal the gap between the mold and the base container with Epoxy putty to prevent the grout from leaking.

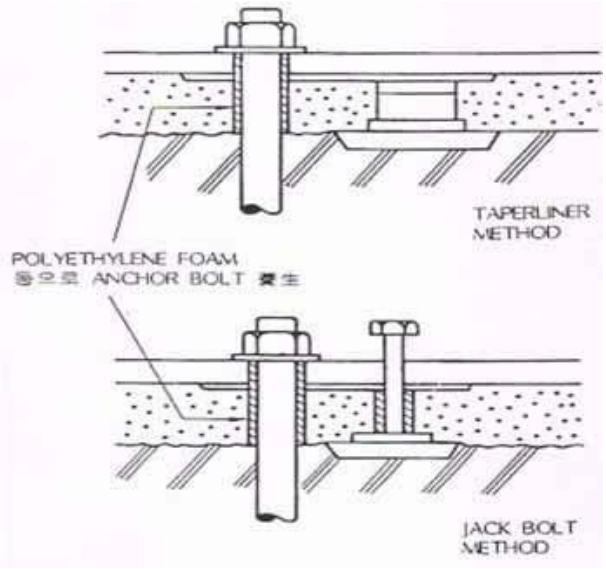


3. Confirmation before GROUT construction

1) Is the amount of prepared grout sufficient?
2) Are construction equipment available?
3) Is the surface of basic concrete clean and dry well?
4) Is the mold firmly fixed and is the sealing between the gaps well?
5) Is the release agent completely applied to the inside of the mold?
6) Is the curing of parts where grouts such as bolts should not be attached?
7) Are the ingredients warmly prepared in winter?

4. Construction preparation

1-1. Construction pretreatment



1) LAITANCE (10~25mm) of the foundation concrete surface, remove the chipping from the weak layer and the emulsion using a chipping hammer, etc., and expose the dry contact surface to dry.
   Also, use a vacuum cleaner to remove dust sufficiently.
2) In particular, never spray water on the concrete side during finishing chipping.
3) Remove machine oil, expanded rust or mixed debris from the bottom of the base plate before setting the base plate.
4) In the jack bolt for anchor bolt level adjustment, prevent the bolt from being locked right under the machine.
   In order to facilitate the disassembly of the jack bolt after hardening of the grout, wrap it with a POLYETHYLENE FOAM SHEET (1~2mm thick) to prevent adhesion to the grout.

CHAPTER Ⅲ. OPERATION

Ⅲ-1 OPERATION AND CONTROL

1) Before operating the compressor, check as follows.

1-1) Check that the control panel status (operation switch and various indicator lights) and signal interconnection with the outside are correctly connected.

1-2) Before starting the compressor, Aux. Pre-Lubrication should be performed for 10~30 minutes with lube oil pump.

1-3) Check the open status of various valves in the cooling water line of the compressor.

1-4) Check if the indication of crank case lube oil level is appropriate.
(The intermediate indication of the oil level gauge is normal.)

1-5) Check if the valve is completely open on the suction side & discharge side, and check if the positions of various valves such as other vents are open/closed to the normal position.

1-6) Check the N2 purge system installed in the compressor.

1-7) Check if N2 gas is being supplied normally.

1-8) Check that there is no abnormal state by rotating the compressor coupling with the turning device.

1-9) Check if the direction of rotation of the compressor is correct.

2) Running

2-1) Compressor operation method

2-1-1) Test Running

2-1-2) Normal Running

2-2) Test Running

When starting the first compressor unit after installation or overhaul, perform test running in the following order prior to “Normal Running”.

Especially, when disassembling the compressor for overhaul, be sure to purify the residual gas must be purged.

Gas piping through cylinder valve must be cleaned. If in gas piping when the remaining slug after welding flows into the compressor cylinder, piston rings and packing rings, etc. will be damaged.

2-2-1) Piping

ITEM	PROCEDURE	REMARKS	RESULT
Piping	(1) Check if gas piping, cooling water piping, lube oil piping, instrument roots valves, and auxiliary piping are installed correctly. (2) Check if Stop Valves, Safety/Relief Valves, Check Valves, etc. are installed correctly. (3) Check that there is no blind flange on the piping. (4) Check if Pressure Gauge, Thermometer, etc. are in the correct position.	* Comparison check for P&ID and Piping layout drawing. * Check the flow direction. * Check by hydrostatic test and press tightness test. * Remove the blind flange.	□YES □NO □YES □NO □YES □NO □YES □NO
※ Refer to the “P and I Diagram”			

2-2-2) Compressor

ITEM	PROCEDURE	REMARKS	RESULT
Compressor	(1) Check whether abnormal causes remain during installation and assembly. (2) Check if Suction, Discharge Valve and Flare Header Vent Line are installed correctly. (3) Check whether packing and gaskets are set in the correct position (4) Check whether various bolts and nuts are completely locked (5) Check whether the crank case and all lube oil lines are completely flushed.		□YES □NO □YES □NO □YES □NO □YES □NO □YES □NO

2-2-3) Check before Test Running

ITEM	PROCEDURE	REMARKS	RESULT
Before Test Running	(1) Check if you have used a Lubricant that meets the Spec. (2) Completely open the cooling water valves such as the main pipe of the compressor, cooler, and cylinder. Check the coolant flow and leak. (3) Check that there are no irregularities in all driving parts by turning manually. (4) When cleaning operation conditions are completed Suction inlet filter and temporary filter are cleaned or replaced. (5) Check if there is no Power & Abnormal condition of Local Control Panel.	* Check by Electric Barring Device	□YES □NO □YES □NO □YES □NO □YES □NO □YES □NO
Details to check before Compressor Start	(1) Momentarily turn on/off the switch to check the rotation direction of the motor. (2) In case of no-load break-in operation, the suction pipe should be left open. (3) No-load cleaning operation (if Required). (4) Pressurizing operation procedure a) Atmosphere air (if required) b) N2 Gas (if required) c) Process gas (5) Full load continuous operation In case of continuous operation in (4), it is carried out when there is no irregular abnormality as a result of the inspection in unloaded operation. After normal operation for about 3~4 hours after full load operation, check the motor power capacity, bearing temperature, and vibration.	* Check whether abnormal noise is generated from the driving part * Check the noise, vibration, and motor current fluctuation status. * It must be kept clean so that there are no foreign substances in the piping. * When using a separate test gas, inert gas must be used.	□YES □NO □YES □NO □YES □NO □YES □NO □YES □NO

2-2-4) Check after Test Running

ITEM	PROCEDURE	REMARKS	RESULT
After Test Running	After full load continuous operation, check the following before normal operation. (1) Check the bearings of each driving part. (2) Disassemble the Suction and Discharge Valve and check if there is any problem. (if Required) (3) Recheck whether each tightening bolt & nut is loose.		 □YES □NO □YES □NO □YES □NO

2-3) Normal Operation

ITEM	PROCEDURE	REMARKS	RESULT
Before Normal Operation	(1) Check the cooling water supply and air vent for the following items. * Cylinder * Lube oil cooler * Gas cooler * Rod pressure packing assembly		□YES □NO
	(2) Check the crank case oil level and oil supply pressure.	* Check the Crank case oil level is maintained above the center of the oil level gauge. Check the oil supply pressure.	□YES □NO
	(3) Check the full open of each drain valve.	* Close valve after drain	□YES □NO
	(4) If the compressor is stopped for a long time in winter, it must be manually turned and lubricated sufficiently in case of initial start-up, and check whether oil is supplied inside without fail.	* Check by running Auxiliary lube oil pump motor.	□YES □NO
	(5) Check the supply of N2 Gas to the distance piece.		□YES □NO
	(6) Check whether the open/close of each stop valve works well. a) Full close valve : * Vent Valve * Drain Valve b) Full close valve : * Main suction / discharge valve * Cooling water main In/out valve		□YES □NO
	(7) Check the device for no-load start-up : * Solenoid valve	* Put the switch installed on the Local Control Panel in the Unload position.	□YES □NO
	(8) Check if process gas is normally supplied.		□YES □NO

2-4) Precaution during Continuous Normal Operation

During continuous normal operation, if there is an abnormal problem for the following items, immediately stop the compressor and check the problem.

2-4-1) Hourly Inspection

ITEM	PROCEDURE	REMARKS	RESULT
Hourly Inspection	Check the following items every hour. (1) Suction and discharge gas pressure. (2) Suction and discharge gas temperature (3) Lube oil press. (4) Cooling water pressure and temperature (5) Electric motor current		□YES □NO

2-4-2) Periodical Inspection

ITEM	PROCEDURE	REMARKS	RESULT
Periodical Inspection	Check the following items periodically.		
	(1) Abnormal Noise		□YES □NO
	(2) Crank case lube oil level		□YES □NO
	(3) Oil scraping condition of piston rod in distance piece		□YES □NO
	(4) Operation condition of rod pressure packing assembly	* Piston Rod surface inspection	□YES □NO
	(5) Deterioration of lube oil function	* Oil change	□YES □NO
	(6) Oil filter failure (clogging)	* Check Oil Pressure Drop	□YES □NO
	(7) Check whether the cylinder cooling water jacket is overcooled.	* If condensate occurs outside the jacket, it is recognized that it is over cooling.	□YES □NO
	(8) Compressor or auxiliary abnormal vibration of the device occurs	* Stop the compressor and check the cause of vibration.	□YES □NO

2-4-3) Caution when Stopping for a Long Time

ITEM	PROCEDURE	REMARKS	RESULT
Caution when Stopping for a Long Time	(1) Completely drain the water remaining in the cylinder & packing and cooler.		□YES □NO
	(2) All open stop valves are fully closed when stopped		□YES □NO
	(3) Lock SWGR to avoid accidental start.		□YES □NO
	(4) Sealing N2 gas to the cylinder to prevent rust of the machine during stop.	* Turn off control power. * Proceed emergency lock.	□YES □NO
	(5) It is recommended to conduct regular no-load operation on a 30-minute basis per week.		□YES □NO
	(6) For sufficient lubrication of each bearing part, during no-load operation, perform pre-lubrication for about 5 minutes.		□YES □NO

Ⅲ-2. PREPARATION FOR STARTING

On starting the compressor after installation work being completed, or overhauling, or long stoppage, the following inspections and preparations should be performed.

a In foundations, installations, piping, wiring, etc., such abnormality as mentioned below must not be found.

Cracks of foundation

Slack of foundation bolts

Slack of piping connections

4 Breakage or earth of electric wire

b Compressor proper and fittings to be in good order. Confirm that the minor modifications have been finished, if any.

No slack of bolts and nuts all parts should be found.

Check the lube oil level in crankcase whether oil has been filled up to nearly center line of level gauge.

e If cylinders are lubricated, fill up the lubricator reservoir with oil. In that case, take care not to confound this oil with the crankcase oil.

Inspect the lube oil filter and clean it, if necessary.

g Supply cooling water to the lube oil cooler, compressor cylinders and stuffing box, if water-cooled. In that case, the valves of pipeline should be fully opened. As a general rule, these valves are not be throttled. And make sure that cooling water is flowing through the equipment by sight glass at the outlet.

If thermo-syphon coolant system or static-filled coolant systems are provided, fill up to nearly center line of the tank level gauge.

i Supply cooling water to the gas cooler.

j) If suction valve unloaders or clearance pockets are equipped for the capacity control, the formed should be set under the unload condition, and the latter shoulder be fully opened.

k) By-pass valve of gas pipeline should be fully opened. Open the drain valves and eliminate the drains. Then, shut the drain valves.

l) Turn the crankshaft by bar in order to make sure that all moving parts are run freely. The turning of the compressor should be done under the condition of leaving the pressure in the cylinder.

m) Turning the compressor, prime the lube oil to compressor by the priming pump. And confirm the lube oil to be supplied to moving parts.

If the motor-driven priming pump is equipped, this pump should be driven continuously until starting of compressor. At the same time, the lube oil pressure should be confirmed.

n) Even if it is winter season, raise lube oil temperature above 20℃ as minimum by means of steam or electric heater.

o) If cylinders are lubricated, turn the lubricator by hand cranking for 20 to 30 times. And check whether oil is filled in the pipes up to cylinders. This can be confirmed by disconnecting the line at the non-return valve on cylinder.

p) Confirm whether any tool does not remain forgotten around compressor or any people do not remain near the compressor.

q) Confirm all safety devices to be in operating condition.

Ⅲ-3. STARTING OF COMPRESSOR

a) On no alarm condition, start the main driver.
If the shaft-driven main lube oil pump and the motor-driven oil pump for priming or the spare are equipped, after the main drive has reached the rated speed, stop the motor-driven oil pump.
In case that the motor-driven oil pump is supplied for the spare, after stopping it, set the motor switch in the position of "Auto".

b) Check the lube oil pressure in order to confirm the feed condition of the crankcase oil force-red to the main, crank-pin and crosshead-pin bearings.
If cylinders are lubricated, confirm the oil feeds to cylinder and stuffing box by sight glasses of the lubricator.

c) After main driver runs up to normal speed and all parts are confirmed in good order, load up the compressor.

d) In case that the capacity control devices are equipped, load up the compressor gradually, as increasing the capacity by loading on the top side of cylinder and then setting the clearance pocket valve closing, and the loading on the crank side, at the same time on each stage.

e) When starting the compressor after long stoppage (more than a week), or overhauling, confirm whether abnormal conditions do not exist in any parts of compressor during no-load running, and then load up.
Especially, attentions should be paid for lube oil pressure, bearing and lube oil pump temperatures, sound of moving parts and the reading of am-meter.
In no-load running, suction gas temperature gradually increases, because of gas being blown back to suction side through unloaded suction valve and heated by friction.

Accordingly, a period of no-load running by suction valve unloaders or by-pass through no gas cooler should be possibly shortened. (Max. 20 minutes)

Ⅲ-4 INSPECTION AND CARE DURING OPERATION

a) Watch the gages to ascertain that they indicate normal figures.

(1) Suction and discharge gas pressures and temperatures :

In such case as the heating system of the gas being provided, attention should be paid for suction gas temperature so that it is kept at a uniform temperature to protect the gas from condensing.

(2) Lube oil pressure and temperature, and pressure drop across oil filter :

Adjust the lube oil temperature to keep it above 40℃ even in winter by the by-pass valve.

b) Watch the reading of am-meter for motor.

c) Regulate the temperature of cooling water.

(1) As a general rule, cylinder cooling water should be always fullflowed. In case of regulating the temperature by throttling the valves, the temperature difference between inlet and outlet should not exceed 5℃ as standard.

(2) Valves of cooling water to stuffing box should be fully opened.

(3) In such cases as the temperature-controlled hot water being supplied to the cylinder jackets to prevent the gas from condensing, care should be paid for the inlet temperature so that it is kept at a uniform temperature.

d) Watch the level of cooling water in the tank.

In such cases as thermo-syphon system or static-filled system, if the amount of coolant is lessened, the cooling effect for a cylinder is decreased for that.

Keep the level of coolant at the nearly center line of the level gauge of the tank.

e) Watch the level of lube oil.

(1) Check if oil in crankcase is keeping normal oil level (not lower than min. level and not higher than max. level), and if necessary, fill up the lube oil.

(2) If cylinders are lubricated, fill up the lubricator reservoir with cylinder oil regularly. No feed of oil must cause serious damages.

f) Watch the sound and vibration of moving parts.

Abnormal sound and vibration are the first sign causing a serious damage. In such a case, the compressor should be stopped at once and inspected.

g) Make sure that the compressor valves are acting normally. Watch the temperature of valve cover, the gas temperature, the flow capacity of gas, the moving sound of valves, etc.

In case of temperature rising of valve cover or gas, check whether the bolts of valve keeper have been tightened sufficiently or not, as the insufficient tightening causes such troubles.

h) Drain off frequently and regularly, and watch the amount and color of drain.

Take care of black drain. Black drain means the abnormal wear of cylinder liner and piston rings in most cases.

i) When the relief-valve is blown, before re-starting of the compressor, check each part, and trace the cause, if any.

j) Watch the amount and temperature of leakage gas from stuffing box (rod packing) and compartment adjacent to the cylinder.

k) Inspect that all foundation bolts are tight, and there is no leakage from gaskets and pipe connections All checking points as mentioned above should be checked and all running conditions should be noted in an operation diary.

Daily checking also should be made regularly.

Ⅲ-5. STOPPING OF COMPRESSOR

Cares and procedures when compressors are stopped are as follows.

a) Unload the compressor by opening the suction valve unloaders or the by-pass valves. When stopped, the compressor shall be under the condition of no cmoressing in the cylinders.

b) Then stop the main driver

c) Close the main valves in the discharge line.

d) Close the main valves in the suction line.

e) Relieve the pressure in the cylinders and gas to be replaced by Nitrogen.

f) Shut and drain off the cooling water, if the freezing temperature is expected or the shutdown is expected long. But, it is not necessary that ethylene-glycol solution for thermo-syphon or static-filled coolant system is drained off.

g) Drain off all the drains in the same case as mentioned above.

h) Abnormal points to be checked and repaired during stoppage.

i) Management in case that the long stoppage is expected :

(1) After the cylinders have been cooled, all liquid in the cylinders should be drained off to prevent the cylinder inside from corrosion during the stoppage. It is preferable to coat the rust preventive oil on the cylinders.

(2) Run the compressor for about five minutes every week under an unloaded condition to prevent the parts from being rusty or corrosion. In such case as an unload running being impossible, the compressor to be turned at least five

revolutions by barring device, while the oil primed with the priming lube oil pump and the cylinder lubricator.

(3) In such case that the process gas piping, in which corrosive gases are handled, is overhauled and left open to atmosphere, the piping ends to be fitted with blind flanges and the inside of the piping to be filled up with nitrogen to prevent it from being rusty or corrosion. None of this work may cause a serious trouble.

(4) Close the main stop valve in suction and discharge lines, and take off or lock the handle.

(5) Take off the instruments which are liable to damage.

Ⅲ-6. CARES OF AIR RUNNING

During the mechanical test, the following cautions are required when operating with air.

The following attentions should be paid for air running:

a) Air circulation running to be absolutely avoided.

b) Before air running, inspect whether carbon deposit adheres to the high temperature zone (discharge valves, discharge snubbers, discharge pipings, gas coolers, etc.) or not. Carbon deposits to be taken off as much carbon deposits eventually cause fire and perhaps explosion.
Thickness of the carbon deposit layer should be below 1mm.

c) During air running, frequently drain off the accumulated lube oil From the points where it tends to accumulate, especially from discharge snubbers, bends in discharge pipings, etc.

d) Care should be paid for temperature rise of the points where oil and carbon deposit tend to accumulate, especially discharge snubbers, and bends in discharge pipings, all the while of air running.
The temperature rise should be watched by any alarming system for high temperature such as temperature switch. The alarming temperature to be set at about 15 to 25℃ higher than normal air temperature.
It is preferable to keep the air temperature as low as possible.

e) Cylinder oil must have excellent oxidation stability and less carbonizing property. Feed rate of the cylinder oil to be reduced to a half of normal one.

Such partial load running as air velocity in the piping being slow should be avoided.

g Of course, it is preferable to shorten the duration of air running.
The capacity of compressor can be controlled by using the suction valve unloaders which are provided on all suction valves. The suction valve unloaders are of pneumatic type and can be manually operated from the local control panel.
Capacity control step (-STEP [0-50-100%])

Caution : Running under the condition of zero capacity should not be continued for longer hours, and it should be limitted only at start and stop.
No-load operation for a long time will cause abnormal heat generation inside the cylinder. (Max. 20 min or less no-load operation)

Ⅲ-7. COMPRESSOR SAFETY DEVICE

1) The following safety devices are furnished with the compressor.
(a) Lube oil safety valve
(b) Cooling water thermal relief valve
(d) Other safety devices provided are listed in the attached
"INSTRUMENT LIST"

2) Emergency Stop
The compressor is provided with some protective devices to prevent serious damages from any troubles. When lube oil (crankcase) pressure drops to predetermined value, the compressor is stopped automatically.
As there may be erroneous operations of instrument itself in case of emergency stops, the cause should be examined taking this into consideration.
The compressor must be instantly stopped and checked in case that the

following running conditions have been noticed:

(a) Abnormal knocking sound

(b) Abnormal vibration

(c) Crack or damage of pipe and violent gas blow Immediately after stopping the compressor for checking

Immediately after stopping the compressor for checking

(a) Close the main stop valves in gas line and purge the process gas in the compressor cylinder under the unloaded conition,

(b) Operate the lube oil pump, and

(c) Turn the compressor, at least three rounds.

3) Troubles and Checkings.

a) Low lube oil pressure

Causes	Remedies
Clogged filter	Clean (Check inside)
Trouble of lube oil pump	Repair
Breakage of pipe	Repair
Leakage of oil from joint	Repair

b) High lube oil temperature

Causes	Remedies
Fouling of shell side or tube side of lube oil cooler	Clean
Clog or fouling of cooling water passage in the oil cooler	Clean
Seizure of any moving part in crankcase	Check bearings and crosshead shoes and repair, if necessary.

c) High discharge gas temperature

As to causes and remedies for it, see “Trouble Shooting Guide" in chapter VI.

