TYPE 28 ST

GAS SEAL

Installation, Operation & Maintenance Instructions

Foreword

This manual relates to matters affecting the operation of the Type 28 ST dry gas seal within a steam turbine. It covers areas directly associated with the installation, removal, operation and maintenance of the gas seal. For other related subjects, such as the correct operation of associated systems or guidance when conducting hazard analysis (as may be required under the European ATEX Directives), consult with the turbine equipment supplier and their documentation.

The gas seals are robust in operation. However, any incorrect handling or assembly fitting can easily lead to seal damage. Therefore, John Crane gas seals may only be installed, commissioned and maintained by a fully trained and authorised plant machinery specialist. This person must pay close attention to these instructions, the John Crane gas seal installation drawing, turbine equipment supplier's manuals and documentation and all relevant regulations. Failure to do this relieves the manufacturer John Crane from any liability or warranties. It is strongly recommended that the seals are fitted by John Crane trained and approved technicians.

Safety instructions

The safety notes refer to the gas seal arrangement supplied. They can never be exclusive and must be used in conjunction with the relevant safety regulations for the machine, auxiliary equipment, plant and sealed fluid.

WARNING SYMBOLS

The following symbols are used in this instruction manual to highlight information of particular importance:

⚠ Danger – Mandatory instructions designed to prevent injury or extensive damage

ATTENTION Special instructions and/or information to avoid damage to the seal and/or its surroundings

NOTE Information for easy installation and efficient operation

⚠ Prior to any installation, removal, operation and maintenance of the gas seals, all personnel involved in these activities must have read and understood this document before the commencement of any work. If there is not adequate understanding, contact John Crane for further advice.

All personnel involved in the installation, operation and maintenance of the gas seals must have adequate training and understanding with regards to:

- The gas seals being used
- The equipment being worked on, including any relevant auxiliary equipment and systems
- All tooling and equipment associated with fitting and removing gas seals
- The environment in which work is being carried out
- Health, safety and environmental issues associated with the above points including all relevant local site, national and international health, safety and environmental procedures and regulations.

Any working practice that compromises safety must be avoided.

All personnel involved in the installation, removal, operation and maintenance of the gas seals must be authorised by the responsible party to work on the equipment that the gas seals are fitted to.

At all times, adequate personal protection equipment should be worn/used. This equipment needs to be suitable for the environment and surroundings that a person is working within.

At all stages in work relating to the gas seal, reference must be made to the John Crane installation drawing, this document and the turbine equipment supplier's manuals and documentation and all relevant regulations.

Gas seal cartridge disassembly is not required for normal operation and maintenance and must never be undertaken other than by a John Crane trained technician approved for the seal type being worked on. Where gas seals require inspection and refurbishment, please contact John Crane.

Modifications and/or alterations of the gas seal in any way are not permitted without the authority of John Crane. Failure to obtain this authority relieves the manufacturer John Crane from any liabilities or warranties.

In the event of an operating problem, the machinery must be immediately switched off and made safe. Problems must be solved promptly.

A small controlled gas flow (commonly called the gas seal leakage) will occur within the gas seal during normal seal operation. In cases of a worn or defectives, the leakage volumes will increase.

Attention must be given to the leakage as the fluid (steam) will be at a high temperature and can be hazardous. This needs to occur under all circumstances including when the gas seals ARE and ARE NOT working normally. It is the responsibility of the turbine/ machine manufacturers and equipment operators to ensure that the systems and procedures are in place to accommodate this and that these systems provide adequate health and safety to all people, as well as protection for the environment.

TYPE 28 ST

GAS SEAL

Installation, Operation & Maintenance Instructions

In the rare case of catastrophic gas seal failure, a bulk escape of steam within the turbine casing can occur past the gas seal. It is the responsibility of the turbine/machine manufacturers and equipment operators to ensure that systems and procedures are in place to deal with this occurrence and that these systems provide adequate health and safety to all people, as well as protection for the environment.

Hot surfaces have to be protected against accidental contact.

Dry gas seals can become exposed to extreme conditions, particularly during process upset and seal failure. Suitable personal protection equipment must be worn during handling removal and disassembly of previously used seals. This includes gloves, coveralls and footwear, as well as protective headgear appropriate to the location.

Follow the local relevant guidelines for the safe and environmentally friendly disposal of assembly lubricants, supplied fluids and scrapped components. Compounds containing PTFE, fluorocarbons and perfluoro elastomers should never be burned as the fumes and residues are highly toxic.

When returning seals to John Crane, customers MUST confirm in writing that the specific seals being returned are safe to handle and provide any additional safety-critical information on request. This is further discussed in Appendix II of this document.