CHAPTER IV. ASSEMBLY, DISASSEMBLY AND MAINTENANCE

IV-1. CONSTRUCTION AND ASSEMBLY

* Attach. 4-1. Compressor Sectional Drawing with Part List

PART LIST		DOCUMENT NO.	-	
		PAGE NO.	1 OF 3	Rev. 1
PROJECT NAME	Binak Oil Filed Development Project	CUSTOMER	HAVAYAR INDUSTRIAL GROUP	
M/O NO.	SR23006	ITEM NO.	C-2101A/B/C & C-2102A/B/C	

NO.	DESCRIPTION	MATERIAL ASTM or AISI	Q'TY	REMARK
1101	CRANK CASE	A278 CL.NO.35	1	
1102	CRANK CASE SIDE COVER	A278 CL.NO.35	1	
1103	CRANK CASE SIDE COVER	A278 CL.NO.35	1	
1107	CRANK SHAFT COLLAR	A283 Gr.C	1	
1108	OIL SEAL	NBR	1	
1109	AIR BREATHER	A283 Gr.C	1	
1110	OIL LEVEL GAUGE	ACRYL	1	
1112	CRANK CASE UPPER COVER	A278 CL.NO.35	1	
1115	OIL SEAL COVER	A283 Gr.C	1	
1201	CRANK SHAFT	A668 CL.D	1	
1203	COUNTER WEIGHT	A283 Gr.C	4	
1301	CONNECTING ROD	A668 CL.D	2	
1302	BOLT, CONNECTING ROD	A29 Gr.4140	8	
1303	RING NUT, CONNECTING ROD	A29 Gr.1045	8	
1303-1	HEX NUT, CONNECTING ROD	A29 Gr.1045	8	
1304	CRANK MEATL	A53 Gr.A/B23 WM2	2	
1305	CROSS HEAD PIN METAL	A53 Gr.A/B584 C93700	2	
1306	CROSS HEAD PIN	A534 NO.B25	2	
1308	MAIN METAL	A53 Gr.A/B23 WM2	1	
1309	MAIN METAL	A53 Gr.A/B23 WM2	2	
1310	CROSS HEAD MAIN METAL	A53 Gr.A/B584 C93700	4	
1311	MAIN METAL COVER	A278 CL.NO.35	3	
1401	CROSS HEAD	A216 Gr.WCB	2	
1402	CROSS HEAD SHOES	A278 CL.NO.35	2	
1403	CROSS HEAD GUIDE	A278 CL.NO.35	2	
1404	STAY HEX BOLT	A29 Gr.1045	2	
1405	CROSS HEAD PIN NUT	A29 Gr.1025	2	
1406	CROSS HEAD SIDE COVER	A283 Gr.C	4	
1408	CROSS HEAD GUIDE COVER	A278 CL.NO.35	4	
1410	CROSS HEAD GUIDE COVER	A278 CL.NO.35	4	
-	WIPER RING CASE PART ASS'Y	AS-13-53-001.dwg	2	
1507	OIL STOPPER	B221,2024	2	
-	OIL PUMP ASS'Y	AS-13-53-002.dwg	1	
1707	OIL PUMP COUPLING	A534 NO.B25	1	
1901	COUPLING(COMP'R SIDE)	A278 CL.NO.35	1	
1902	CON-KEY(COMP'R SIDE)	A536 Gr.80-55-06	1	
2111	1ST CYLINDER	A395 Gr.60-40-18	1	
2112	1ST CYLINDER HEAD	A395 Gr.60-40-18	1	
2112-1	1ST CYLINDER HEAD GASKET	C-4400	1	

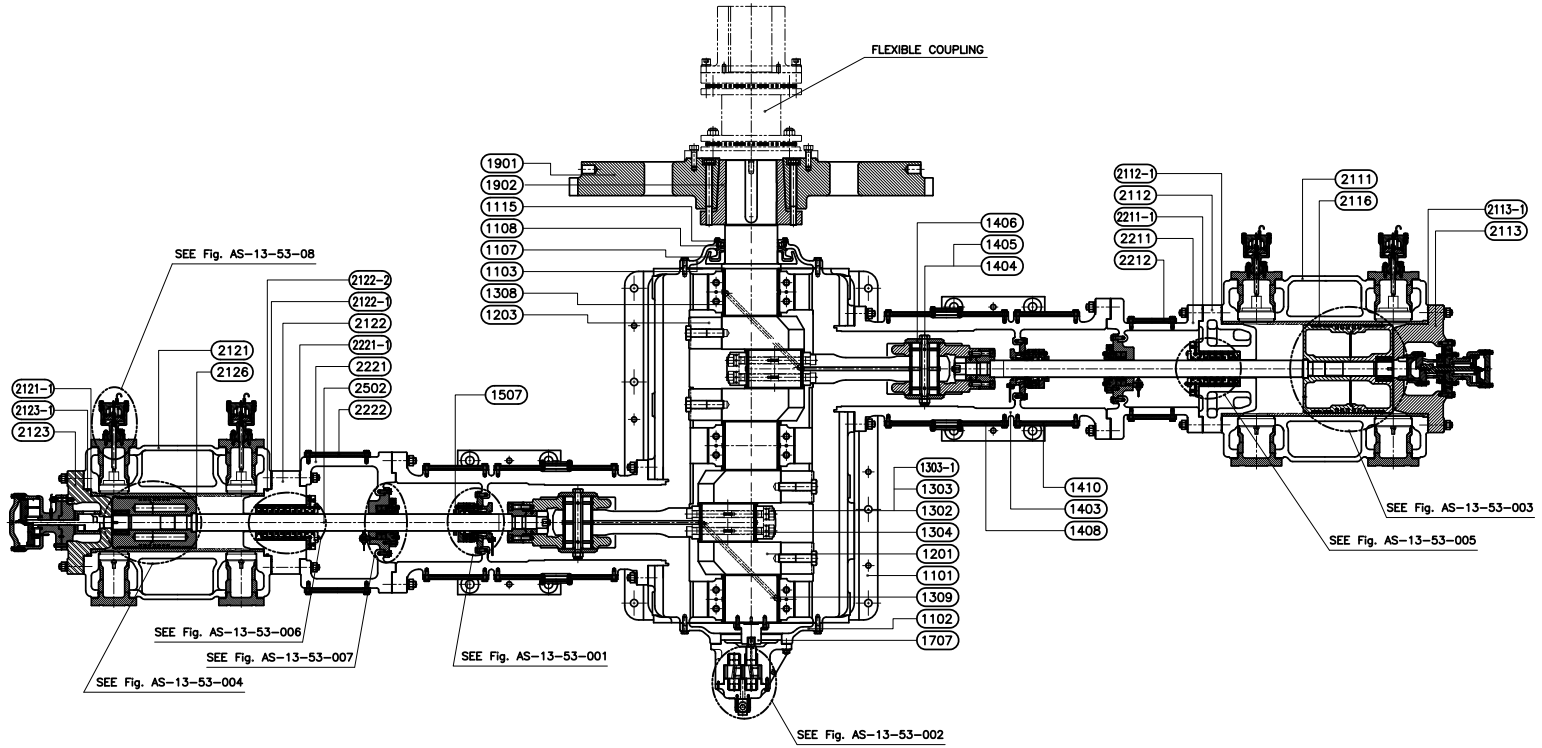
PART LIST		DOCUMENT NO.	-	
		PAGE NO.	2 OF 3	Rev. 1
PROJECT NAME	Binak Oil Filed Development Project	CUSTOMER	HAVAYAR INDUSTRIAL GROUP	
M/O NO.	SR23006	ITEM NO.	C-2101A/B/C & C-2102A/B/C	

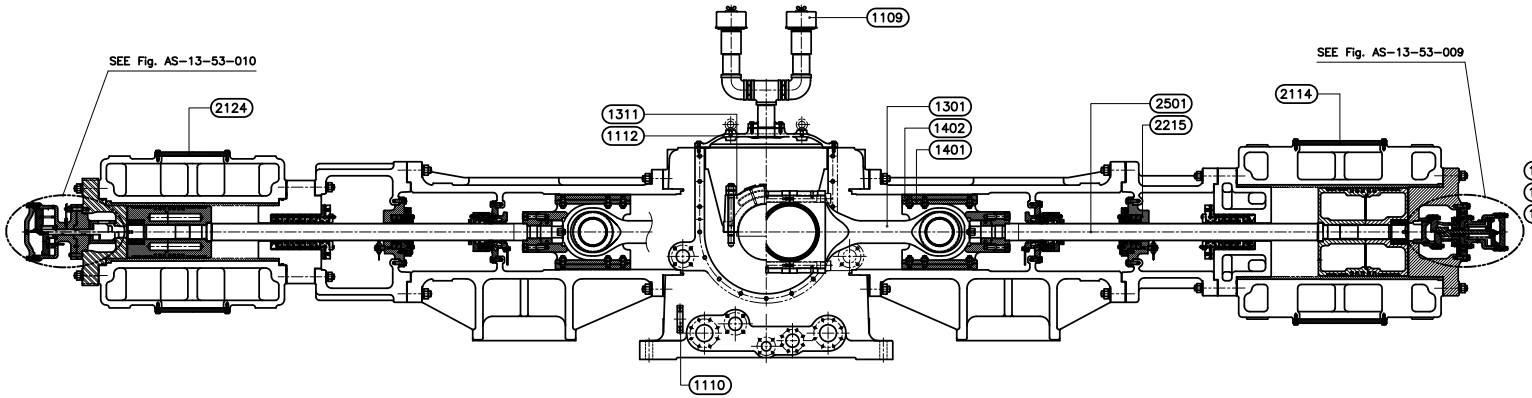
NO.	DESCRIPTION	MATERIAL ASTM or AISI	Q'TY	REMARK
2113	1ST CYLINDER COVER	A395 Gr.60-40-18	1	
2113-1	CYLINDER COVER GASKET	C-4400	1	
-	1ST POCKET VALVE ASS'Y	AS-13-53-009.dwg	1	
2114	1ST CYLINDER SIDE WATER COVER	A283 Gr.C	2	
2116	1ST CYLINDER LINER	A278 CL.NO.40	1	
2117	1ST SNAP RING	A276 Type 316	4	
2121	2ND CYLINDER	A395 Gr.60-40-18	1	
2121-1	2ND CYLINDER GASKET	C1220P	1	
2122	2ND CYLINDER HEAD	A395 Gr.60-40-18	1	
2122-1	2ND CYLINDER HEAD GASKET	C-4400	1	
2122-2	2ND CYLINDER HEAD O-RING	FKM(F201)	1	
2123	2ND CYLINDER COVER	A395 Gr.60-40-18	1	
2123-1	2ND CYLINDER COVER O-RING	FKM(F201)	1	
-	2ND POCKET VALVE ASS'Y	AS-13-53-010.dwg	1	
2124	2ND CYLINDER SIDE WATER COVER	A283 Gr.C	2	
2126	2ND CYLINDER LINER	A278 CL.NO.40	1	
2127	2ND SNAP RING	A240 Type 316L	4	
2211	1ST DISTANCE PIECE	A395 Gr.60-40-18	1	
2211-1	DISTANCE PIECE UPPER GASKET	C-4400	1	
2212	1ST DISTANCE PIECE SIDE COVER	A395 Gr.60-40-18	2	
2215	STUFFING BOX	A395 Gr.60-40-18	1/1	
2221	2ND DISTANCE PIECE	A395 Gr.60-40-18	1	
2221-1	2ND DISTANCE PIECE UPPER GASKET	C-4400	1	
2222	2ND DISTANCE PIECE SIDE COVER	A395 Gr.60-40-18	2	
-	1ST PISTON ASS'Y	AS-13-53-003.dwg	1	
-	2ND PISTON ASS'Y	AS-13-53-004.dwg	1	
2501	1ST PISTON ROD	A564 Type630	1	
2502	2ND PISTON ROD	A564 Type630	1	
2519	CROSS HEAD NUT	A29 Gr.1045	1/1	
-	1ST GLAND PACKING ASS'Y(CYL.)	AS-13-53-005.dwg	1	
-	2ND GLAND PACKING ASS'Y(CYL.)	AS-13-53-006.dwg	1	
-	GLAND PACKING ASS'Y(D/P SIDE)	AS-13-53-007.dwg	1/1	
4110	1ST SUCTION VALVE ASS'Y	A276 Type 420	4	
4131	1ST SUCTION VALVE HOLDER	A395 Gr.60-40-18	4	
4132	1ST SUCTION VALVE COVER	A276 Type 316L	4	
4133	1ST VALVE SEAT GASKET	A276 Type 316L	8	
4134	1ST VALVE COVER O-RING	FKM(V9117AA)	8	
4134-1	1ST VALVE COVER O-RING(UNLOADER SIDE)	FKM(V9117AA)	8	
4210	2ND SUCTION VALVE ASS'Y	A276 Type 420	4	

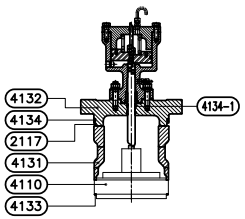
PART LIST		DOCUMENT NO.	-	
		PAGE NO.	3 OF 3	Rev. 1
PROJECT NAME	Binak Oil Filed Development Project	CUSTOMER	HAVAYAR INDUSTRIAL GROUP	
M/O NO.	SR23006	ITEM NO.	C-2101A/B/C & C-2102A/B/C	

NO.	DESCRIPTION	MATERIAL ASTM or AISI	Q'TY	REMARK
4231	2ND SUCTION VALVE HOLDER	A395 Gr.60-40-18	4	
4232	2ND SUCTION VALVE COVER	A240 Type 316L	4	
4233	2ND VALVE SEAT GASKET	A240 Type 316L	8	
4234	2ND VALVE COVER O-RING	FKM(V9117AA)	8	
4234-1	2ND VALVE COVER O-RING(STEM ROD)	FKM(V9117AA)	8	
4234-2	2ND VALVE COVER BACK-UP RING	PTFE	8	
5110	1ST DISCHARGE VALVE ASS'Y	A276 Type 420	4	
5131	1ST DISCHARGE VALVE HOLDER	A395 Gr.60-40-18	4	
5132	1ST DISCHARGE VALVE COVER	A276 Type 316L	4	
5210	2ND DISCHARGE VALVE ASS'Y	A276 Type 420	4	
5231	2ND DISCHARGE VALVE HOLDER	A395 Gr.60-40-18	4	
5232	2ND DISCHARGE VALVE COVER	A240 Type 316L	4	
-	UNLOADER PART ASS'Y	AS-13-53-008.dwg	4/4	

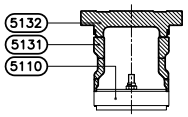
NO.	CODE NO.	PART NAME	MATERIAL	Q'TY	WEIGHT(kg) UNIT	WEIGHT(kg) TOTAL	REMARKS



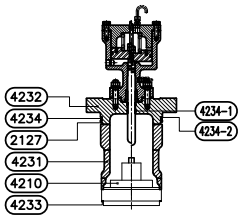




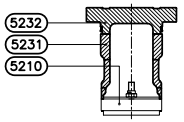
1ST SUCTION VALVE PART DETAIL



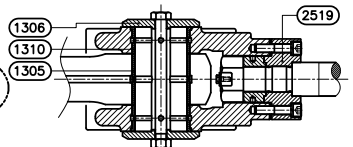
1ST DISCHARGE VALVE PART DETAIL



2ND SUCTION VALVE PART DETAIL



2ND DISCHARGE VALVE PART DETAIL



CROSS HEAD PART DETAIL

Reciprocating Compressor
KWANGSHIN MACHINE INDUSTRY CO., LTD.

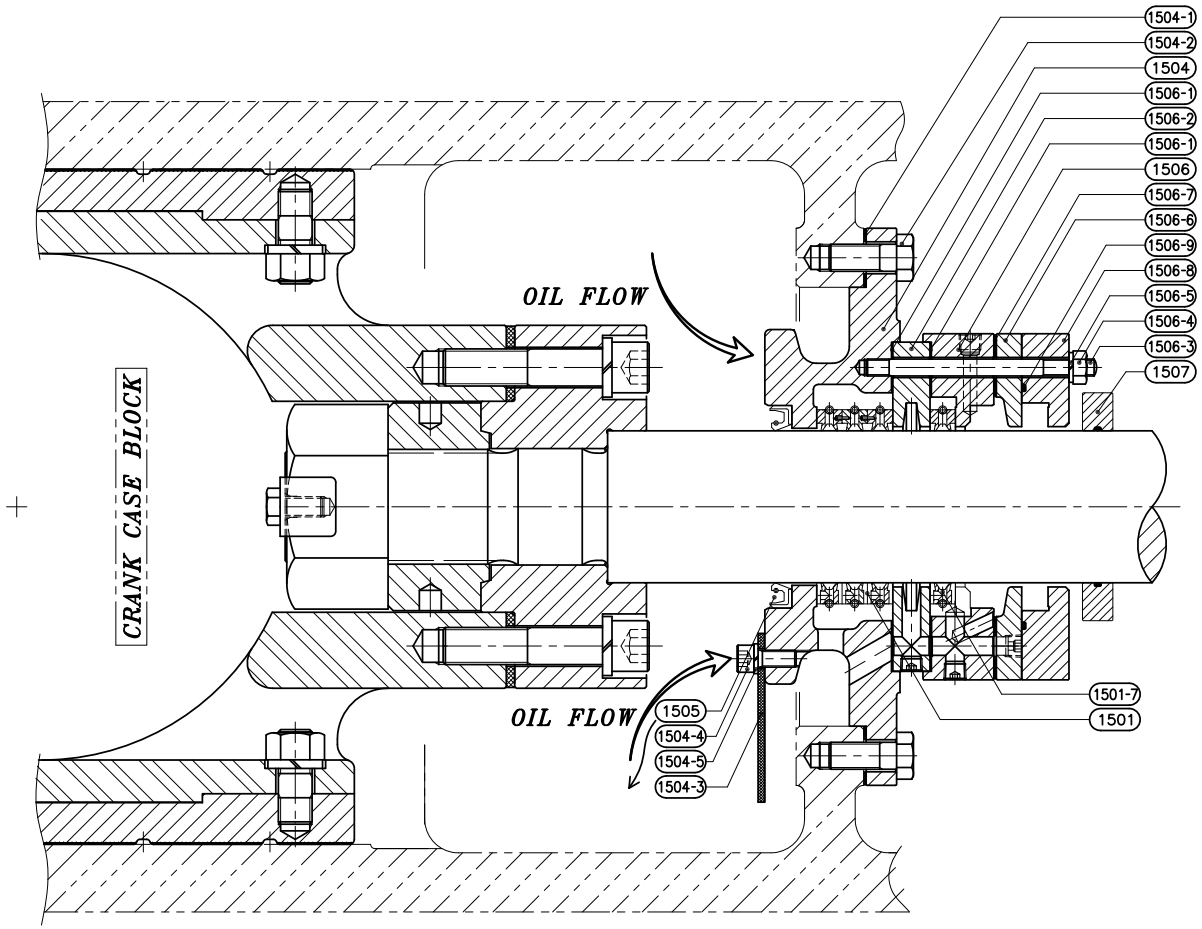
PROJECTION	UNITS	TITLE
	INCH	ASSEMBLY DWG (OPT)
SHT. NO. 1/11	SCALE 1 : 13	DWG. NO. Fig. AS-13-53-00A

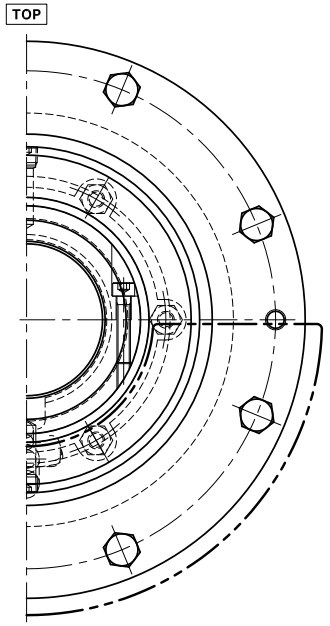
A1 (594x841mm) CAD NO. : AS-13-53-00A

NO.	CODE NO.	PART NAME	MATERIAL ASTM or AISI	Q'TY	REMARKS
1501		OIL WIPER RING (3EA = 1Set)	B23 NO.1	1	Set
1501-7		OIL SCRAPER RING	B23 NO.1	1	Set
1507		OIL STOPPER	B211 Gr.2024	1	Set

NO.	CODE NO.	PART NAME	MATERIAL ASTM or AISI	Q'TY	REMARKS
1504		WIPER RING CASE	A278 CL.NO.35	1	
-1		WIPER RING CASE GASKET	F104 P1141A	1	
-2		HEX BOLT	A29 Gr.1045	8	
-3		PLATE	A283 Gr.C	1	
-4		WRENCH BOLT	A29 Gr.4140	4	
-5		SPRING WASHER	A686 Type W1	4	
1505		OIL SEAL	NBR	1	
1506		WIPER RING COVER	A283 Gr.C	1	
-1		WIPER RING COVER GASKET	F104 P1141A	1/1	
-2		SEAL PLATE	A283 Gr.C	1	
-3		STUD BOLT	A29 Gr.1045	6	
-4		HEX NUT	A29 Gr.1025	6	
-5		SPRING WASHER	A686 Type W1	6	
-6		PLATE COVER	A283 Gr.C	1	
-7		PLATE COVER GASKET	F104 P1141A	1	
-8		WIPER PACKING CASE	A283 Gr.C	1	
-9		O-RING	VITON	1	

*. The number of assemblies per unit. : 2 Sets



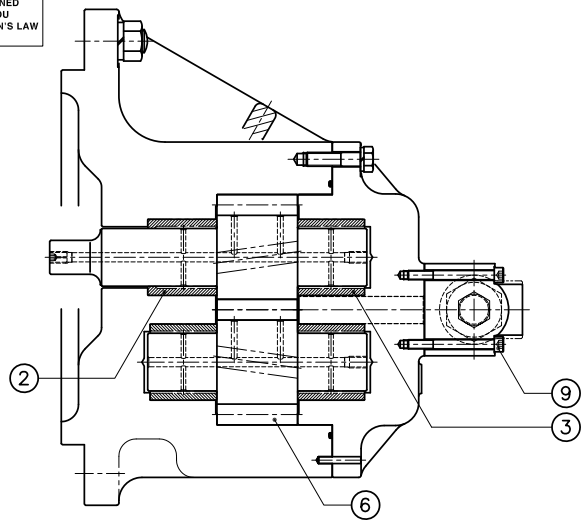


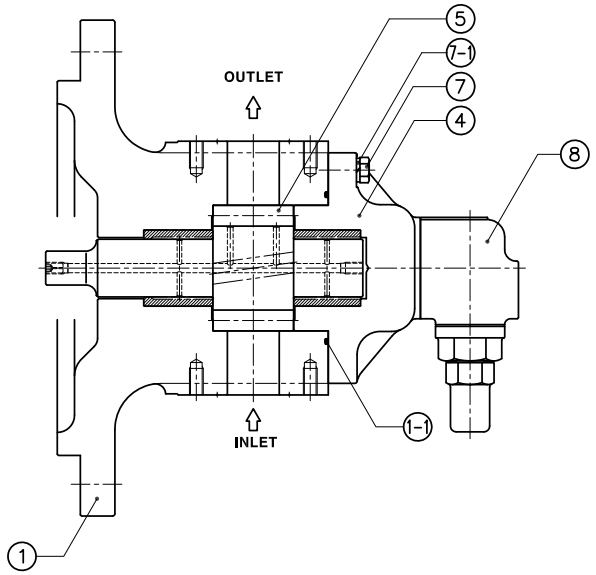
KwangShin Dependable Compressor
KWANGSHIN MACHINE INDUSTRY CO., LTD.

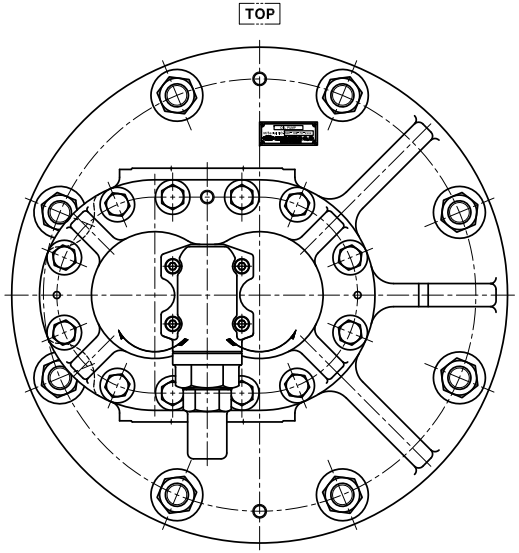
PROJECTION	UNITS	TITLE
	INCH	WIPER RING CASE PART ASS'Y
SHT. NO. 2/11	SCALE 1 : 2	DWG. NO. AS-13-53-001

A2 (420x594mm) CAD NO. : AS-13-53-001

NO.	CODE NO.	PART NAME	MATERIAL ASTM or AISI	Q'TY	REMARKS
		OIL PUMP ASS'Y	–	1	Set
1		OIL PUMP BODY	A536 GR.80–55–06	1	
1–1		O–RING	NBR	1	
2		BUSH	Kelmet Metal	1	
3		BUSH	Kelmet Metal	3	
4		OIL PUMP COVER	A536 GR.80–55–06	1	
5		MAIN GEAR	A534 No.B25	1	
6		AUX GEAR	A534 No.B25	1	
7		HEX BOLT	H/TENTION	12	
7–1		SPRING WASHER	A686 Type W1	12	
8		RELIEF VALVE	A278 CL.NO.35	1	
9		WRENCH BOLT	A29 Gr.4140	4	





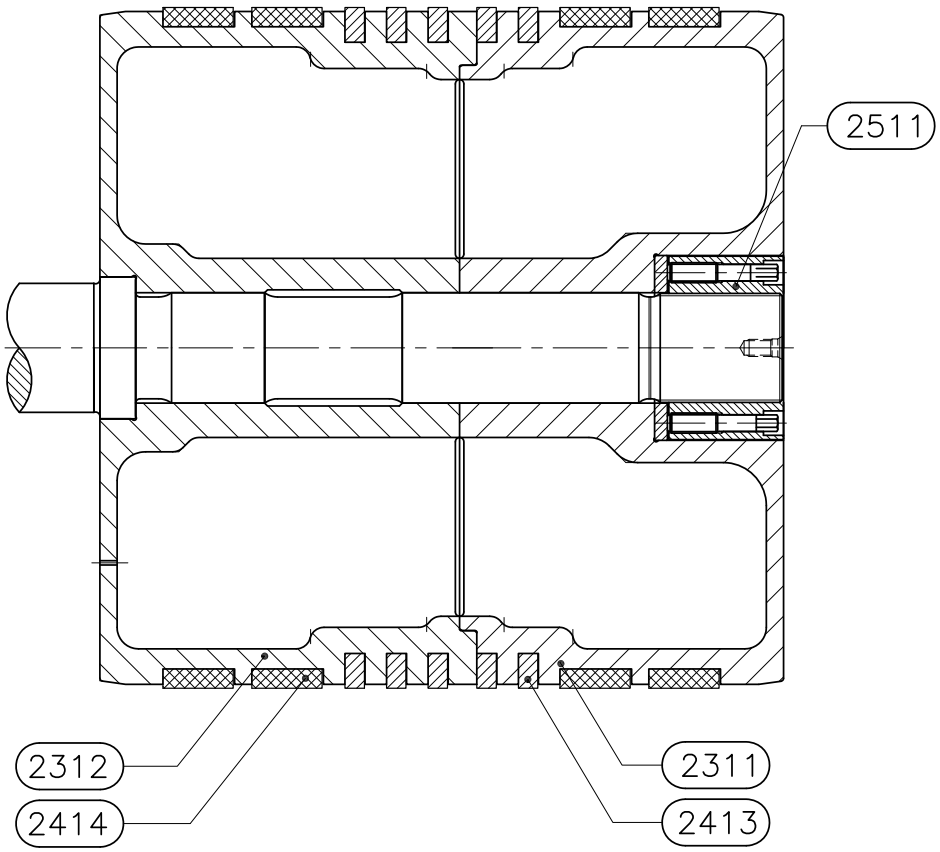


KwangShin — Dependable Compressor
KWANGSHIN MACHINE INDUSTRY CO., LTD.

PROJECTION	UNITS	TITLE	(MODEL : 50F-108-70) OIL PUMP ASS'Y
	INCH		
SHT. NO. 3/11	SCALE 1 : 3	DWG. NO.	AS-13-53-002

A2 (420x594mm) CAD NO. : AS-13-53-00A

NO.	CODE NO.	PART NAME	MATERIAL ASTM or AISI	Q'TY	REMARKS
2311		PISTON BODY(UPPER)	A395 Gr.60-40-18	1	
2312		PISTON BODY(LOW.)	A395 Gr.60-40-18	1	
2413		PISTON RING	Filled PTFE	5	
2414		RIDER RING	Filled PTFE	4	
2511		PISTON NUT	A240 Type 316L	1	

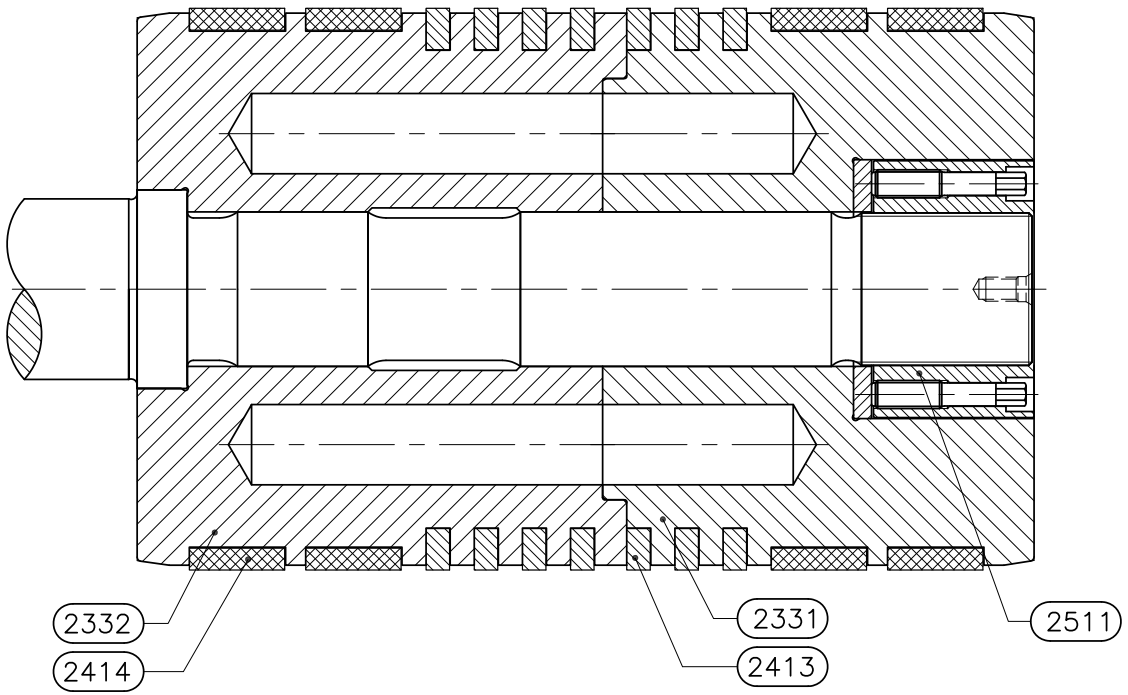


Dependable Compressor
KwangShin **KWANGSHIN MACHINE INDUSTRY CO., LTD.**

PROJECTION	UNITS	TITLE
	MM INCH	(1ST) PISTON ASS'Y
SHT. NO. 4/11	SCALE 1:3.5	DWG. NO. AS-13-53-003

A3 (297x420mm) CAD NO. : AS-13-53-00A

NO.	CODE NO.	PART NAME	MATERIAL ASTM or AISI	Q'TY	REMARKS
2311		PISTON BODY(UPPER)	A395 Gr.60-40-18	1	
2312		PISTON BODY(LOW.)	A395 Gr.60-40-18	1	
2413		PISTON RING	Filled PTFE	7	
2414		RIDER RING	Filled PTFE	4	
2511		PISTON NUT	A240 Type 316L	1	

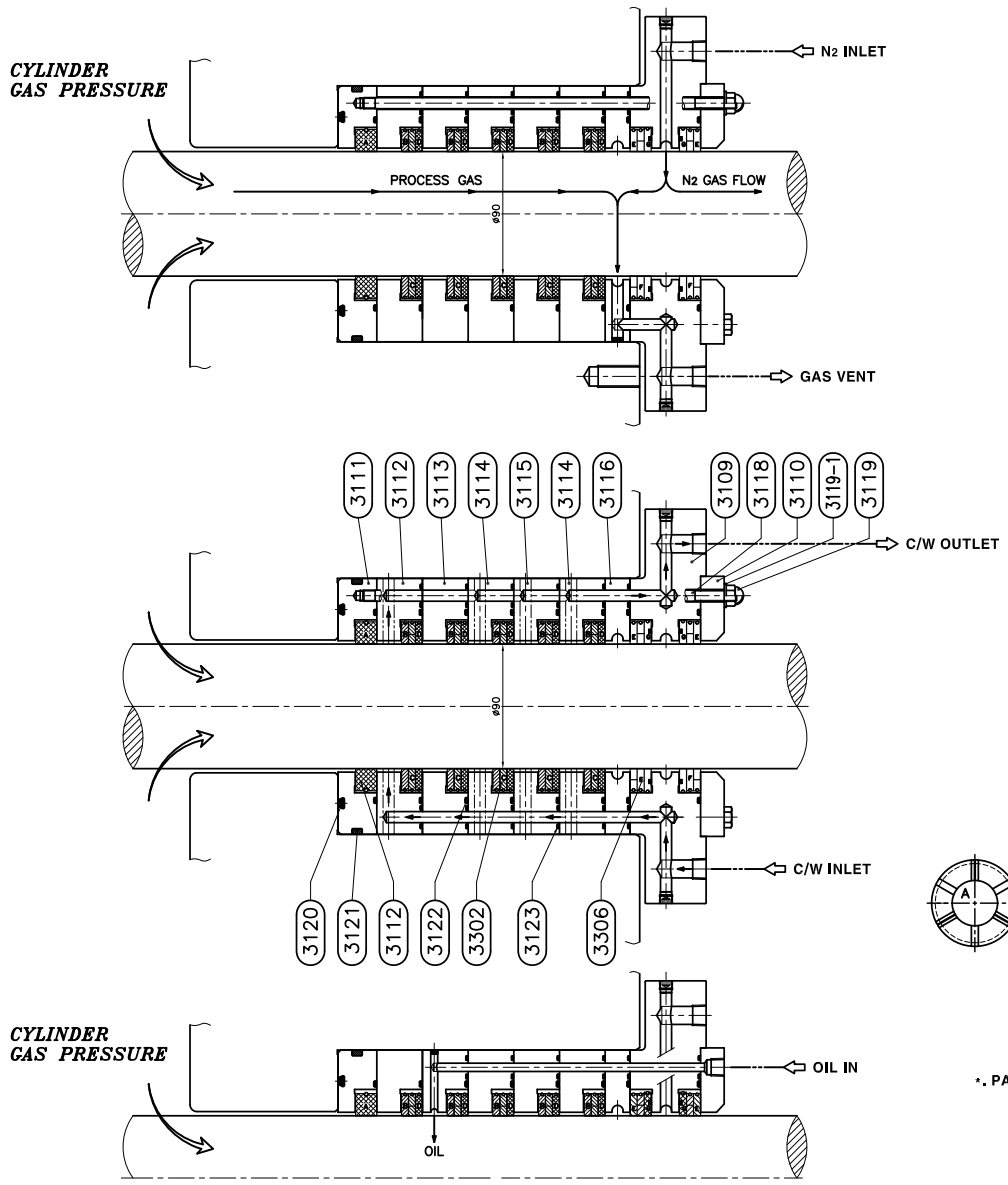


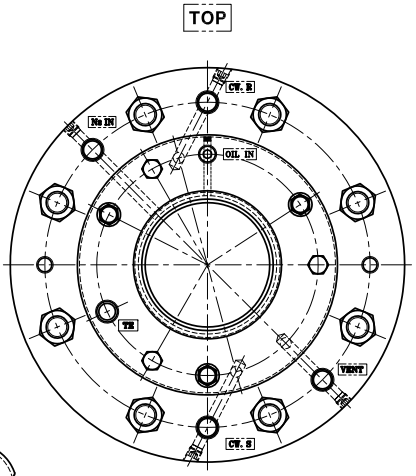
KwangShin *Dependable Compressor*
KWANGSHIN MACHINE INDUSTRY CO., LTD.

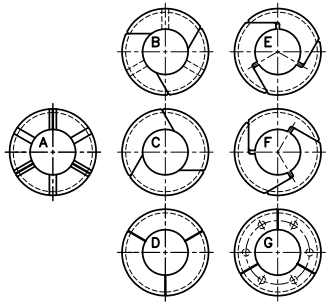
PROJECTION	UNITS	TITLE
	MM INCH	(2ND) PISTON ASS'Y
SHT. NO. 5/11	SCALE 1:2.5	DWG. NO. AS-13-53-004

A3 (297x420mm) CAD NO. : AS-13-53-00A

NO.	CODE NO.	PART NAME	MATERIAL ASTM or AISI	Q'TY	REMARKS
3111		GLAND PACKING CASE	A276 Type 316L	1	
3112		GLAND PACKING CASE	A276 Type 316L	1	
3113		GLAND PACKING CASE	A276 Type 316L	1	
3114		GLAND PACKING CASE	A276 Type 316L	2	
3115		GLAND PACKING CASE	A276 Type 316L	1	
3116		PLATE(FOR GLAND PACKING CASE)	A276 Type 316L	1	
3109		PACKING GLAND	A276 Type 316L	1	
3110		PACKING COVER	A276 Type 316L	1	
3120		O-RING	FKM(V9117AA)	1	
3121		O-RING	FKM(V9117AA)	1	
3122		O-RING	FKM(V9117AA)	8	
3123		O-RING	FKM(V9117AA)	19	
-		PACKING RING SET	-	1	
3112		PRESSURE BREAKER	FILLED PTFE	1	
3302		MAIN SEAL	FILLED PTFE	5	
3306		PURGE SEAL	FILLED PTFE	2	
3118		LOCK BOLT	A276 Type 316L	3	
3119		CAP NUT	STAINLESS STEEL	3	
-1		GASKET	A276 Type 316L	3	







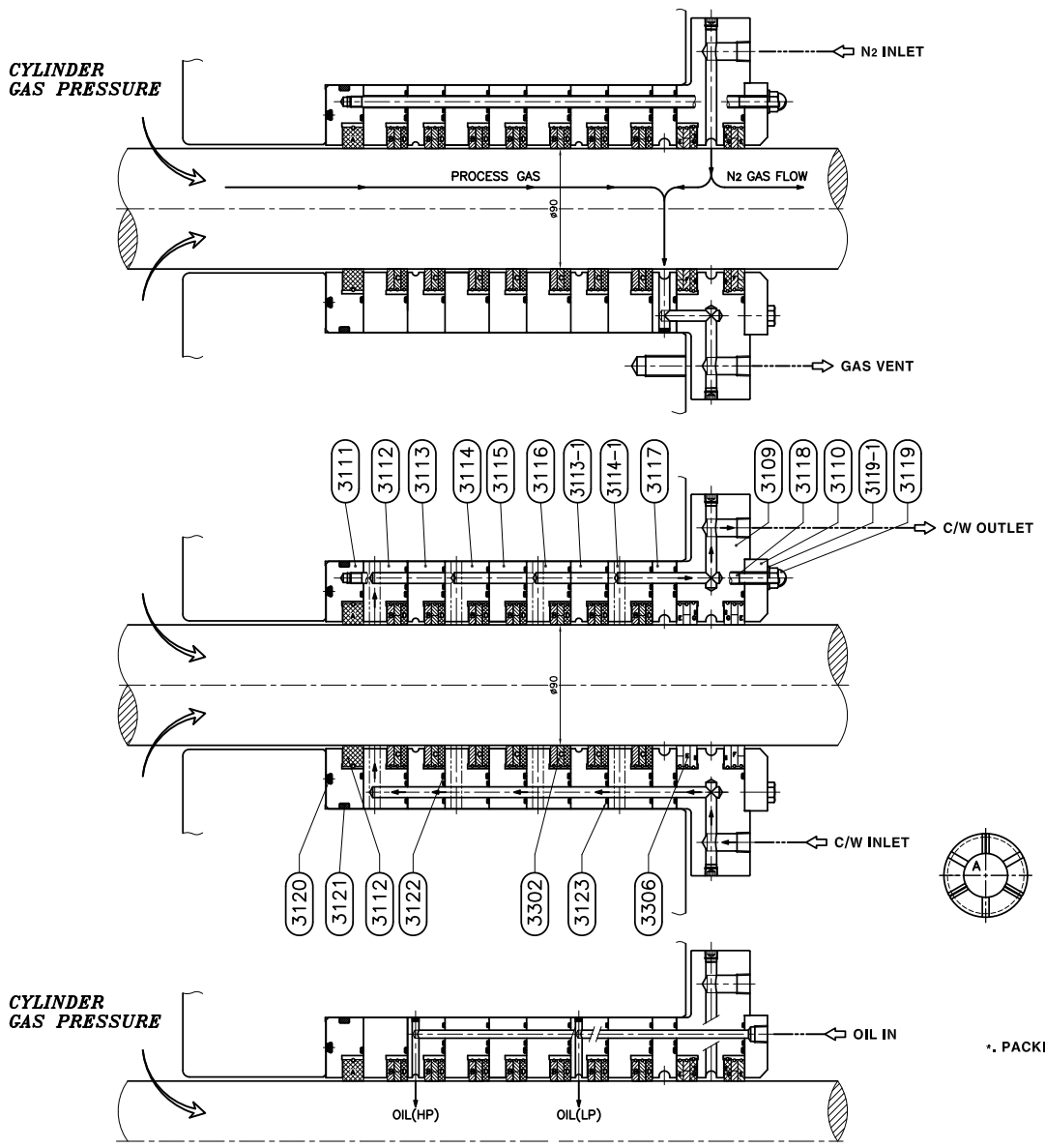
*. PACKING RING SET (1st Stage)

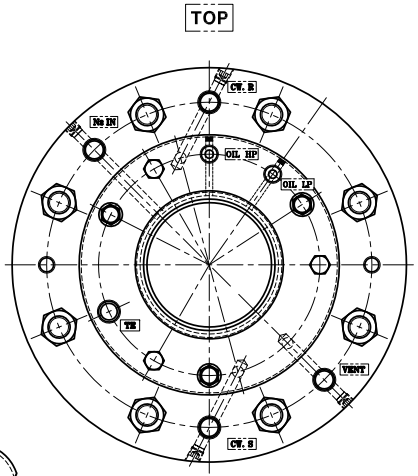
Dependable Compressor
KWANGSHIN MACHINE INDUSTRY CO., LTD.

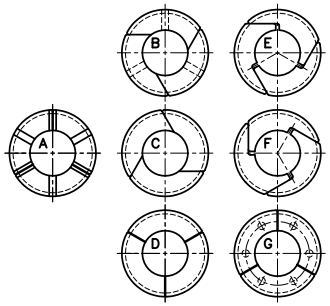
PROJECTION	UNITS	TITLE	(CYLINDER SIDE)(1ST) GLAND PACKING ASS'Y
	INCH		
SHT. NO. 6/11	SCALE 1:2.5	DWG. NO.	AS-13-53-005

A2 (420x594mm) CAD NO. : AS-13-53-00A

NO.	CODE NO.	PART NAME	MATERIAL ASTM or AISI	Q'TY	REMARKS
3111		GLAND PACKING CASE	A276 Type 316L	1	
3112		GLAND PACKING CASE	A276 Type 316L	1	
3113		GLAND PACKING CASE	A276 Type 316L	1	
3113-1		GLAND PACKING CASE	A276 Type 316L	1	
3114		GLAND PACKING CASE	A276 Type 316L	1	
3114-1		GLAND PACKING CASE	A276 Type 316L	1	
3115		GLAND PACKING CASE	A276 Type 316L	1	
3116		GLAND PACKING CASE	A276 Type 316L	1	
3117		PLATE(FOR GLAND PACKING CASE)	A276 Type 316L	1	
3109		PACKING GLAND	A276 Type 316L	1	
3110		PACKING COVER	A276 Type 316L	1	
3120		O-RING	FKM(V9117AA)	1	
3121		O-RING	FKM(V9117AA)	1	
3122		O-RING	FKM(V9117AA)	10	
3123		O-RING	FKM(V9117AA)	29	
-		PACKING RING SET	-	1	
3112		PRESSURE BREAKER	FILLED PTFE	1	
3302		MAIN SEAL	FILLED PTFE	7	
3306		PURGE SEAL	FILLED PTFE	2	
3118		LOCK BOLT	A276 Type 316L	3	
3119		CAP NUT	STAINLESS STEEL	3	
-1		GASKET	A276 Type 316L	3	







*. PACKING RING SET (2nd Stage)

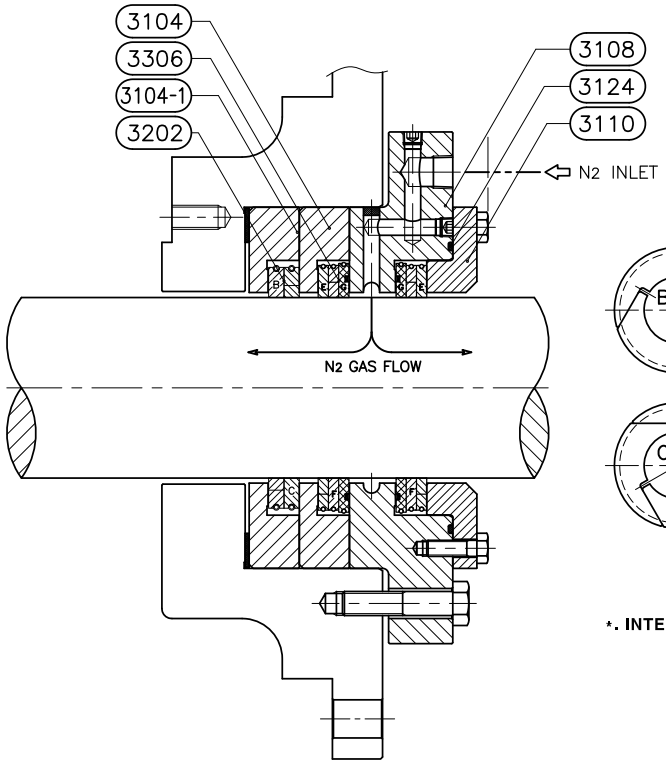
Dependable Compressor
KWANGSHIN MACHINE INDUSTRY CO., LTD.