Unit preparation for inside mounted seals

A. Split the steam turbine casing and remove the rotor.

B. Thoroughly clean the area where the seal will be located. The shaft should be free from scratches and burrs. Ensure there are appropriate chamfers on the shaft and an anti-rotation pin hole in the case.

C. Ensure that the seal envelope dimensions on the steam turbine are in accordance with the appropriate John Crane drawing for the unit in question. Shaft diameter should fall within the given specified dimensions and tolerances.

D. The seal bore should be inspected for surface pitting. Surface pitting is acceptable but should not exceed a depth of 0.5 mm (0.020 inches). The edges of the pits should be blended or feathered into the seal diameter bore.

E. Shaft hardness in the area of the set screw drive collar should not exceed 30 Rc. If there is a chrome or other hard coating on this area, it should be ground off.

F. Place shaft with dial indicator attached into the bottom half of the bearings.

G. Measure the runout of the housing per Figure 2-1.

H. Measure the runout of the abutment face of the housing per Figure 2-2.

I. Spot facing the shaft under two of the set screws is recommended. **NOTE: SET SCREWS SHOULD NEVER BE RE-USED PER FIGURE 2-3-1.**

FIGURE 2-1

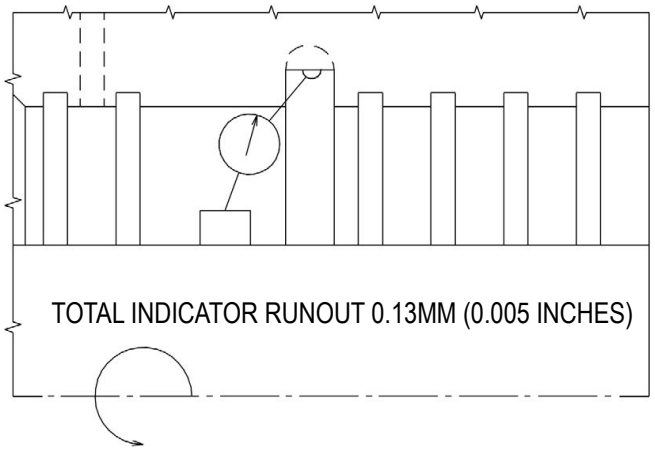
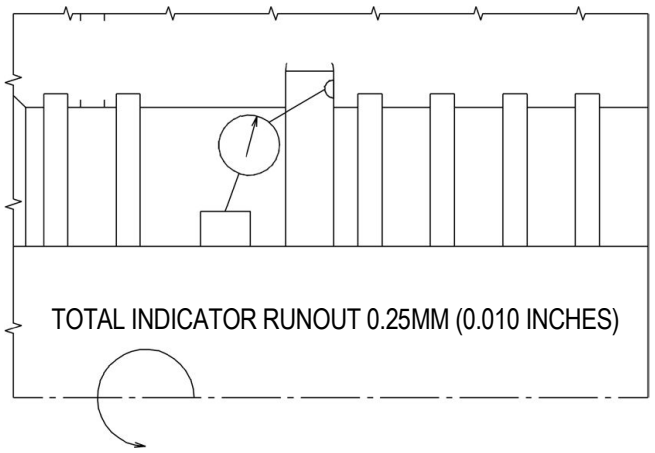


FIGURE 2-2

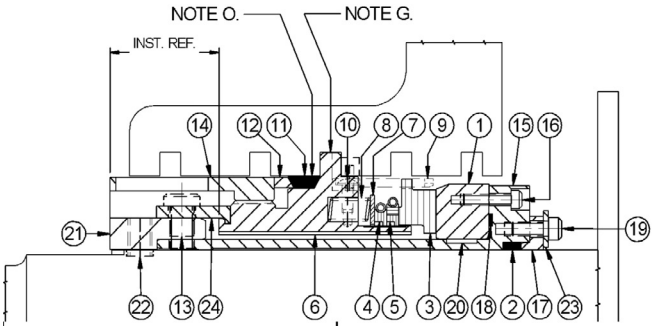


TYPE 28 ST

GAS SEAL

Installation, Operation & Maintenance Instructions

FIGURE 2-3-1



Part name		Part name	
1	Mating ring	**13**	12 point cap screw
2	Packing ring	**14**	Locknut
3	Primary ring	**15**	Shaft sleeve
4	Split ring assembly	**16**	Socket head cap screw
5	Split ring assembly	**17**	Clamping ring
6	Retainer	**18**	Packing ring
7	Disc	**19**	Socket head cap screw
8	Spring	**20**	Tolerance ring
9	T-bar	**21**	Collar
10	Button head cap screw	**22**	Cup point set screw
11	Packing ring	**23**	Washer
12	Compression ring	**24**	Holding clip

Installation of inside mounted seals

AXIAL SEALS (LOCKNUT DESIGN)

A. Ensure that the direction of the shaft rotation is correct for the seal being installed. This can be accomplished by checking the directional arrow on the seal, and the bucket orientation on the wheel.