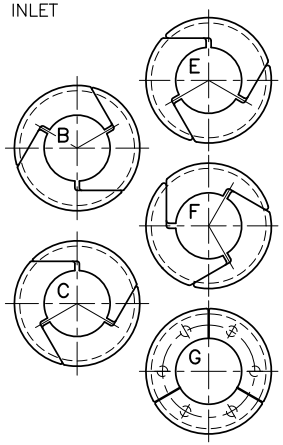
PROJECTION	UNITS	TITLE
	INCH	(CYLINDER SIDE)(2ND) GLAND PACKING ASS'Y
SHT. NO. 7/11	SCALE 1:2.5	DWG. NO. AS-13-53-006

A2 (420x594mm) CAD NO. : AS-13-53-00A

NO.	CODE NO.	PART NAME	MATERIAL ASTM or AISI	Q'TY	REMARKS
3104		GLAND PACKING CASE	A276 Type 316L	2	
3104-1		GASKET	A276 Type 316L	1	
3108		PACKING GLAND	A276 Type 316L	1	
3110		PACKING COVER	A276 Type 316L	1	
3124		O-RING	FKM(V9117AA)	1	
–		INTERMEDIATE PACKING SET	–	1	Set
3202		VENT SEAL	Filled PTFE	1	
3306		PURGE SEAL	Filled PTFE	2	

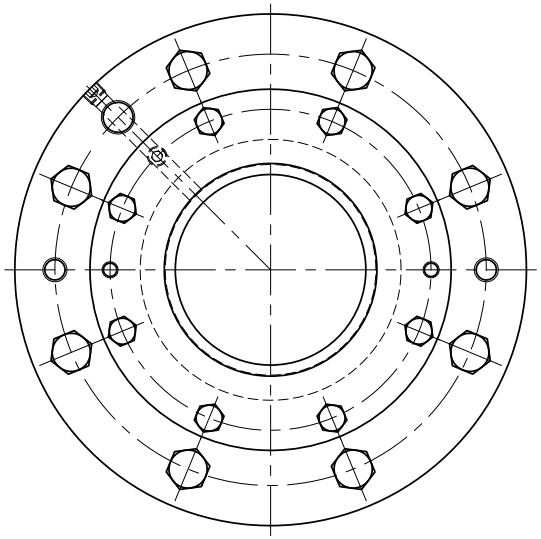
*. The number of assemblies per unit. : 1/1 Sets





*. INTERMEDIATE PACKING SET

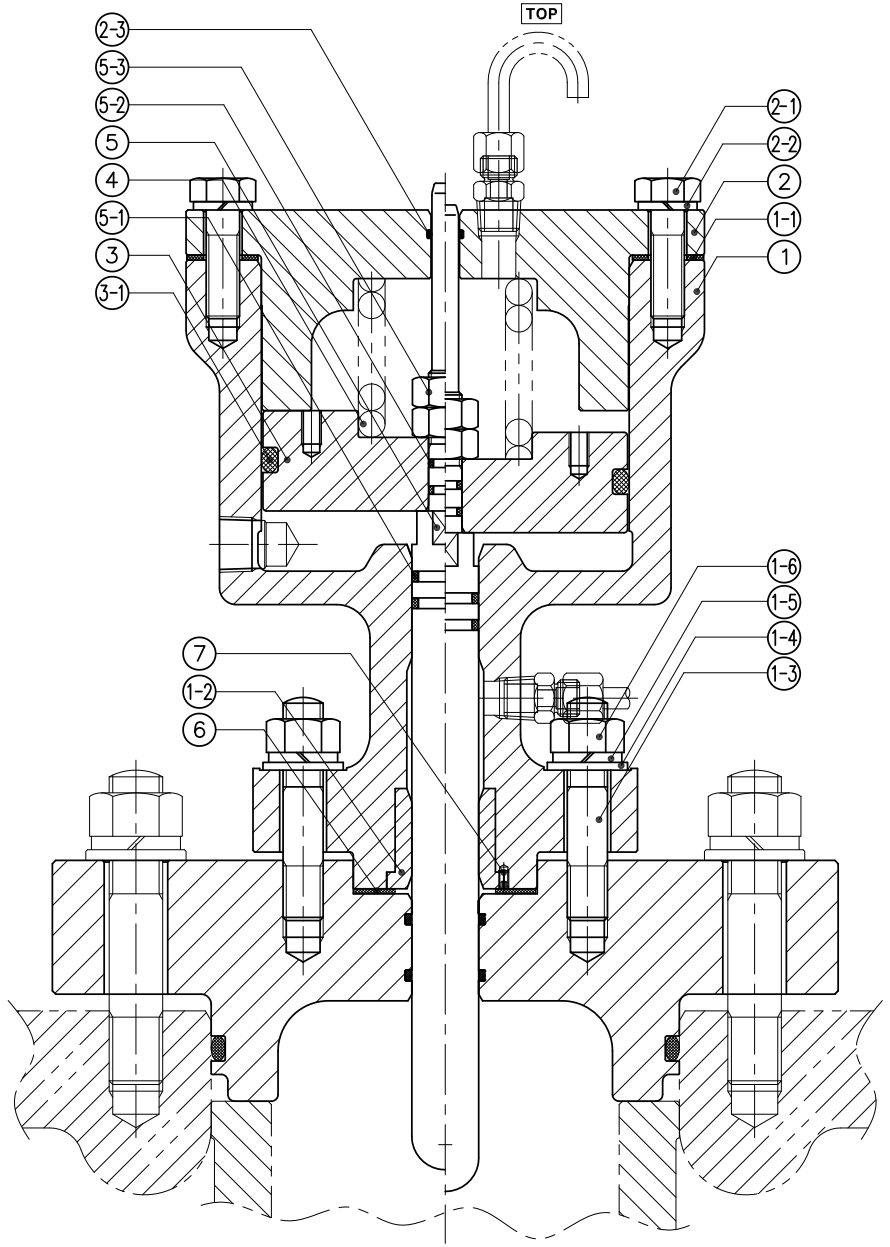
TOP



Dependable Compressor
KwangShin KWANGSHIN MACHINE INDUSTRY CO., LTD.

PROJECTION	UNITS	TITLE
	MM INCH	(DISTANCE PIECE SIDE)(1ST/2ND) GLAND PACKING ASS'Y
SHT. NO. 8/11	SCALE 1:2.5	DWG. NO. AS-13-53-007

A3 (297x420mm) CAD NO. : AS-13-53-00A

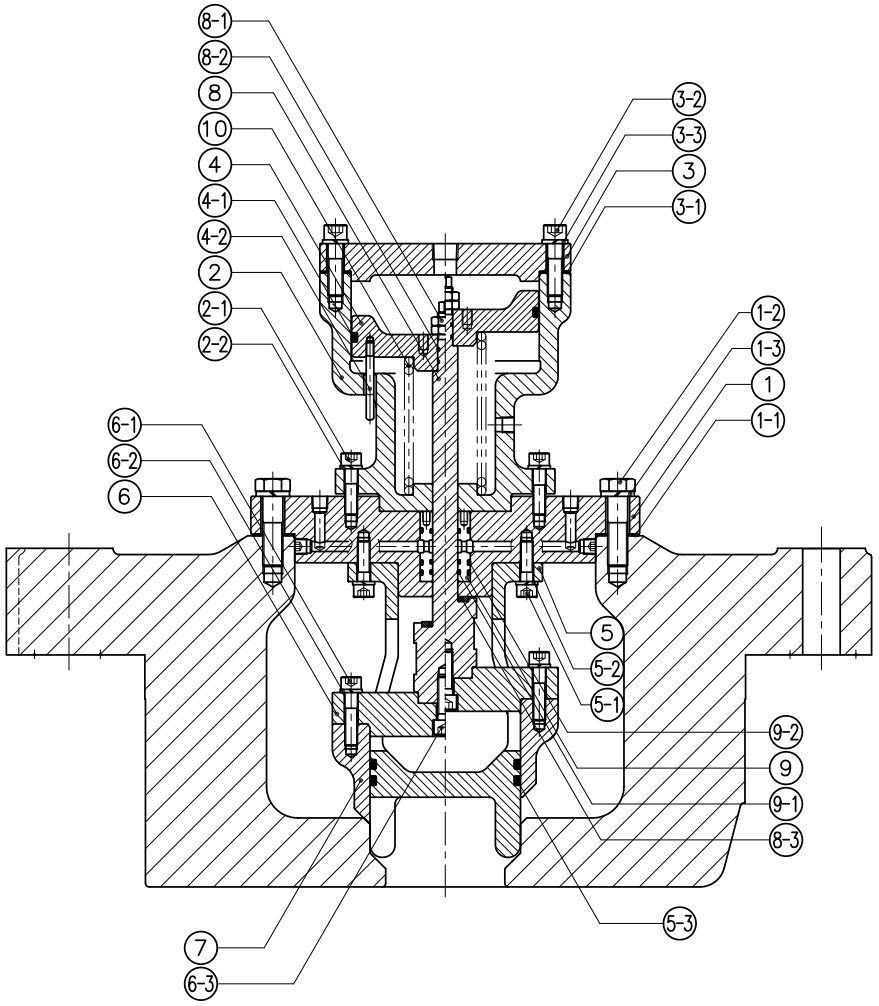


NO.	CODE NO.	PART NAME	MATERIAL ASTM or AISI	Q'TY	REMARKS
1		DIAPHRAGM BODY	A276 Type 316L	1	
1-1		DIAPHRAGM BODY GASKET	F104 P1141A	1	
1-2		GUIDE BUSH	A6061	1	
1-3		STUD BOLT/NUT	A193 B7	4	
1-4		PLATE WASHER	A283 Gr.C	4	
1-5		SPRING WASHER	A686 Type W1	4	
1-6		HEX NUT	A29 Gr.1045	4	
2		DIAPHRAGM COVER	A276 Type 316L	1	
2-1		HEX BOLT	A29 Gr.1045	10	
2-2		SPRING WASHER	A686 Type W1	10	
2-3		O-RING	FKM(V9117AA)	1	
3		PISTON	A395 Gr. 60-40-18	1	
3-1		O-RING	FKM(F201)	1	
4		UNLOADER SPRING	A276 Type 316L	1	
5		UNLOADER STEM ROD	A276 Type 316L	1	
5-1		O-RING	FKM(V9117AA)	2	
5-2		O-RING	FKM(V9117AA)	2	
5-3		UNLOADER STEM NUT	Stainless Steel	2	
6		GASKET	A1050P	1	
7		SET SCREW	A276 Type 304	1	

KwangShin *Dependable Compressor*
KWANGSHIN MACHINE INDUSTRY CO., LTD.

PROJECTION	UNITS	TITLE
	MM INCH	(1ST/2ND) UNLOADER PART ASS'Y
SHT. NO. 9/11	SCALE 1:1.5	DWG. NO. AS-13-53-008

A3 (297x420mm) CAD NO. : AS-13-53-00A

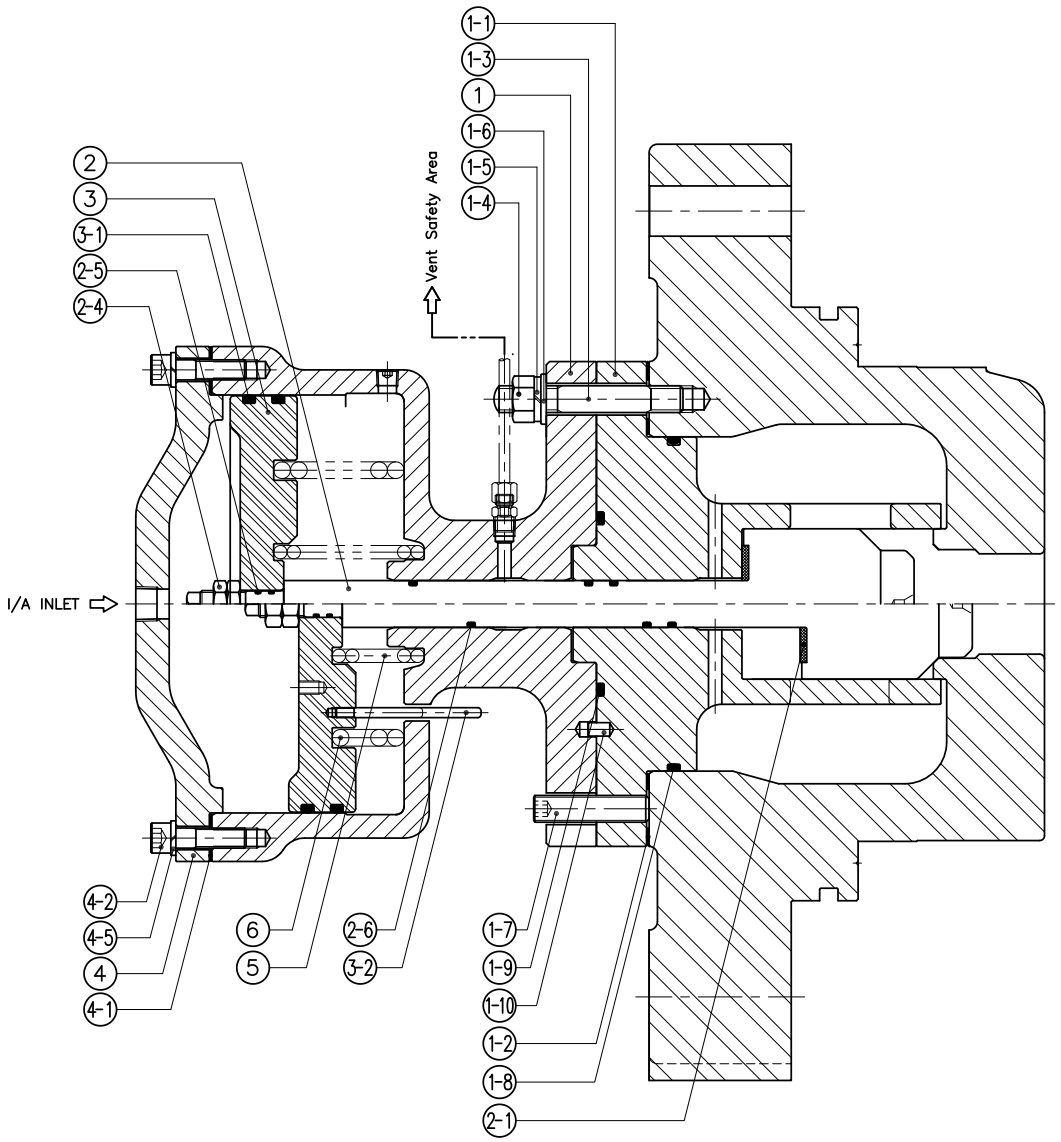


NO.	CODE NO.	PART NAME	MATERIAL ASTM or AISI	Q'TY	REMARKS
1		POCKET VALVE FLANGE	A276 Type 316L	1	
1-1		POCKET VALVE FLANGE GASKET	C-4400	1	
1-2		HEX BOLT	H/TENSION	12	
1-3		SPRING WASHER	A686 Type W1	12	
2		DIAPHRAGM BODY	A276 Type 316L	1	
2-1		WRENCH BOLT	A29 Gr.4140	6	
2-2		SPRING WASHER	A686 Type W1	6	
3		DIAPHRAGM COVER	A276 Type 316L	1	
3-1		DIAPHRAGM COVER GASKET	F104 P1141A	1	
3-2		WRENCH BOLT	A29 Gr.4140	12	
3-3		SPRING WASHER	A686 Type W1	12	
4		PISTON	A395 Gr. 60-40-18	1	
4-1		O-RING	FKM(F201)	1	
4-2		PISTON BAR	A276 Type 304	1	
5		DISK GUIDE	A276 Type 316L	1	
5-1		WRENCH BOLT	A276 Type 316L	8	
5-2		SPRING WASHER	Stainless Steel	8	
5-3		O-RING	FKM(V91177AA)	2	
6		DISK COVER	A276 Type 316L	1	
6-1		WRENCH BOLT	A276 Type 316L	4	
6-2		SPRING WASHER	Stainless Steel	4	
6-3		WRENCH BOLT	A276 Type 316L	1	
7		DISK	A276 Type 316L	1	
8		STEM ROD	A276 Type 316L	1	
8-1		HEX NUT	Stainless Steel	2	
8-2		O-RING	FKM(F201)	2	
8-3		GASKET	TEFLON	1	
9		COLLAR	A276 Type 316L	1	
9-1		O-RING	FKM(V91177AA)	3	
9-2		O-RING	FKM(V91177AA)	3	
10		SPRING	A276 Type 304	1	

KwangShin *Dependable Compressor*
KWANGSHIN MACHINE INDUSTRY CO., LTD.

PROJECTION	UNITS	TITLE
	MM INCH	POCKET VALVE ASS'Y (1ST)
SHT. NO. 10/11	SCALE 1 : 4	DWG. NO. AS-13-53-009

A3 (297x420mm) CAD NO. : AS-13-53-00A



NO.	CODE NO.	PART NAME	MATERIAL ASTM or AISI	Q'TY	REMARKS
1		POCKET VALVE BODY(UPPER)	A276 Type 316L	1	
1-1		POCKET VALVE BODY(LOW)	A276 Type 316L	1	
1-2		POCKET VALVE BODY GASKET	C-4400	1	
1-3		STUD BOLT	A193 B7	8	Sets
1-4		HEX NUT	A29 Gr.1045	8	
1-5		SPRING WASHER	A686 Type W1	8	
1-6		PLATE WASHER	A283 Gr.C	8	
1-7		HEX SOCKET SET SCREW	A29 Gr.4140	2	
1-8		O-RING	FKM(V91177AA)	1	
1-9		O-RING	FKM(F201)	1	
1-10		LOCK PIN	A29 Gr.1045	1	
2		STEM DISK	A276 Type 316L	1	
2-1		GASKET	TEFLON	1	
2-4		DOUBLE NUT	A276 Type 304	2	
2-5		O-RING	FKM(V91177AA)	2	
2-6		O-RING	FKM(V91177AA)	3	
3		PISTON	C5191B	1	
3-1		O-RING	FKM(F201)	2	
3-2		PISTON BAR	A276 Type 304	1	
4		POCKET VALVE COVER	A276 Type 316L	1	
4-1		POCKET VALVE COVER GASKET	F104 P1141A	1	
4-2		WRENCH BOLT	A29 Gr.4140	16	
4-5		SPRING WASHER	A686 Type W1	16	
5		SPRING	A276 Type 304	1	
6		SPRING	A276 Type 304	1	

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KWANGSHIN MACHINE INDUSTRY CO., LTD.

PROJECTION	UNITS	TITLE
	MM INCH	POCKET VALVE ASS'Y (2ND)
SHT. NO. 11/11	SCALE 1 : 3	DWG. NO. AS-13-53-010

A3 (297x420mm) CAD NO. : AS-13-53-00A

IV-1-1. FRAME

The frame is of cast iron and takes a form of box type. The frame forms with individually fitted distance pieces and through going studs over each main bearing a very rigid construction.

The inside of it forms the crankcase in which a crankshaft and connecting rods are provided. The bottom of it forms the oil tray in which lubricating oil is stored for lubrication of moving parts.

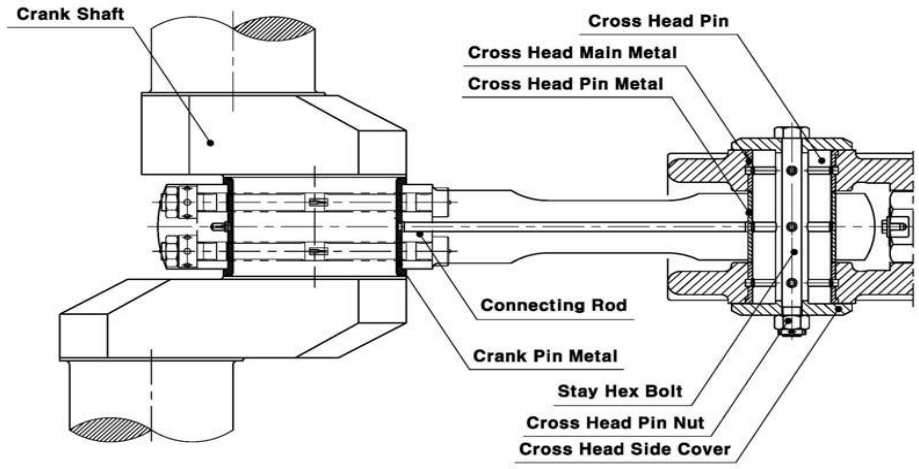
On both sides, the crosshead guides are mounted. On upper side of it are mounted one or more steel covers which enable easy inspection, cleaning, regulation, dismantling and exchange of the parts.

IV-1-2. CRANK SHAFT AND CONNECTING ROD

The crankshaft is one piece forging and supported by main bearings.

The most adjacent bearing to the driver has collars on both sides and works as guide bearing so as to hold the position of crankshaft in the axial direction.

The connecting rod of forged steel has the crank-pin bearing in the big end (crank end) and the crosshead pin bearing in the small end (crosshead end).



CRANK SHAFT, CONNECTING ROD & CROSS HEAD ASSEMBLY

The oil to the main bearings is supplied under pressure through the inlet pipes in the frame and the oil holes in the bearing housings.

The drilled passages in the crankshaft and connecting rods enable the oil supply from main bearings to crank-pin bearings and to crosshead pin bearings.

It is very important to keep these drilled holes always clean. In case of checking or renewing main bearings, first remove the frame top covers, secondly the reinforced distance pieces over each main bearing and take off main bearing caps then the upper halves can be dismantled.

The crank-pin bearings are also precision symmetric metal. To prevent the metal from turning in the big end, a guide lock is provided at the side of each metals. The crosshead pin bearings are one piece bush and have oil grooves on the surface.

When the bearing clearance becomes large due to wear of metal, the bearing should be renewed.

The precision metals which have been machined in very precise dimensions can be fitted with appropriate clearance by tightening the bolt with given tightening torque or giving elongation to bolt. Also, scraping for adjusting the bearing clearance is not allowed for these precision metals.

After taking out the metal which had been worn down, check the wear condition of the crankshaft carefully.

It is not reasonable that original new metals are fitted in the worn crankshaft.

When the crankshaft is re-machined because of its wear, the new another bearings, the inside diameter of which suits the outer diameter of re-machined crankshaft, should be used to give appropriate clearance between the metal and the crankshaft, of course this being very rare case.

In case of ordering the bearing applied to the small diameter shaft from us, please inform us of the re-machined diameter of shaft. Depend on the conditions, re-machining the crankshaft outer diameter and Cr plating and to fit the original size.

During the installation or inspection of the crank shaft, a dial gauge is attached to the specified measuring point to measure the web deflection and check whether the value satisfies the following regulations.

IV-1-3. CROSS HEAD AND CROSS HEAD GUIDE

The running surfaces of crossheads are lined with white metal.

The crosshead pin is fitted in the crosshead with forced fitting method. Proper clearance is given between crosshead pin and bush. Plate are fixed on the both ends of crosshead pin for stopped in it against axial movement.

When pulling out the connecting rod, for one thing, remove the frame top cover and besides remove the crankpin bearing cap of the connecting rod big end, and separate the connecting rod from the crosshead, then it can be taken out from the frame top.

Covers are provided on both sides of the crosshead guides and serve for checking of the crosshead and connection condition between the crosshead and the piston rod, and for disassemble of the crosshead pin.

IV-1-4. STUFFING BOX COVER

Partition cover of crosshead guide which is so called as crosshead side stuffing box is provided with oil wiper(scraper) rings and gas sealing rings. (In case of two compartment construction)

The oil wiper ring minimize oil leakage from crankcase to distance pieces. The seal rings prevent the gas leakage into the crankcase. Drains are taken out from the bottom of the compartment.

To prevent the gas leakage to the crankcase, the gas which has leaked out from stuffing box is ejected in the open air or safety area through piping.

In another case that the double compartment distance piece is applied, one more another partition cover is provided between the cylinder and the crosshead guide.

This partition cover provides gas sealing rings, and a longer distance than the piston stroke is provided between both partition covers.

IV-1-5. COMPRESSOR CYLINDER

Compressor cylinder is provided with cylinder liner, cylinder cover (upper and lower), cooling jacket, compressor valves and stuffing box.

Assembling and disassembling of the liner are facilitated by filling hot water into the cooling jacket and cooling the liner before disassembling with a jet of cold water or carbon dioxide snow (dry-ice), if necessary.

The cylinder covers are fastened to the cylinder by studs. The top cover has threaded holes for easy disassembling of it and is dismantled by using jack bolt, and this can transferred by eye-bolts.

Cylinders are designed as water-cooled type. In case of wet gas, in order to ensure fast and complete possible draining of condensation products which might appear in the cylinder, the suction valves are fitted at the top side and the discharge valves at the bottom side of the cylinder.

The stuffing box is fitted on where the piston rod runs through the cylinder, and prevents the gas leakage from the cylinder. Gas seals between cylinder body and bottom cover or top cover can made by gasket or O-ring.

When dismantling the cylinder cover for maintenance, caution should be paid whether the pressure in the cylinder is perfectly relieved.

* Attach. 4- . Cylinder (Liner) Overhaul Data

KwangShin - 124, Okog-ro, Chirwon-eup, Haman, Gyeongnam, Korea
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Cylinder (Liner) Overhaul Data

1) After 8000 hours of operation, disassembly inspection and replacement of consumables should be carried out.

2) Disassemble cylinder cover, piston, piston rod, valve assembly, valve holder, and valve cover from cylinder.

3) Check the condition of the inner surface of the cylinder Liner and measure the inner diameter to check whether it is replaced.

4) If the inner surface condition of the cylinder liner is good and the measured inner diameter of the cylinder liner is available, clean the gas passage and cooling water passage at the site before use.

5) If extended use is impossible due to severe scratches or abrasion on the inner surface of the cylinder liner, the cylinder liner must be replaced.

6) Replacing the cylinder liner is carried out at the KWANGSHIN workshop after disassembling the cylinder and taking it out.

7) Cylinder liner after reassembling the replaced cylinder, finish the work by assembling the remaining parts.

IV-1-6. COMPRESSOR VALVE

Both the suction and discharge valves consist of a valve seat, valve guard, valve plate and valve spring, fitted together by a center bolt and nut, the correct spacing being obtained by spacer placed around the bolt. Between valve seat and guard, the valve plate and one or two damper plates are fitted and the valve plate is set on the valve seat by a set of coil springs.

The valve guard, valve plate and damper plates are positioned by two guide pins. The valve is fixed on the valve port in the cylinder by the valve cover through the valve holder or by the bolts fitted on the valve cover through the valve holder after the valve cover being secured by the studs for valve cover.

Gas tightness at the seating surface of valve in the valve port of cylinder can be secured by means of metal gasket, and O-ring is fitted between cylinder and valve cover for easy to maintenance and perfect gas tightness.

The valve should be mounted on the cylinder in the following below ;

1) Prepare Valve seat gasket, Valve assembly, Valve holder, Valve cover, O-ring in order.
2) Carefully push the valve seat gasket, valve assembly, and valve holder into the valve port of the cylinder and install it.
3) Check if the valve assembly and valve seat gasket are in the normal position of the valve port.
4) Close the valve cover and lock the hex nut while being careful not to damage the O-ring of the valve cover.

** Maintenance of Compressor Valve

Satisfactory operation of the compressor is largely dependent on the maintenance carried out on the compressor valves.

We advise to disassemble, clean and inspect the valves at the time past 500 operating hours after the compressor is started up.

After this first inspection, unless something is wrong, the interval of this inspection may be made be longer by yourselves considering the operating condition of the compressor.(The maximum interval is 4,000 hours)

All valve plates and valve springs to be preferably renewed for the preventive maintenance after 8,000 hours running even if they are not damaged.

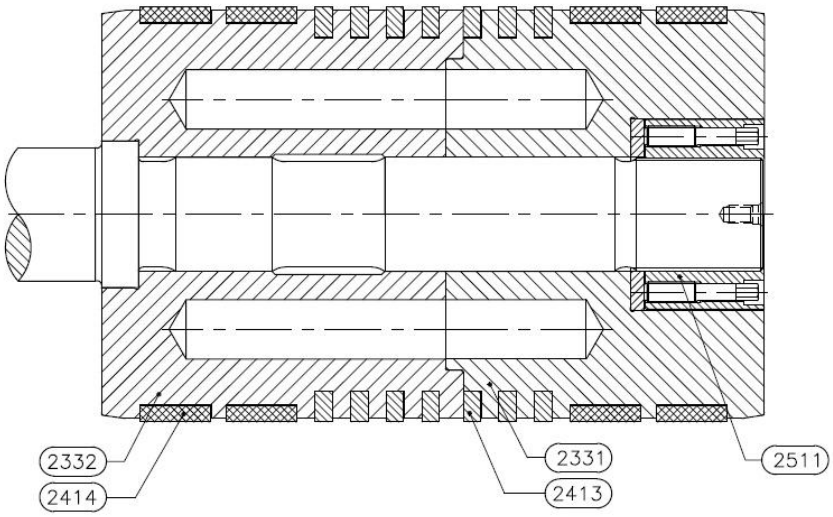
The procedure for the replacement of the suction valve is as follows:

1) Remove the valve from the compressor.
2) Remove the unloader pusher from the valve.
3) Clean the unloader pusher clean.
4) Assemble the pusher on the SPARE suction valve.
5) Assemble in a compressor.

IV-1-7. PISTON

Piston is provided with Miscellaneous filled PTFE piston rings and rider rings. When fitting piston rings and rider rings on the piston, be sure not to enlarge the ring gap more than necessity.

As to clearances for connection of piston and piston rod, refer to “Technical data".



NO.	CODE NO.	PART NAME	MATERIAL ASTM or AISI	Q'TY
2311		PISTON BODY(UPPER)	A395 Gr.60-40-18	1
2312		PISTON BODY(LOW.)	A395 Gr.60-40-18	1
2413		PISTON RING	Filled PTFE	7
2414		RIDER RING	Filled PTFE	4
2511		PISTON NUT	A240 Type 316L	1

PISTON ASSEMBLY

IV-1-8. PISTON ROD

The piston rod is provided to .4 4 material with "Tc-coating".

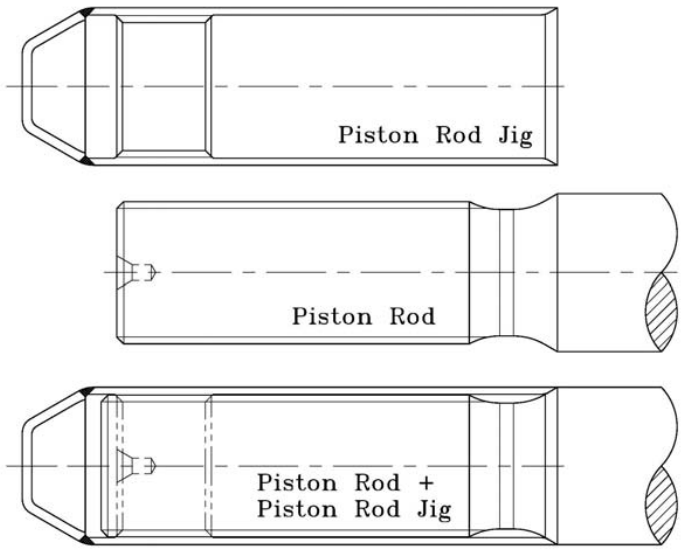
When the piston is mounted on a piston rod, assemble it in the order of the piston, thrust nut, and piston nut.

After attaching the piston and the piston rod, completely lock the piston nut to the fastening torque value, and then lock the Multi-bolt diagonally by checking the fastening torque value.

The fastening torque of piston nut is 20 kg-m and the fastening torque of multi-bolt is 4.5 to 5.5 kg-m.

*** When assembly and disassembly Piston rods**

The first to install the Piston rod jig supplied as a special tool on the screw slot between the piston rod and Crosshead can protect the Oil wiper ring and Gland Packing or Rod Packing ring from damage.



PISTON ROD & PISTON ROD JIG

IV-1-9. STUFFING BOX

The stuffing box consists of several packing cases in which a pair of seal rings are inserted. The garter springs around the rings give them the required surface pressure on the piston rod.

The contact surfaces of each packing case operate the sealing of leakage gas. The sealing of gas between the bottom packing case and cylinder shall be kept by gasket.

The leakage gas from the stuffing box is vent to the flare-line, to safety location through piping or connected with suction line in accordance with their gas property.

Constructions and materials of the stuffing boxed are varied with the specified operating conditions, pressure, temperature and property of handled gas.

The followings are general guides in servicing and installing, and should be closely watched to keep the stuffing box in good order.

1) When assembling the stuffing box, always carefully clean up the packing cases, rings, springs and the piston rod surface.

2) Dirts on the ring will cause sticking the rings, and dirts on the sealing face of packing case will result in incorrect alignment and cause the leakage between them.

3) Inspect carefully the cooling water holes and vent holes in the gland and each packing case.

4) Care should be taken to assemble the seal rings and the packing case in the correct sequence. One or more types of the rings are arranged in grooves to give the best sealing effect according to the specified condition.

5) In case of assembling the rings in the incorrect sequence, the stuffing box will not seal the pressure. Incorrect sequence of the packing cases will result in the serious damage coming from the stop of oil feed. Furthermore, care must be taken to arrange the pair of rings in correct direction in a groove. All ring segment ends are lettered or match-marked and accordingly, should be assembled. When water cooled type and/or oil feed type packing case is supplied, all cases must be assembled in accordance with their own match-mark.

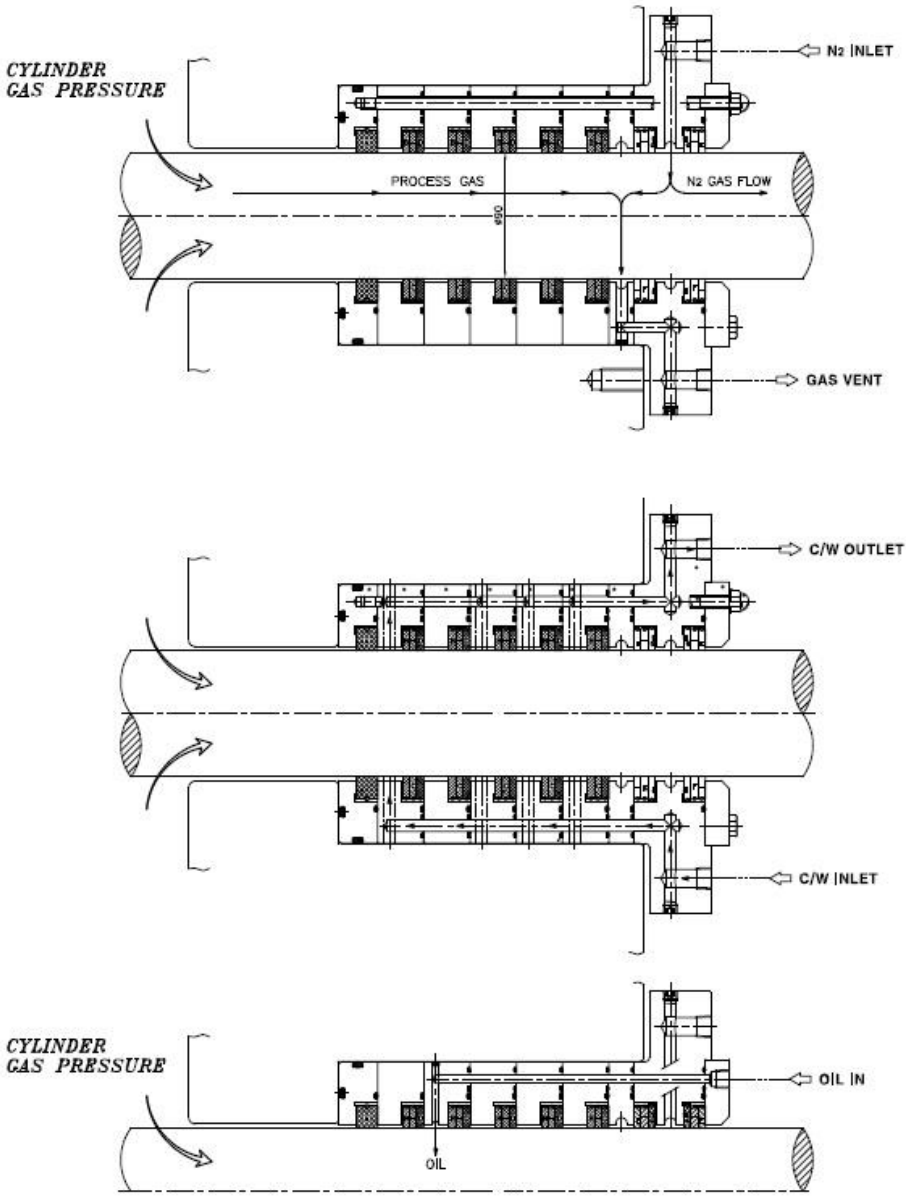
6) Through tie bolts, screw the nuts securely and uniformly.

7) Clean the faces of the pocket in the cylinder on which the gasket of the stuffing box rests.

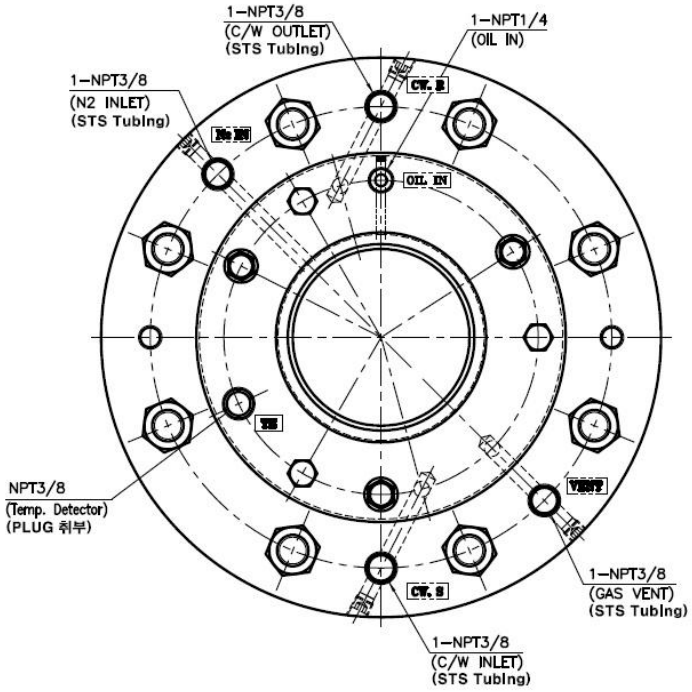
8) If gas leakage occurs in operation, first check whether the tightening bolts are securely screwed, and secondly check the side clearances and the end gaps of the rings, the garter springs and the sealing surfaces of packing cases.

As the gas leakage from stuffing box can be as certaind by by the surface temperature of the vent pipe, care must be taken to the increase of this temperature, because high temperature means much leakage.

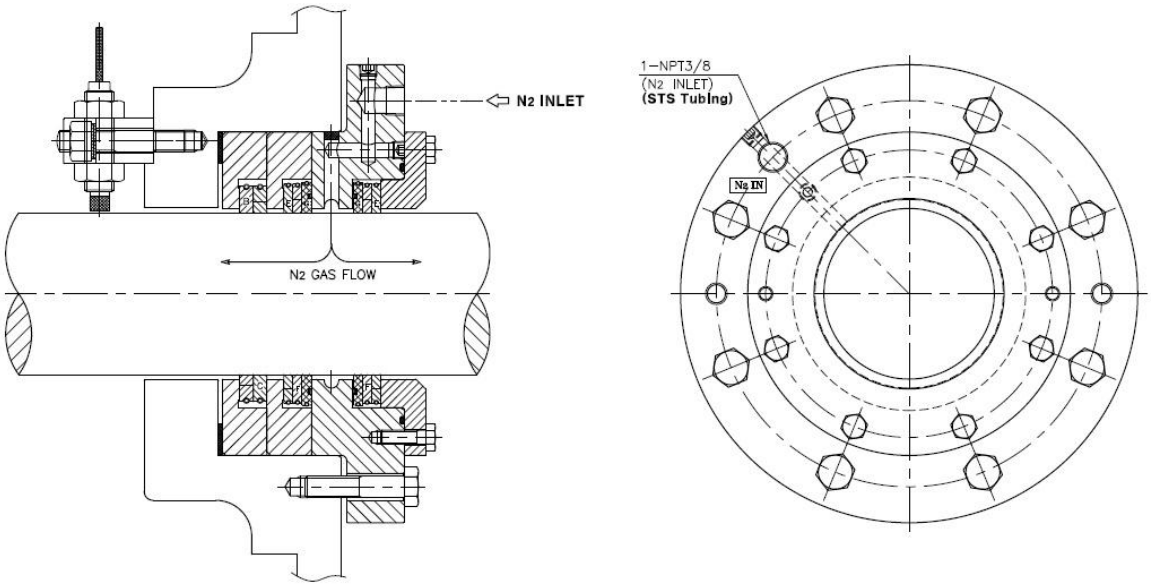
Gas leakage from the stuffing box can be confirmed by the surface temperature of the gas vent pipe, and high temperature means a lot of leakage, so care must be taken for temperature rise.



1ST ROD PRESSURE PACKING RING ASSEMBLY



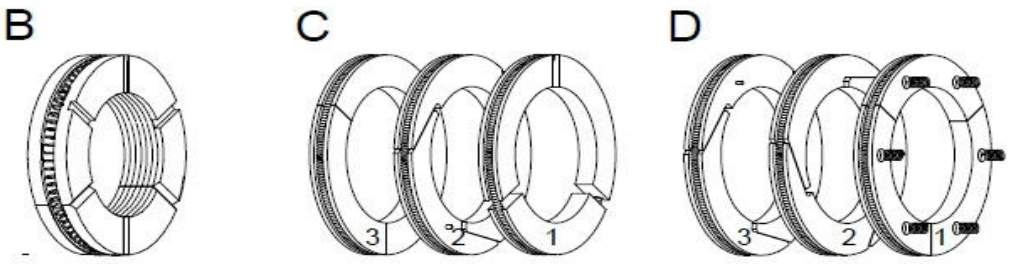
1ST ROD PRESSURE PACKING RING ASSEMBLY



1ST & 2ND GLAND PACKING ASSEMBLY (DISTANCE PIECE SIDE)

*** Assembly of Stuffing box and Gland packing (Rod Packing Ring)**

Gland packing (Rod packing ring) consists of two or three pairs of the following shapes.