B. Break all shaft edges to avoid damage to seal inner diameter.

C. Remove clamping ring (Item #17) and packing ring (Item #2) and slide them onto the shaft independently of the seal. **EXTREME CARE SHOULD BE TAKEN AS NOT TO DAMAGE THE PACKING RING ON SHAFT CORNERS.**

D. Slide seals onto their respective ends of the turbine rotor. **NOTE: PRIOR TO INSTALLING OTHER COMPONENTS OF THE STEAM TURBINE, ENSURE THAT ALL PARTS FOR THE SEAL ARE ON THE SHAFT.**

E. Install other components (such as flingers, collars and thrust bearings) onto shaft per manufacturer's recommendation.

F. Slide packing ring (Item #2) and then clamping ring (Item #17) toward seal, pushing the shaft packing ring into it's groove. Finger tighten screws (Item #19), securing clamping ring and packing ring in place. **NOTE: THE SEAL SHOULD STILL BE ABLE TO SLIDE ALONG THE SHAFT.**

G. A small bead of high temperature sealant should be applied to the smaller diameter bores (lands) in the lower casing. This sealant will help facilitate a positive seal between the Type 28ST seal and the casing. John Crane recommends the use of Copaltite, as needed, manufactured by ESCO Products, Birkosit or equivalent.

H. Lower rotor into case and allow it to rest on the bearings. Seals should be aligned and positioned axially to fit in the appropriate grooves. Push seals in enough to avoid the packing ring (Item #11) from being crushed by top half of the casing. After top half of casing is installed, installation of the locknut (Item #14) will draw the seal back and seal with the packing ring (Item #11).

I. Evenly tighten set screws (Item #22) in rotor collar (Item #21). Refer to Figure 2-3-1.

J. The seal is designed so that the shaft can be rotated to reach all the set screws.

K. Remove any holders/spacers (item #24) and screws (Item #13).

TYPE 28 ST

GAS SEAL

Installation, Operation & Maintenance Instructions

L. Torque all set screws according to the Torque Chart, if possible.

If a torque wrench is not available, a standard hex key wrench can be used as follows. Insert the short arm in the set screw and apply a force near the end of the long arm. When the wrench deflects 25-30 degrees, the appropriate torque has been achieved.

M. Tighten screws (Item #19) securing clamping ring & washer (Items #17 & 23) to compress packing ring (Item #2). Refer to Figure 2-3-1.

N. Remove locknut (Item #14) and lightly coat with anti-seize compound. Reinstall locknut, but **DO NOT TIGHTEN LOCKNUT AT THIS TIME**.

O. Carefully apply sealant to the outside diameter of the packing ring (Item #11).

P. When the sealant is applied to the split casing joint, it must come into full contact with the retainer and the casing joint. **NOTE: ANY GAP BETWEEN SEALANT, CASING AND SEAL WILL RESULT IN A LEAK PATH**. Refer to Figure 2-4. The sealant should be kept away from the seal, except in the area of the retainer.

Q. Lower top cover into place using guide pins.

R. Torque case to manufacturer's specifications.

S. Insert wrench into casing and tighten locknut (Item #14). Tighten locknut according to installation reference on layout drawings. Refer to Figure 2-3-1.

FIGURE 2-4

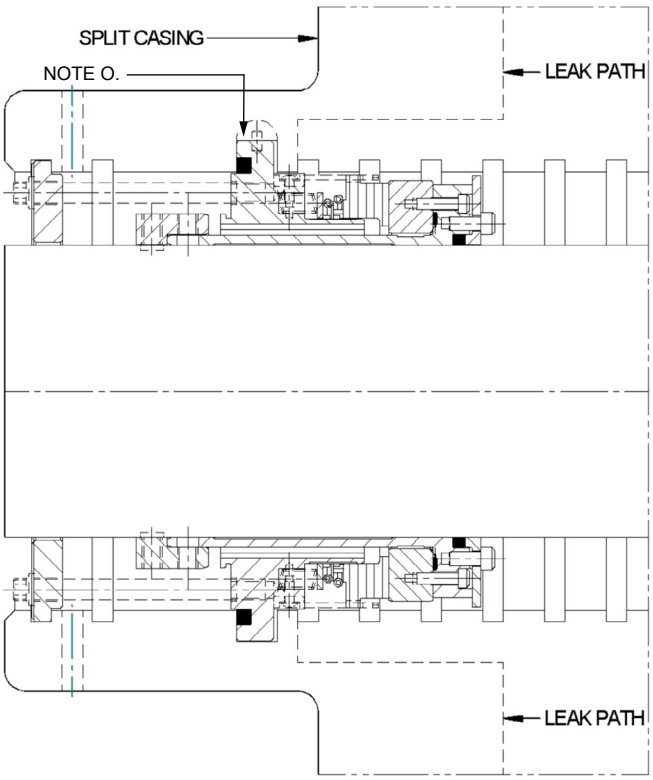
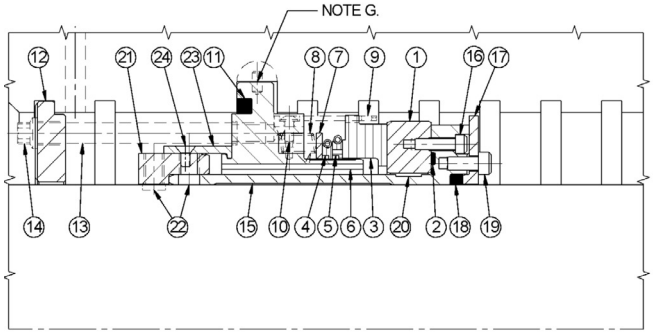