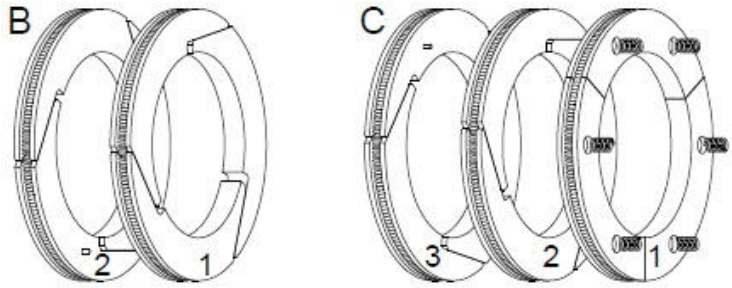


Product - 3112
RRT: 15.0

Product - 3302
RRT: 15.0

Product - 3306
RRT: 15.0

1ST ROD PRESSURE PACKING RING SETS



Product - 3202
RRT: 15.0

Product - 3306
RRT: 15.0

GLAND PACKING ASS'Y RING SETS (DISTANCE PIECE SIDE)

The stuffing box is mounted inside the lower (crank end) of cylinder. When inserting the piston rod into the stuffing box, be sure to use the piston rod jig to prevent damage to the rod packing ring.

In the case of a structure in which oil is supplied to the stuffing box, in winter, an electric heater should be used to keep the minimum oil temperature above 20℃ and then start the compressor.

IV-1-10. CYLINDER COOLING

**** Forced Water-Cooled Cylinder**

In case that the cooling water controlled its temperature is supplied for the cylinder cooling, keep to the following ;

(1) For wet gas, the inlet temperature of cooling water should be maintained above 4℃ than the process gas inlet temperature by the reason of protecting the gas from condensing.

(2) As a general rule, also during the stoppage of compressor, the cooling water maintained its temperature should be continuously supplied into the cylinder jackets.

(3) Also in case of starting the compressor after long stoppage, after the inlet temperature of cooling water is maintained above 4℃ than the process gas inlet temperature, the compressor should be started.

IV-2. GENERAL INSTRUCTION FOR MAINTENANCE

1) Tightening Torque

When two mechanical parts are joined by a bolt and nut, you want the nut to be tight, but the word "tighten" is a vague and flexible concept.

Even if it is assumed that the trainee has filled the nut with the full force of the trainee using a normal open spanner, the trainee will tighten more weakly. He will be sure without a doubt that the nut is tightened, and in some conditions is actually "as tight as possible" tightening.

In other cases, if a machinist has the help of a round box spanner with a conventional long screwdriver to fill the nut in place, it is not very difficult to fill the nut in place quite a bit, in which case he considers the nut to be tight.

This added force increases the tensile stress of the bolt and at the same time receives the correspondingly increased compressive stress so that the part is held between the nut and the bolt.

The manufacturer specifies the tightening torque to be used. This torque is in principle the product of force and arm distance. Those responsible for connecting the parts can use any force or arm distance if the product of the two values has a specified value.

For example, a 20 N-m tightening torque can be obtained by using a 0.5 m long spanner with a force of 40 N, or by using a spanner with a length of 2 m with a force of 10 N. In practical practice, a spanner is used to measure the generated torque as a scale at the same time.

If the tightening torque is specified constant, the nut to be bolted must be tightened until the torque value appears on the scale.

It became clear why the tightening torques described in “Technical data” must be observed as closely as possible to achieve support for the crankcase, bearing cap of the connecting rod, cylinder cover, cylinder support to the crosshead, and frame of the crosshead guide.

This will prevent accidents due to insufficiently tightened joints or excessively stressed bolts and overloaded joints. If excessive force is applied to the mating part, the sealing surface, bearing surface or guide may be destroyed, causing easy leakage or tangling of moving parts.

Note: In SI unit systems, tightening torque is usually expressed in N-m (Newton-meters), while torque spanners used in the metric system country are graded in Kg-m (Kilogram-meters).

The ratio between these units is 1 Kg-m = 9.8 N-m. 1) Tightening torque

2) How to Tighten the Bolt

Another factor to consider when tightening a nut on a bolt or stud is when connecting with multiple bolts. Examples of this are cylinder covers, compressor valve covers, or stuffing box flanges, where the bolts are arranged at a regular polygonal angle.

It need not be emphasized that the sealing or clamping function cannot be performed unless the nuts are tightened evenly on the bolts, i.e., sequentially tightened one by one until the nuts apply practically the same pressure to the cover or flange.

To achieve this purpose, the nuts are tightened one by one and little by little in the correct sequence.

When filling the "ring" of the nut holding the gland of the cover or stuffing box, the correct way to do this is to increase the torque applied to each nut little by little each time and run it approximately along the diagonal.

If the ring of the nut goes along a circle and tightens the nut next to it from one nut to it, and if you fill the nut all at once, the pressure will not be uniform throughout the area, which can lead to undesirable results.

3) Split Pin

Nuts must not be secured with split pins moistened with “oil”. This is the case even if no damage has been taken during the previous decomposition process.Split pins are inexpensive and can keep a small amount of inventory on site, so using previously used split pins does not have to introduce even the least risk. When disassembling the bolted part, it became difficult to remove the split pin of this joint, so there was a case where the head and end of the split pin were cut by forcibly loosening the nut while leaving the split pin in place.

There should never be such a “disassemble procedure”. In addition to unavoidable damage to the threads, the bolts are subjected to considerable torsional stress (especially when the protruding part of the split pin is bent rather than cut off and caught between the bolt and nut), resulting in tightening work during reassembly. With full tensile stress, this bolt is no longer reliable.

4) Gasket and Sealing Ring

Previously used gaskets and sealing rings are likely to lose some of the properties (compressibility and resilience) necessary to perform the sealing function. If these parts are to be reused, higher pressure than before must be applied to the joints to ensure a complete seal.

Then, the parts of the joined area are subject to high deformation. Therefore, it is recommended that gaskets and sealing parts are not reused, regardless of the material of manufacture, or if there is no obvious breakage or deformation in shape during the disassembly process.

To comply with the above principle, you must have a set of spare gaskets and sealing rings, especially for connections that are expected to be disassembled in the near future.

5) New Machine Bolts and Nuts

The bolted connections on the new compressor turned out to be less tight after the initial operating period than when shipped by the manufacturer.

In many cases, this joint compressive force drop due to the bed effect of the part in question is not detected without checking the nut with a torque spanner. However, in some cases, even if the nut is secured against loosening with a split pin or lock nut, you can determine if the nut is loose by touching it with your hand. It is usually sufficient to check and tighten the new compressor after several days of operation. This check should be repeated several times over and over after a certain period of operation, eg 100 hours. In addition, special attention should be

paid to bearing cap bolts and other important connections with specified tightening torques.

6) Textile Cleaning Cloth

Waste cotton or worn rags should not be used for cleaning purposes. Any fibers or lint left behind the cleaned parts can adversely affect machine operation.

7) Points to note when supplying cold cooling water to a heated machine

If the cooling water system of a compressor that is still running or has just been shut down shows a significant water shortage, this means that the additional water supplied is relatively deep into the machine. If the temperature here is high, especially if it is too high due to insufficient cooling water, it causes local excessive thermal deformation and, without exception, cracks or permanently deforms mechanical parts.

Therefore, if cold water needs to be added to a coolant system that is not filled with water to the mark or near the mark, it must be poured very slowly to give the coolant time to rise to normal before the water reaches the cylinder.

8) Selection of Lubricant

Due to the ever-increasing knowledge and experience in the field of lubrication and lubricants, today's compressor lubricants meet the highest quality standards. These developments are accompanied by a tight coupling between specific lubrication operations and lubricant properties. The use of good grade lubricants

for all purposes has long since disappeared. Even high-quality modern lubricants cannot take advantage of their benefits unless you select the oil grade that best suits the type of machine you intend to use. In many cases, operating conditions play a decisive role in lubricant selection.

Therefore, it is very important that the compressor uses the type of oil specified in several places in this book. It was selected by consulting with experts in the oil industry with long experience.

The oils specified in this book have been found to give optimum results for lubrication of the machine used. Indicating the type of oil as the brand name used by a particular oil company is simply an example of this name and is for the convenience of the reader of this book.

This means that oils of the same class supplied by other renowned oil companies are equally suitable for the purpose. Your oil supplier will explain which type of lubricant from your company has the same characteristics as the type mentioned in this book.

9) Prohibit Excessive Lubrication

The dangers caused by insufficient lubrication are generally well understood, but it is not well understood that excessive lubrication can also produce unwanted results. (The exception is that excess oil supplied to moving parts is drained and recirculated to an unfilled oil reservoir.)

Excessive lubrication in the compressor cylinder causes “sticking”. And in long-term operation, a “failure” of the piston ring occurs. Excess oil partially collects in the groove behind the piston ring, thickens, and eventually carbonizes under the

influence of compression temperature. The fixed piston ring reduces the gas tightness between the piston and the cylinder wall, and leaking gas coming out along the piston destroys the lubricating oil film on the cylinder wall.

Excess lubricating oil from the cylinder along with the compressed gas contaminates the discharge valve, and after a while the valve does not perform its function properly. When these factors overlap, the compressor power decreases, the power absorbed by the machine increases, and the cylinder is likely to wear excessively.

10) Checking for Impurities Filtered from Lubricant

When removing sediment from the oil filter installed in the lubricating oil system, do not discard the sediment immediately, but first check for signs of excessive contamination or mechanical wear. If white metal powder, for example, is filtered out of a lubricant, then excessive wear has occurred in parts of the machine. This is a warning to take action as soon as possible.

11) Gas Leakage from Stuffing Box

A certain amount of piston rod stuffing box leakage is no exception for new compressors. This is because the packing rings and piston rods have to be ready for a certain period of time until complete sealing is guaranteed. As this operation proceeds, the gas leakage gradually decreases to a small amount that can be considered normal.

In the lubricating type, properly adjust the oil supply to the stuffing box.

If a significant amount of gas leak remains after disassembling the compressor part, or if gas continues to leak from the stuffing box of a fully prepared machine, the operation should not be run for a period of time to investigate the cause of the leak. In fact, the leak in this case is an indication that the packing ring is not correctly installed on the piston rod.

Particularly in the case of cast iron rings, the iron powder polished for this ring combines with the lubricant to form a wear compound and increases the wear of the ring and piston rod.

Incorrect installation of the packing ring occurs because various parts of the stuffing box were not installed in the original piston position during reassembly or were not completely cleaned in the event of a reinstallation. Another possible cause is not tightening the nut of the gland evenly.

12) Compressor Valve Maintenance and Regeneration

The compressor valve must be disassembled, cleaned and carefully inspected 500 hours of operation after the compressor has started. If there is no significant phenomenon after the first inspection, this inspection interval can be set long by the driver himself taking into account the operating conditions of the compressor. (The maximum interval is 8,000 hours.)

Valves placed on the ground are prone to breakage, so they should be soaked in oil and cleaned with a soft brush. Do not use wire brushes or hard tools that can scratch or deform the disc. When reassembling the valve, special care must be taken to ensure that the various parts are installed in the correct position. Care must be taken not to interchange the springs of the intake and discharge valves. In most cases, the characteristics of each spring are different.

The moving valve parts are prone to fatigue damage after long-term operation. To maintain maximum safety, it is recommended that the valve disc and valve spring be replaced after 8,000 hours of operation. This is true even if there are no signs of wear or early cracking.

13) Impurities in the Suction line of the Compressor

Before operating a newly installed compressor, the temporary filters (cone type) must be installed in the initial suction line. This temporary filter is used to filter contaminants, rust, welding debris or other foreign objects that may be present in newly installed piping systems. Of course, these temporary filters must be inspected and cleaned at regular intervals during the first driving period.

Special care should be taken to ensure that the compressor is not operated with a large inlet block. And it should not be operated at very low suction pressures due to partially clogged cone filters. If the ratio of the suction pressure and the discharge pressure increases, the final compression temperature of the gas rises, causing problems with the lubricating oil, and in the case of an air compressor, the lubricating oil may ignite and cause an explosion.

Therefore, if the temporary filters are installed in the suction line, it is important to regularly check the pressure in the cylinder suction space with a pressure gauge.

If no more impurities are detected in the oil, the cone filter can be removed.

IV-3. TIME SCHEDULE FOR MAINTENANCE

* GENERAL MAINTENANCE

The following instruction for the maintenance schedule is to be understood as a general guidance for efficient maintenance of the compressor and may be altered by operators or people in charge of maintenance work in accordance with the experience at site based on the actual results of the operation. Especially in the case of contaminated gases, it is preferable that the maintenance intervals are shortened.

As a rule, it is not recommended to disassemble the compressor for inspection or maintenance except when data in the daily records indicate that readjustment or replacement of certain parts is called for or when distinguished troubles occur on the compressor parts.

We advise to record a number of operating data at regular intervals.

a) Temperature and pressure of lube oil
b) Pressure drop across lube oil filter
c) Temperature and pressure of handling gas
d) Average load
e) Gas analysis

In addition to the above data, operator should bear in his mind the conditions of lube oil, handling gas and cooling water, drains from individual parts, and sound under normal operating conditions of the compressor.

The abnormal value of above data, the lube oil consumption, the gas leakage from stuffing box, etc. will often indicate the omen of accident or replacement of parts.

1) Piston ring & rider ring inspection instructions in initial operation (recommended)

a) Wear measurement after 650 (Non-lube) hours of operation

b) Wear measurement after 1300 (Non-lube) hours of operation

c) Wear measurement after 4000 (Non-lube) hours of operation

➔ After obtaining these measurements, an expected inspection schedule can be established.

2) Daily Maintenance

a) Fill systematically the above mentioned operating data in records.

b) Check cooling water supply.

c) Check lube oil level by sight glass. If necessary, replenish the oil.

d) Check pressure difference across lube oil filter.

e) Drain off all condensate from individual parts and inspect the colors. Check the oil dropped out of stuffing box.

g) Check the sound around the compressor valve for normal conditions.

h) Sweep the compressor and around.

3) Every after 500 hours of Operation

a) Check operation of safety devices.

b) Check gas, oil and water systems for leakage.

c) Inspect and clean lube oil filter, if necessary.

d) Check condition of lube oil.

Note : After first time operation, check the rider ring and piston ring after 650 and 1300 hours of operation.

3) Overhauling Schedule for Parts

Part Name	Maintenance Interval (hr)	Detail of maintenance
a) Cylinder		
Cylinder or Cylinder Liner	8,000	Inspect the inside and measure the inside diameter.
Gas Passage in the Cylinder	8,000	Inspect the condition of inside and clean the passage, if necessary
Cooling Water Jacket	8,000	Take off the cover and clean out the dirt of jacket inside.
Clearance Pocket	8,000	Inspect the condition of inside and clean. Confirm the moving of handle and grease the thread.
b) Piston and Piston Rod		
Piston	8,000	Inspect the outside and measure the groove dimension and the outside diameter.
Piston Ring	8,000	Inspect the ring condition and measure the amount of wear.
Rider Ring	8,000	Inspect the sliding surface and measure the amount of wear.
Piston Rod	8,000	Measure the amount of wear and check the plated surface condition at the sliding section Inspect whether the crack is observed.
	16,000	Examine the rod by Ultrasonic. (As a rule, the piston rod is worn down on the sliding section should be renewed.)
c) Stuffing Box		
Gland packing	8,000	Inspect the spring and contact surface to the piston rod. Measure the side clearance and the thickness of the ring.
Oil wiper ring	8,000	Inspect the spring and contact surface to the piston rod.

Part Name	Maintenance Interval (hr)	Detail of maintenance
d) Compressor Valve		
Valve Seat	8,000	Inspect the seat face, if any damage is shown, re-machine and lap the seating area.
Valve Plate	8,000	Inspect the seat face and measure the thickness. Inspect the warp and breakage. (Renew after 8,000 operating hr.)
Damper Plate	8,000	Inspect the warp and breakage. (Renew after 8,000 operating hr.)
Valve Spring	8,000	Inspect the warp and breakage. When a spring in a valve indicate damage, all springs as well as its spring in this particular valve must be renewed. (Renew after 8,000 operating hr.)
Guide Pin	8,000	Inspect the contact to valve plate or damper plate, and examine any breakage or damage.
Valve Cover Gasket (O-Ring)	4,000	Inspect cut off or hardened.
Suction valve Unloader	8,000	Inspect the condition of packing, diaphragm, spring, etc. (As a general rule, diaphragm packing should be renewed after one year operation.)

Part Name	Maintenance Interval (hr)	Detail of maintenance
e) Cross Head		
Cross Head	8,000	Inspect the sliding surface.
Cross Head Guide	8,000	Inspect the sliding surface and measure the clearance between crosshead and guide by feeler gauge.
Cross Head Pin	8,000	Examine the surface PT or MT. Measure the outside diameter.
Cross Head Pin Bearing	8,000	Inspect the surface and measure the inside diameter.
f) Connecting Rod		
Crank Pin Bearing	8,000	Inspect the surface.(PT or MT) After assemble the bearing into the connecting rod, measure the inside diameter and the elongation of rod bolt.
Connecting Rod Bolt	8,000	Inspect the surface.(PT or MT) Measure the free length of it. (The connecting rod bolt should be renewed after 20,000 running hours or 10 times of retightening)
g) Crank Shaft		
Crank Pin	8,000	Inspect the surface and measure the outside diameter.
	16,000	Inspect the surface.(PT or MT)
Crank Journal	16,000	Inspect the surface(PT or MT) and measure the outside diameter.
Main Bearing (Sleeve)	16,000	Inspect the surface(PT or MT) and measure the inside diameter
Main Bearing (anti-friction)	16,000	Measure the bearing radial gap.
Deflection of Crank	8,000	By reason of confirming the alignment of crank shaft, measure the deflection. If bad alignment is appeared adjust and/or renew the main bearing or motor bearing

Part Name	Maintenance Interval (hr)	Detail of maintenance
h) Crank Case	8,000	Inspect the inside for dirts or foreign matters.
i) Lube Oil Pump	8,000	Inspect the bearing, gear and their contact condition.
j) Lube Oil System	8,000	Check the working of its element and clean it. Also clean internal piping.
k) Lube Oil Filter	4,000	Investigate the dust on the element, check the abnormal wearing. Renew after 4,000 running hour.
l) Driver (Motor)	8,000	According to instruction for motor.
m) Suction Inlet Filter	Every 500	Inspect the filter for clogging or breakage. After disassembly and repair or contaminated gas Inspect if used.
n) Crank Case Lube Oil	4,000	Analyze and examine the viscosity, inflammable point, etc.
o) Tightening Bolt and Nut	4,000	Inspect the tightening condition of all bolts. If loosened, tighten it firmly. If the anchor bolts are adjusted, after the working, measure the deflection of crankshaft and confirm its value.
p) Heat Exchanger (Gas Cooler, Lube Oil cooler)	4,000	Inspect the clogging condition and the corrosion or corrosion condition inside the tubes. If necessary, measure the tube wall thickness.
q) Vessel & Piping	4,000	Inspect the carbon deposit and watch it not to accumulate more than 1 mm. If necessary, clean it by chemical cleaning. If accumulated more than 1 mm within 2,000 operating hours, clean up it every 2,000 operating hours.

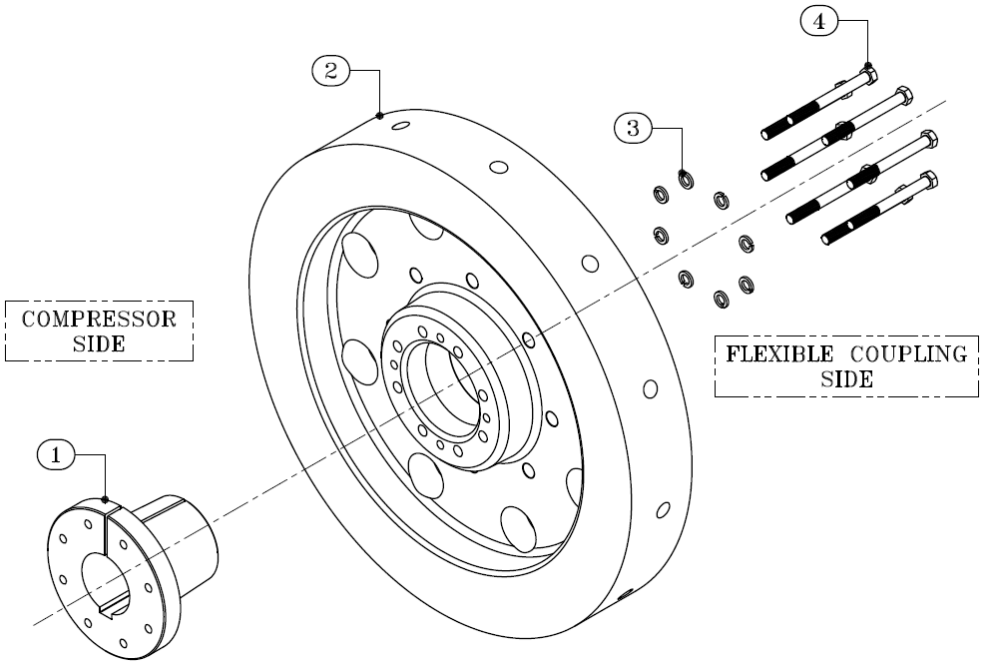
IV-4. COUPLING ASSEMBLY AND DISASSEMBLY PROCEDURE (Rigid Type)

. Mount Con-key of compressor side on crankshaft (①).

. Push coupling of compressor side toward Con-key (②).

. Fit spring washer in Con-key bolt and tighten them (③, ④).
Use dial gauge on face surface to tighten bolt within error range of 0.03mm.

4. Perform disassembly by inverse order of assembly.



4-4. Flexible Coupling Manual

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Instruction Manual

PANFLEX COUPLING

REV. 0

2024 . 05.

NARA CORPORATION

⚠ CAUTION

■ Before any installation, operation and maintenance work on Disc couplings it is essential that the contents of this manual are read and fully understood before starting work.

CLIENT : KWANGSHIN

PROJECT : BINAK OIL FIELD DEVELOPMENT PROJECT

MODEL : NPE-B API 840S

MFG. DATE : 2024. 05

DOC NO. : PC2400335 REV. 0

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NARA CORPORATION

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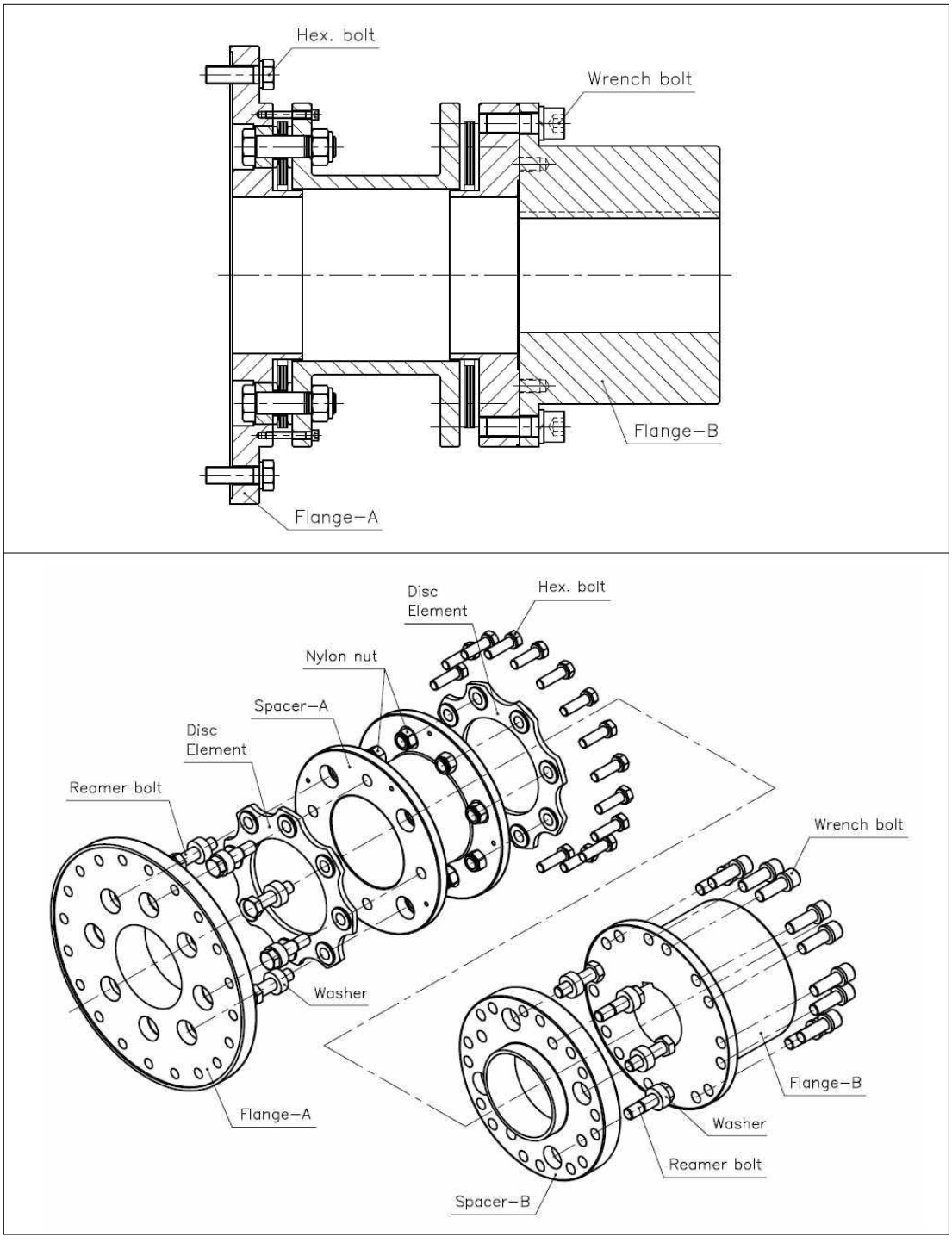
1. STRUCTURE


Hex. bolt
Wrench bolt
Flange–B
Flange–A
Disc
Element
Hex. bolt
Nylon nut
Spacer–A
Disc
Element
Reamer bolt
Wrench bolt
Washer
Flange–A
Flange–B
Washer
Reamer bolt
Spacer–B

2. INSTALLATION

(1). Initial Assembly

1) Wipe the inside diameter of the shaft and flange clean and check for proper fit tolerance.
2) When the flange has been fabricated by interference fit, heat in a 120~150℃ oil bath and fit it to the shaft. Never apply heat locally, It may cause distortion.
3) Move equipment units to permit coupling in the correct position.
   Set both flange faces(BE dimensions) within ± 0.25mm except special cases.

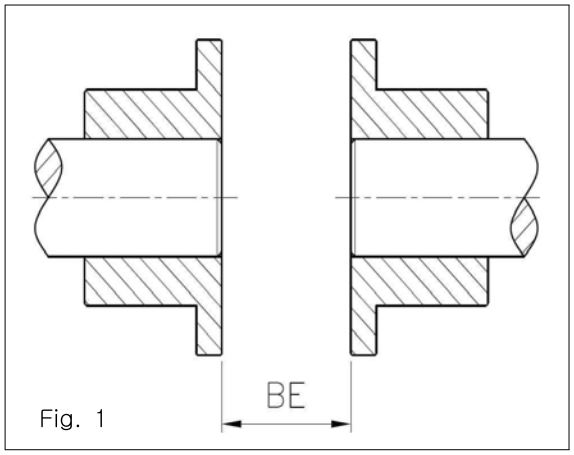


Fig. 1

Table 1

Type	BE (mm)
#830S	460
#840S	460
#850S	500

(2) Angular Misalignment

1) Fix the dial gauge on one side of flange(usually the motor side), rotate fixed flange, find minimum reading on dial gauge, and set gauge at zero.

2) Rotate the coupling flange with the dial gauge again 360 degrees, Read the maximum value of the dial gauge. Permissible values for Angular misalignment are shown in the table below. (See Table 2)

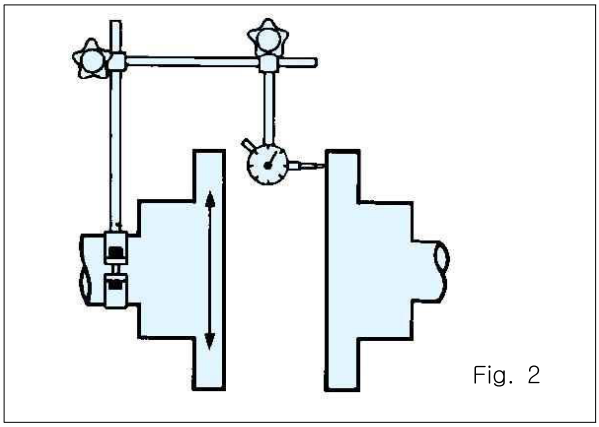


Fig. 2

Table 2

Type	Angular Misalignment	Gauge Reading (TIR mm)								
8 Bolts	0.05°	Size No.	815	820	825	830	840	850	860	870
		Value (mm)	0.26	0.30	0.34	0.38	0.42	0.47	0.50	0.60

(caution!)
If the axis distance (BE) is long, the needle may sag due to the weight of the dial gauge, so a weight must be installed on the opposite side of the dial gauge.

(3) Parallel Misalignment

1) Fix the dial gauge on one side of flange(usually the motor side), rotate fixed flange, find minimum reading on dial gauge, and set gauge at zero. Rotate the coupling flange with the dial gauge again 360 degrees, Read the maximum value of the dial gauge. Permissible values for Parallel misalignment are shown in the table below. (See Table 3)

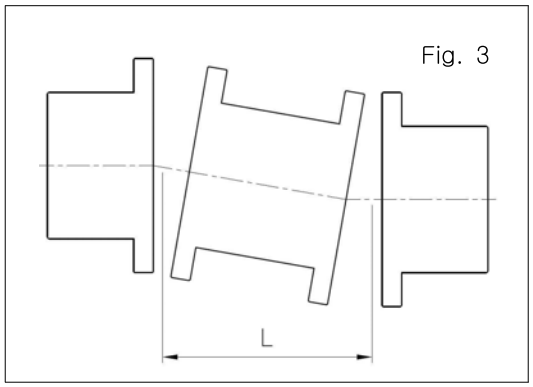


Fig. 3

Table 3

Type	Gauge Reading (TIR mm)
#830S	0.55
#840S	0.54
#850S	0.56

2) Recheck angular misalignment and verify that it is below maximum allowable angular misalignment.

3) The dial gauge circumferential measuring part may not be correct near the hole of the flange. This may cause deformation when drilling hole the flange. Measure away from this area when measuring.

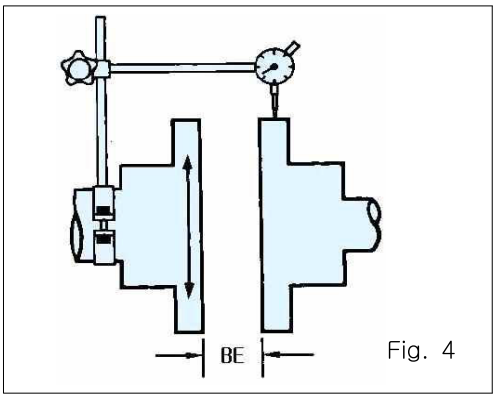


Fig. 4

(caution!)
If the axis distance (BE) is long, the needle may sag due to the weight of the dial gauge, so a weight must be installed on the opposite side of the dial gauge.

(4) Final Assembly

1) The reamer bolt between the spacer and the spacer is tightened with the tightening torque value at the time of shipment, but check it again.
(See Table 4 on page 9)

2) The assembly with confirmed reamer bolt connection cannot be directly assembled between the flanges assembled on the input and output shafts due to the assembly guide. Plug-in bolts reduce the overall length of the assembly by closing the gap between the elements. (Refer to Fig. 5, 6)

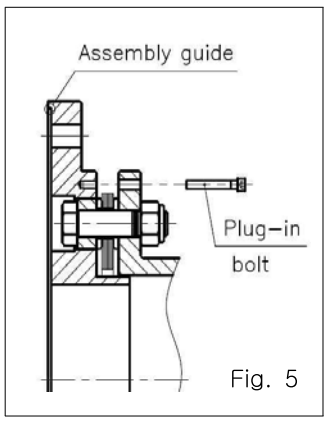


Fig. 5

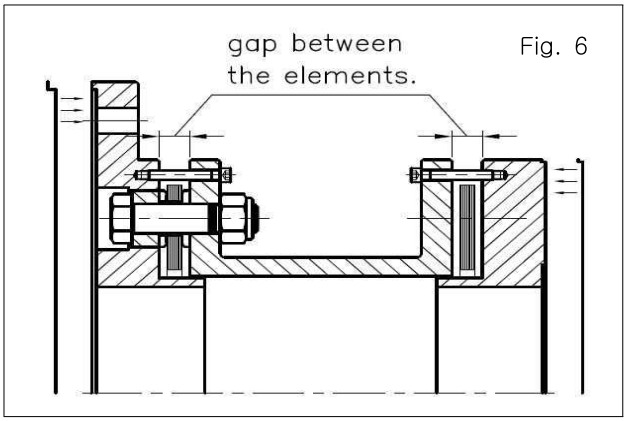


Fig. 6

3) Insert the reduced overall length spacer assembly between both flanges using plug-in bolts.

4) 2) in an item Loosen the plug-in bolt used to compress the spacer assembly, store it separately (to be used for spacer assembly later), restore it to its original length, and then fasten it with a hexagonal or wrench bolt to finish the assemble. (Refer to Fig. 7)

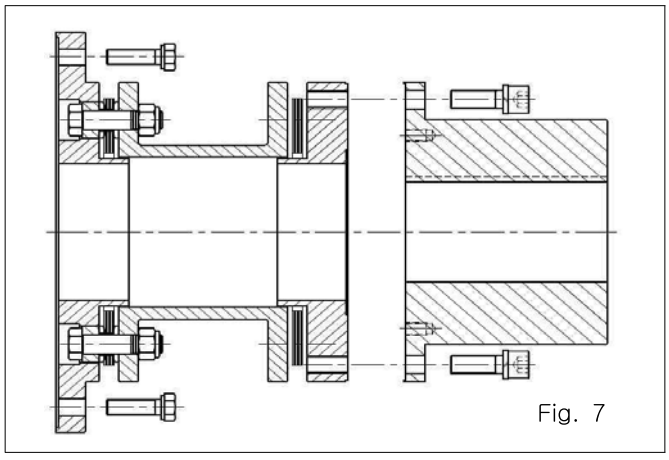


Fig. 7

(5) Bolt Fastening Torque

1) When reamer bolt assembly is required, first insert a thick washer into the large hole in the flange and insert the bolt. Nylon nuts must be tightened with the specified torque according to the table below.

2) Assemble the reamer bolt from the outside to the inside, that is with the nut in the center.

3) Do not apply excessive force when inserting the bolts.

Table 4

Size No.		815	820	825	830	840	850	860	870
8 Bolts	Bolt Size (mm)	M20	M22	M24	M30	M33	M36	M36	M42
	Fastening Torque (N・m)	320	440	570	1,100	1,500	1,700	1,700	3,000

(6) Inspection

1) In order to maintain a long life span, check the axis alignment again within 2 hours after installation and commissioning.

2) When reassembling the bolts, tighten the nuts with the given tightening torque.

3) It is appropriate to disassemble and assemble the nut within 10 times.

4) In order to use the coupling for a long time and to show its maximum capacity, it is necessary to align the axis well during assembly.

3. Trouble Shooting

If damage to the disc coupling is expected or an abnormality occurs during use, the following measures can be taken.

Phenomenon	Cause	Measures
Disc Pack Distortion	Exceeding "BE" distance and eccentricity standards	1) Re-examination of the "BE" distance -Investigation of the "BE" distance under the installation conditions -Investigating the "BE" distance during driving (Check the magnetic point of the motor) 2) Check alignment again - Check the alignment of the shaft in the side and outside direction - Check whether the offset value is appropriate by thermal expansion of the drive and driven and check whether it is reflected in the alignment standard. - Check the amount of end play of the drive and the driven - Check whether the clearance of the sleeve bearing in the radial direction is reflected in the alignment standard. 3) Tightening bolt inspection - Check the tightening torque of the reamer bolt - Check for damage of nuts, washers, bolts, etc.

Ⅳ-5. TURNING GEAR MANUAL

OPERATION AND MAINTENANCE MANUAL
FOR TURNING GEAR

NRT - 350X3

MANUAL

				2
				1
2023.05.19.	H.Y.KIM	H.S.JUNG	First issued	0
Date	Prepared by	Approved by	Description	Rev.

NARA CORPORATION

MANUAL

Turning-Gear with Motor

NARA CORPORATION

194-33, Gwahaksandan-ro, Gangseo-gu, Busan, Korea,
Tel:82-(51)-264-3100, Fax:82-(51)-264-1947

1. General

The Turning Gears with Motor("Turning gear" here in after) are designed, manufactured and tested in accordance with KS, AGMA or etc, and have high rigidity. Even an unskilled operator can handle it easily. However, as improper handling may cause unexpected troubles, read this manual carefully. Normal torque applied to an output shaft should be kept below the rated torque. Continuous use above normal torque may shorten the service life of gears and bearings, and sometimes cause damage to them.

2. Transportation and Installation.

2-1. Transportation

When lifting Turning gear for transportation, use the eye bolt attached at the top of the casing. In this case, Turning gear should be in the parallel position. The following table shows the weights of Turning gears.

Model	Weight (kgf)
NRT - 350X3	175

2-2. Installation

All the Turning gears should be installed in clean, dry place. If there is any excessive dust or moisture around the Turning gears, please consult us. Install Turning gear on a rigid foundation board and fasten fitting bolts and nuts tightly. Improper installation may cause abnormal noise or vibration and shorten the service life of Turning gears and other machinery. If the Turning gear is not installed horizontally (inclined, vertical or upside-down position) lubricating problems can occur.

3. Operation

3-1. Prior to initial start

- Check the connections whether they are still tight enough, and make sure that none of them have loosened during transportation or storage.
- Before starting the Turning gear, check whether the gear unit is properly filled with oil. (center of oil gauge)
- Grease should be applied at tooth surface of the pinion gear when operating the Turning gear.

3-2. Initial start

- Check the operation of brake and the running direction of motor.

- When the Turning gear is started up for the first time, it should, if possible, run without load at least for two hours, checking abnormal noise, abnormal vibration and any other possible problems. If no irregularities are noticed, increase the load gradually.

- As testing drive, operate it with full load for 30 minutes. meanwhile, any abnormal noise and abnormal vibration should not be noticed. Check exceeding heat of bearing(below 90℃).

- Turning gear out of operation for a long time should, if possible, be operated without load for a hour every 3 weeks. If it is impossible, the turning gear must be protected against corrosion.

- If you want to make the Turning gear run in the opposite direction, at first you should stop operating so that the turning gear is not overloaded.

4. Lubrication

4-1. Lubrication system

The general lubrication method of Turning gears is oil bath system, i.e. all components in the gear units are lubricated by splashed oil during operation.

4-2. Oil filling

- Before starting up, all gear units except grease-lubricated types must be filled with oil to the correct level.

- The gear oil should be poured into the gear unit through the oil filler plug hole. Only fresh, clean, unspoilt oil must be used.
- The selection of oil depends on oil viscosity according to the nomal operating condition with ambient temperatures between -10℃ and +50℃.(refer to Table - I .) If ambient temperatures below -10℃ and above +50℃ or extreme fluctuations of temperatures or external heat sources, please consult us.

- It is permissible to use the equivalent oils of others manufacturers provided in Table - I .

- Lubricant selection table (Table - I .)

Viscosity ISO-VG (㎟/s)	Ambient temperature (℃)	M A K E R				
		B. P	MOBIL	SHELL	CALTEX	CASTROL
VG 320	-10℃ ~ +50℃	BP Energol GR-XP 320	Mobilgear 600 XP 320	Shell Omala S2 G320	GEAR EP 320	ALPHA SP 320
VG 220	-10℃ ~ +50℃	BP Energol GR-XP 220	Mobilgear 600 XP 220	Shell Omala S2 G220	GEAR EP 220	ALPHA SP 220

- Model and Quantity of oil

MODEL	NRMT-350X3
OIL Q'TY	4.5 L

4-3. Oil change

- It is commonly recommended to change the lubricating oil after 50 operating hours for the first time. Subsequent oil changes must be made once a year, depending on working conditions or ambient temperatures. The intervals of changing oil must be shortened if the Turning gear operates continuously above 50℃ of ambient temperature.

- **By oil changing, the gear unit should be refilled with the same grade of oil used previously.**

- The gear unit is initially filled with CALTEX「GEAR EP 320」from the company.

5. Inspection and maintenance

It is recommended that a general inspection routine be established to check periodically the following items.

1) Cleanliness
2) Lubrication
3) Noise and vibration

5-1. Cleanliness

- The exterior of the Turning gear should be kept free from such foreign materials as dirt, oil and grease, or etc. They may build up on the exterior of the Turning gear and impair oil seal, leading to oil leakage.

- The dusty air breather(or air vent) may cause pressure rise inside of gear unit while running. It must be always cleaned and checked whether the filter of it is free of dust and pollutions.

5-2. Lubrication

- Oil filling and change must be carried out in accordance with section 4-3. If it is not kept, the life of Turning gear as well as the life of bearing may be shorten.

- Make sure that the oil level is at the correct height.

5-3. Noise and vibration

- Any excessive noise or vibration should be traced to its source and eliminated. Increase in vibration may be indication of change in balance and more commonly a change in alignment. In this case, the run out of shafts and bearing alignment must be checked.

- Noise should be localized during operation of the Turing gear, then shutdown and check if all mechanical clearances are maintained. Note whether noise is reduced when power is removed. If possible, rotate the motor shaft extension by hand to see that it turns smoothly.

- Check whether the surface of teeth is failed after unbolting the inspection covers. In case of doubt, please consult us.

6. Disassembly and reassembly

6-1. Disassembly

- Disassemble Turning gear after full comprehension of it's construction in accordance with the attached assembly section drawing.

- Make clear the purpose of disassembly in order to minimize parts to be disassembled.

- If there is no match mark on a part to be disassembled, disassemble Turning gear after marking.

- Never strike parts strongly nor pull them by force.

- If problems occur during disassembly, do not continue disassembly forcibly. Repeat disassembly after careful inspection or consulting us.

6-2. Reassembly

- Carry out reassembling normally in the reverse order of disassembling.

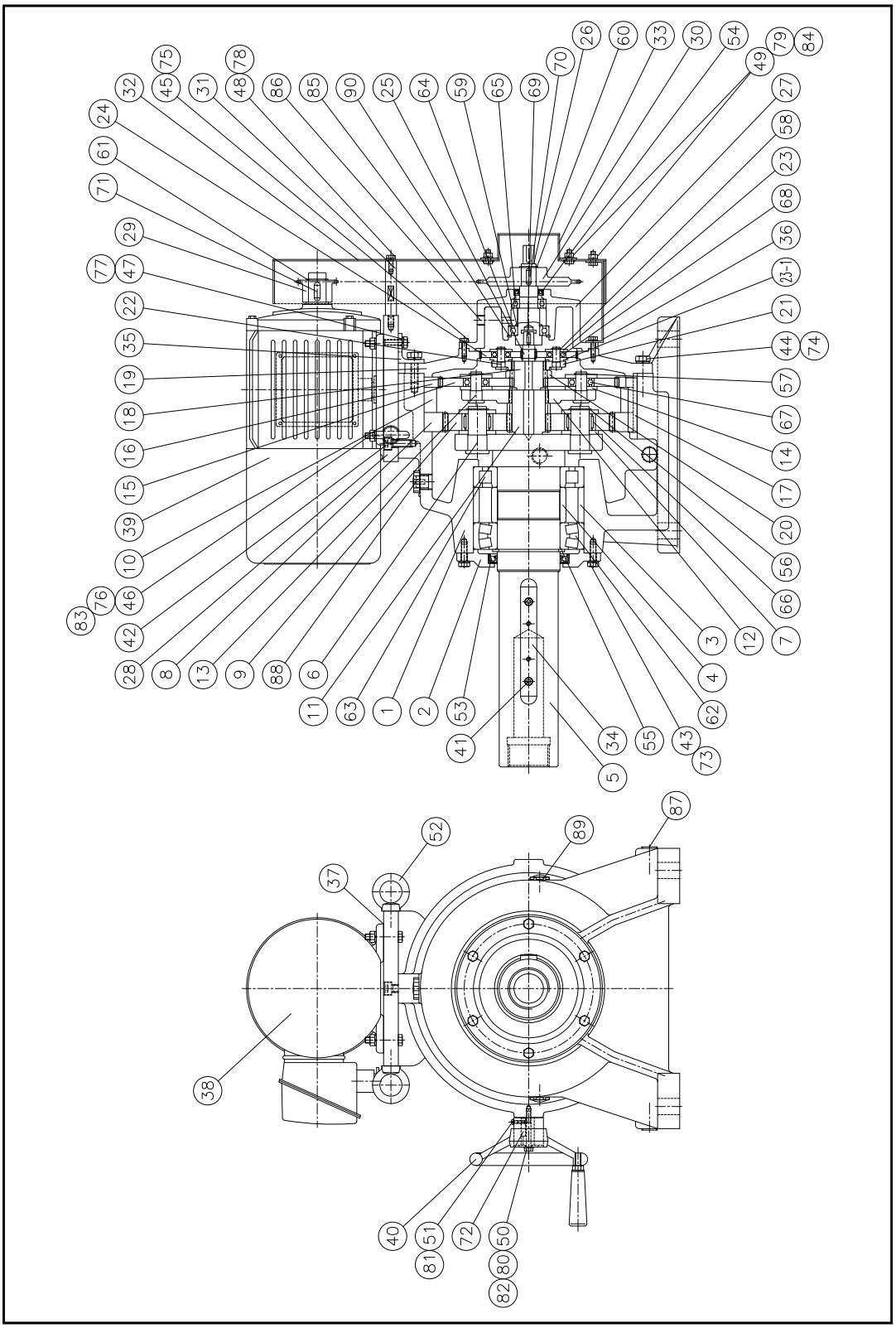
- Reassemble parts after washing them carefully with cleaning oil and applying machine oil or lubrication oil.

- When fitting a new bearing to the shaft, warm it in oil bath maintained of 100℃~120℃ and then set.

- Special care is required when fitting oil seals in order to avoid damage to the sealing lips. Damaged oil seals are the cause of leakage. When inserting an oil seal, apply grease to the shaft for smooth installation of seal. If possible, it is recommended to replace the oil seals with new ones.

- After reassembly, make certain whether the motor shaft can be rotated by hand smoothly and lightly.

Assembly Drawing (NRT - 350X3)



Parts list (NRT - 350X3)

Part No.	NAME OF PARTS	Part No.	NAME OF PARTS	Part No.	NAME OF PARTS
1	CASE	31	SPACER	62	ROLLER BEARING
2	BEARING COVER	32	CHAIN COVER	63	ROLLER BEARING
3	SPACER	33	HANDLE COVER	64	BALL BEARING
4	SPACER	34	KEY	65	BALL BEARING
5	OUTPUT SHAFT	35	MOTOR SUPPORT	66	3RD NEEDLE BEARING
6	3RD PIN	36	COVER SUPPORT	67	2ND NEEDLE BEARING
7	3RD COLLAR	37	LINING	68	1ST NEEDLE BEARING
8	3RD INTERNAL GEAR	38	MOTOR	69	KEY
9	3RD IDLE GEAR	39	DISC BRAKE	70	KEY
10	SPACER	40	HANDLE	71	KEY
11	3RD SUN GEAR	41	WRENCH BOLT	72	KEY
12	2ND CARRIER	42	WRENCH BOLT	73	SPRING WASHER
13	2ND PIN	43	HEX′ BOLT	74	SPRING WASHER
14	2ND COLLAR	44	HEX′ BOLT	75	SPRING WASHER
15	2ND IDLE GEAR	45	HEX′ BOLT	76	SPRING WASHER
16	2ND INTERNAL GEAR	46	HEX′ BOLT	77	SPRING WASHER
17	KEY	47	HEX′ BOLT	78	SPRING WASHER
18	2ND SUN GEAR	48	HEX′ BOLT	79	SPRING WASHER
19	1ST INTERNAL GEAR	49	HEX′ BOLT	80	SPRING WASHER
20	SPACER	50	HEX′ BOLT	81	SPRING WASHER
21	1ST CARRIER	51	SCREW	82	PLAIN WASHER
22	1ST PIN	52	EYE BOLT	83	NUT
23	1ST COLLAR	53	OIL SEAL	84	NUT
23-1	1ST COLLAR	54	OIL SEAL	85	CHAIN
24	1ST IDLE GEAR	55	SNAP RING	86	FILLER PLUG
25	1ST SUN GEAR	56	SNAP RING	87	DRAIN PLUG
26	INPUT SHAFT	57	SNAP RING	88	AIR VENT
27	FRONT COVER	58	SNAP RING	89	OIL GAUGE
28	MOTOR BED	59	SNAP RING	90	SNAP RING
29	SPROCKET	60	SNAP RING		
30	SPROCKET	61	SNAP RING		

⚠ CAUTION.

1. Check and tension adjustment for Roller Chain. (Inspect per 6 months.)

1-1. Check of Roller Chain.

1-1-1. If the noise occurred to the roller chain, Inspect the roller chain after removing the chain cover.

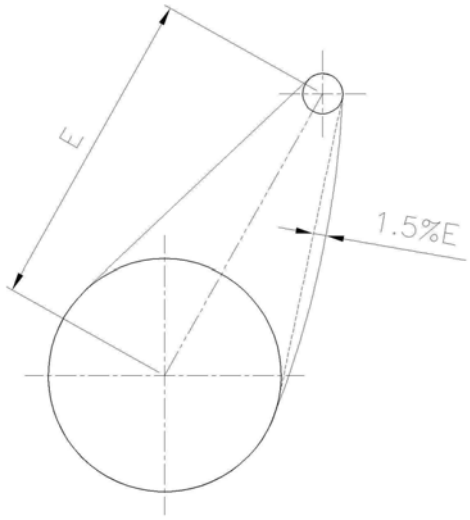
If a heavy noise is still not disappeared, rearrange the sprockets of motor and reducer.

1-1-2. Inspect a failure of each link of chain.

1-2. Adjustment of Roller chain.

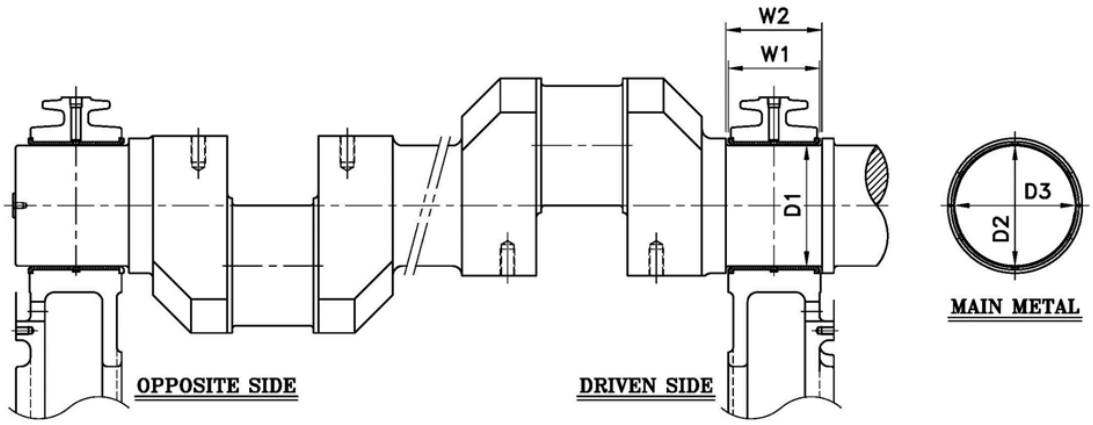
1-2-1. Roller chain has to be tensile-loaded until chain's roller contacts to the root of teeth.

1-2-2. The amount of slack should not be exceeded 1.5% of the center to center distance of sprockets.



Model	1.5%E
NRMT - 350X3	5 mm

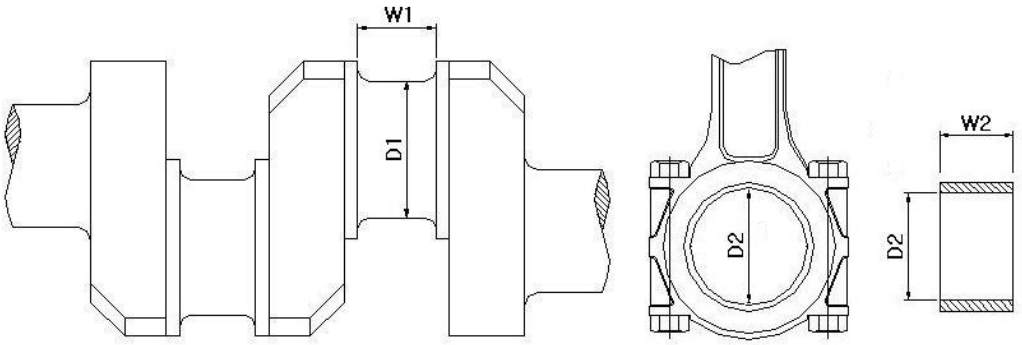
Main Bearing (Driven & Opposite Side)



Unit : mm

Name	기준치 (Design)		허용한계 (Use Limit)	비 고 (Remark)
	치 수 (Dimension)	틈 새 (Clearance)		
Main Metal의 폭(W1) (Wide of Main Metal)	249.4	0.50~0.65	0.85	
Crank Journal의 폭(W2) (Wide of Crank Journal)	250			
Main Metal의 내경(D2) (I.D of Main Meta)	280	0.26~0.35	0.55	
주축의 외경 (D1) (O.D of Journal)	280			
Journal의 진원도 (Ovalness of Journal)	< 0.02		0.08	

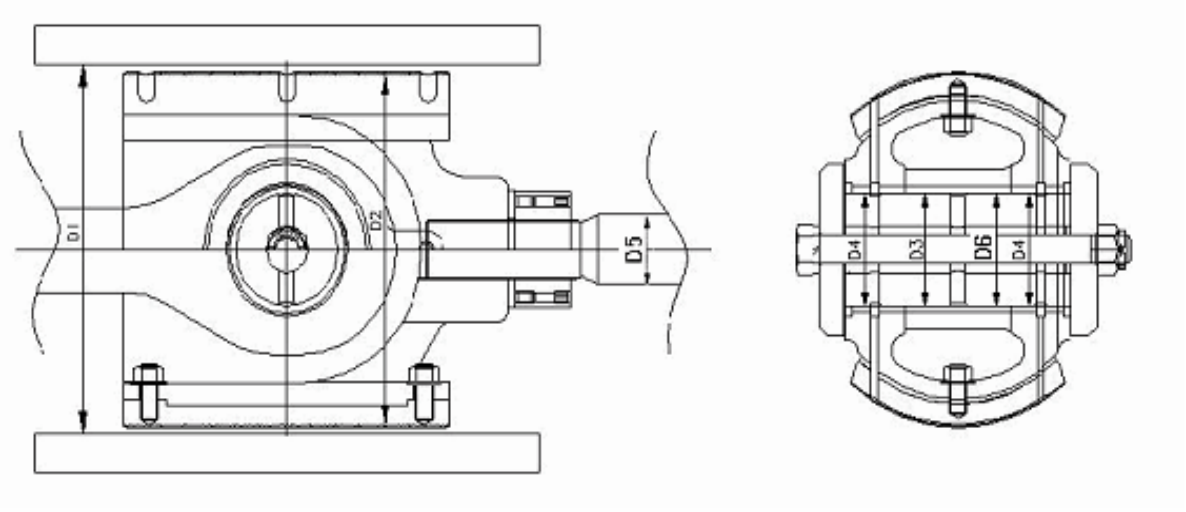
Crank Pin Bearing (Metal)



Unit : mm

Name	기준치 (Design)		허용한계 (Use Limit)	비 고 (Remark)
	치 수 (Dimension)	틈 새 (Clearance)		
Crank Pin의 폭(W1) (Wide of Crank Pin)	200	0.4~0.6	0.8	
Crank Pin Metal의 폭(W2) (Wide of Crank Pin Metal)	200			
Metal의 내경(D2) (I.D of Metal)	280	0.26~0.35	0.55	
Crank Pin 외경 (D1) (O.D of Crank Pin)	280			
Crank Pin의 진원도 Ovalness of Crank Pin)	< 0.02		0.08	

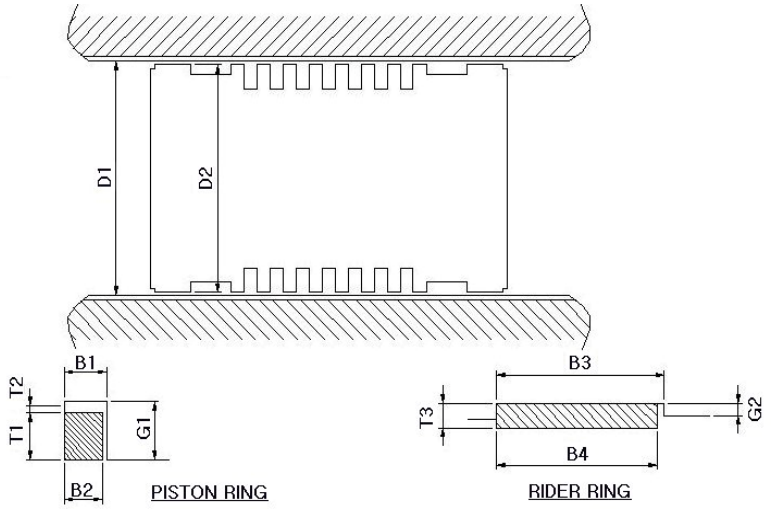
Cross Head



Unit : mm

Name	기준치 (Design)		허용한계 (Use Limit)	비 고 (Remark)
	치 수 (Dimension)	틈 새 (Clearance)		
Cross Head Guide의 내경(D1) (I.D of cross head guide)	400	0.36~0.46	0.66	
Cross Head의 외경 (D1) (O.D of Cross Head)	400			
Cross Head Pin의 외경(D3) (O.D of Cross Head Pin)	140	0.08~0.12	0.32	
Cross Head Main Metal의 내경(D4) (I.D of Cross Head Main Metal)	140			
Cross Head Pin Metal의 내경(D6) (I.D of Cross Head Pin Metal)	120	0.12~0.16	0.36	
Piston Rod의 외경(D5) (O.D of Piston Rod)	90	-0.03	89.9	

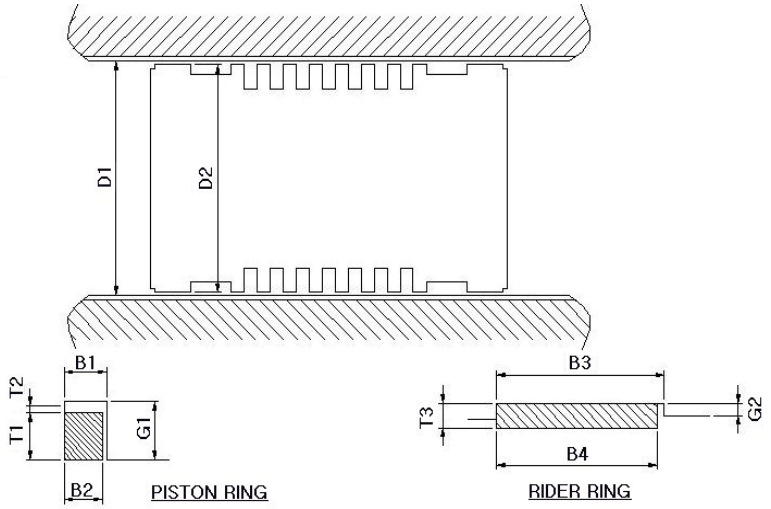
1ST Cylinder and Piston



Unit : mm

Name	기준치 (Design)		허용한계 (Use Limit)	비 고 (Remark)
	치 수 (Dimension)	틈 새 (Clearance)		
실린더(라이너)의 내경(D1) (I.D of Cylinder(Liner))	475	5.43~5.67	475.3	
Piston의 외경(D2) (O.C of Piston)	469.5			
Piston Ring홈의 폭(B1) (Width of Piston Ring Groove)	14	0.27~0.45	0.95	
Piston Ring의 폭(B2) (Width of Piston Ring)	13.65~13.73			
Piston Ring 홈의 깊이(G1) (Depth of Piston Ring Groove)	21.5			
Piston Ring의 두께(T1) (Thickness of Piston Ring)	21		14	
Rider Ring 홈의 폭(B3) (Width of Rider Ring)	50	0.72~0.97	1.97	
Rider Ring의 폭(B4) (Width of Rider Ring)	49.03~49.28			
Rider Ring 홈의 깊이 (G2) (Depth of Rider Ring Groove)	10.7		11.15	
Rider Ring의 두께(T3) (Thickness of Rider Ring)	12.5			

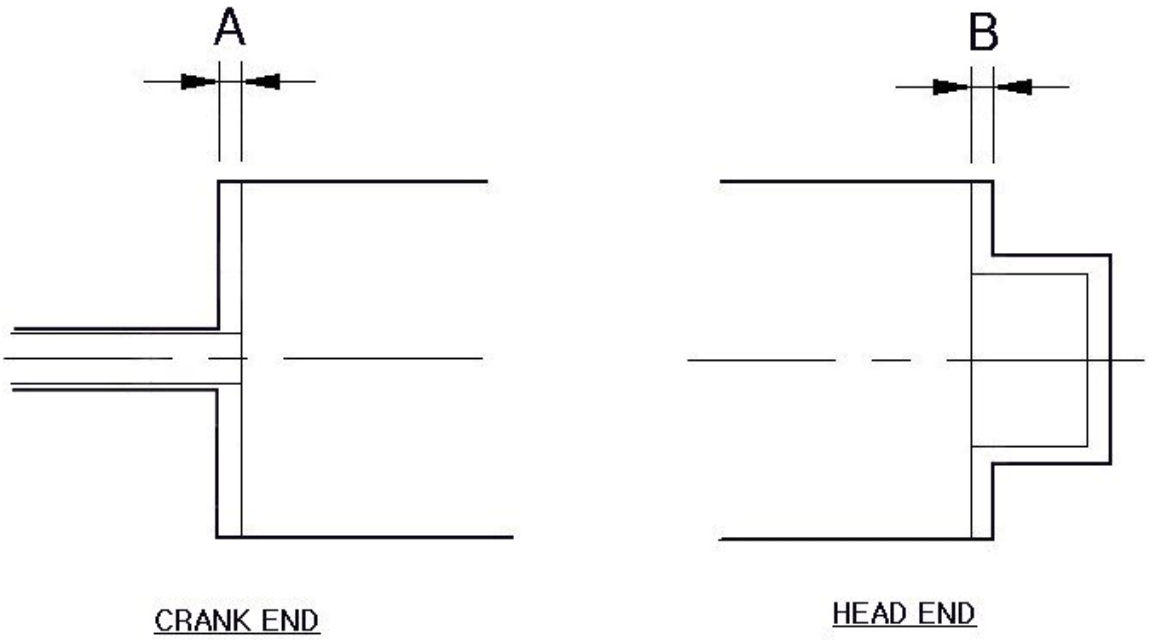
2ND Cylinder and Piston



Unit : mm

Name	기준치 (Design)		허용한계 (Use Limit)	비 고 (Remark)
	치 수 (Dimension)	틈 새 (Clearance)		
실린더(라이너)의 내경(D1) (I.D of Cylinder(Liner))	280	4.74~4.96	280.3	
Piston의 외경(D2) (O.C of Piston)	275.2			
Piston Ring홈의 폭(B1) (Width of Piston Ring Groove)	12	0.25~0.43	0.93	
Piston Ring의 폭(B2) (Width of Piston Ring)	11.57~11.75			
Piston Ring 홈의 깊이(G1) (Depth of Piston Ring Groove)	18.5			
Piston Ring의 두께(T1) (Thickness of Piston Ring)	18		12	
Rider Ring 홈의 폭(B3) (Width of Rider Ring)	48	0.89~1.14	2.14	
Rider Ring의 폭(B4) (Width of Rider Ring)	46.86~47.11			
Rider Ring 홈의 깊이 (G2) (Depth of Rider Ring Groove)	9		9.5	
Rider Ring의 두께(T3) (Thickness of Rider Ring)	11			

Piston End Clearance



Unit : mm

Name	틈 새 (Clearance)		비 고 (Remark)
	상 부 (Head End)	하 부 (Crank End)	
실린더 (Cylinder)	4.5~	3.0±0.5	

일반 BOLT 체결 TORQUE (kg.m)

NO.	Material / Normal Size	Forged Steel & Alloy Steel Hex Bolt, Stud Bolt & Nut (H/Tension, A193 B7)	General Hex Bolt & Nut (A29 Gr.1045, A283 Gr.C, Stainless Steel)	Cast Steel & Cast Iron Stud Bolt & Nut (A193 B7)	Valve Cover Stud Bolt & Nut (A193 B7)
1	M6	0.8	0.5	0.7	-
2	M8	2.0	1.2	1.6	-
3	M10	3.9	2.5	3.2	2.5
4	M12	6.8	4.2	5.5	3.2
5	M14	11	6.7	9.0	6.2
6	M16	16	10	13	7.2
7	M18	22	14	18	12
8	M20	32	20	26	14
9	M22	42	26	34	21
10	M24	54	34	44	30
11	M27	79	50	65	44
12	M30	108	67	88	62
13	M33	145	91	118	-
14	M36	188	117	153	-
15	M39	242	151	197	-
16	M42	300	188	244	-
17	M45	375	234	305	-
18	M48	453	283	368	-

*. Using Thread Lubricants in Bolted Connections.

Big End BOLT 체결 TORQUE (kg.m)

(CONNECTING ROD BOLT)

Connecting Rod Bolt Size	Length (mm)	Elongation		Tightening Torque
		Min. (mm)	Max. (mm)	
M18 x P1.5	128	8.96	10.24	15
M18 x P1.5	152	10.64	12.16	15
M22 x P1.5	164	11.48	13.12	20
M22 x P1.5	174	12.18	13.92	20
M28 x P2.0	216	15.12	17.28	44
M28 x P2.0	236	16.52	18.88	44
M28 x P2.0	256	17.92	20.48	44
M34 x P2.0	248	17.36	19.84	70
M34 x P2.0	258	18.06	20.64	70
M34 x P2.0	268	18.76	21.44	70
M34 x P2.0	284	19.88	22.72	70
M38 x P3.0	322	22.54	25.76	105
M39 x P2.0	287	20.09	22.96	110
M39 x P2.0	297	20.79	23.76	110
M45 x P3.0	320	22.4	25.6	140
M48 x P3.0	349	24.43	27.92	170
M48 x P3.0	369	25.83	29.52	170

*. Using Thread Lubricants in Bolted Connections.