FIGURE 2-3



	Part name		Part name
1	Mating ring	13	12 point cap screw
2	Packing ring	14	Pusher pin
3	Primary ring	15	Shaft sleeve
4	Split ring assembly	16	Socket head cap screw
5	Split ring assembly	17	Clamping ring
6	Retainer	18	Packing ring
7	Disc	19	Socket head cap screw
8	Spring	20	Tolerance ring
9	T-bar	21	Collar
10	Button head cap screw	22	Cup point set screw
11	Packing ring	23	Holding clip
12	Back plate	24	Flat head cap screw

Installation of inside mounted seals

AXIAL SEALS (FLANGED DESIGN)

A. Ensure that the direction of the shaft rotation is correct for the seal being installed. This can be accomplished by checking the directional arrow on the seal, and the bucket orientation on the wheel.

B. Break all shaft edges to avoid damage to seal inner diameter.

C. Remove clamping ring (Item #17) and packing ring (Item #18) and slide them onto the shaft independently of the seal. Refer to Figure 2-3. **EXTREME CARE SHOULD BE TAKEN AS NOT TO DAMAGE THE PACKING RING ON SHAFT CORNERS.**

D. Slide seals onto their respective ends of the turbine rotor. **NOTE: PRIOR TO INSTALLING OTHER COMPONENTS OF THE STEAM TURBINE, ENSURE THAT ALL PARTS FOR THE SEAL ARE ON THE SHAFT.**

E. Install other components (such as flingers and thrust bearings) onto shaft per manufacturer's recommendation.

TYPE 28 ST

GAS SEAL

Installation, Operation & Maintenance Instructions

F. Slide clamp ring (Item #17) toward seal, pushing the shaft packing ring into (item #18) its groove. Finger tighten screws (Item # 19), securing clamp ring (Item #17) and packing ring (Item # 18) in place. **NOTE: THE SEAL SHOULD STILL BE ABLE TO SLIDE ALONG THE SHAFT.**

G. A small bead of high temperature sealant should be applied to the smaller diameter bores (lands) in the lower casing. This sealant will help facilitate a positive seal between the Type 28ST seal and the casing. John Crane recommends the use of Copaltite, as needed, manufactured by National Engineered Products, Birkosit or equivalent.

H. Lower rotor into case and allow it to rest on the bearings. Seals should be aligned and positioned axially to fit in the appropriate grooves.

I. Evenly tighten set screws (Item #22) in rotor collar (Item #21). Refer to Figure 2-3.

J. The seal is designed so that the shaft can be rotated to reach all the set screws.

K. Remove any holders (item #23) and screws (item #24) and replace cap screws with the set screws provided.

L. Torque all set screws according to the Torque Chart, if possible.

If a torque wrench is not available, a standard hex key wrench can be used as follows. Insert the short arm in the socket and apply a force near the end of the long arm. When the wrench deflects 25-30 degrees, the appropriate torque has been achieved.

M. Tighten screws (Item # 19) securing clamp ring (Item #17) to compress packing ring (Item #18). Refer to Figure 2-3.

N. Install back plate (item #12), 12 point cap screw (item #13) and pusher pin (item #14). **DO NOT TIGHTEN SCREWS AT THIS TIME.**

O. When the sealant is applied to the split casing joint, it must come into full contact with the retainer and the casing joint. **NOTE: ANY GAP BETWEEN SEALANT, CASING AND SEAL WILL RESULT IN A LEAK PATH**. Refer to Figure 2-4. The sealant should be kept away from the seal, except in the area of the retainer.

P. Lower top cover into place using guide pins.

Q. Torque case to manufacturer's specifications.

R. Tighten screws (item #14) onto retainer (item #6). Refer to Figure 2-3.

FIGURE 2-5

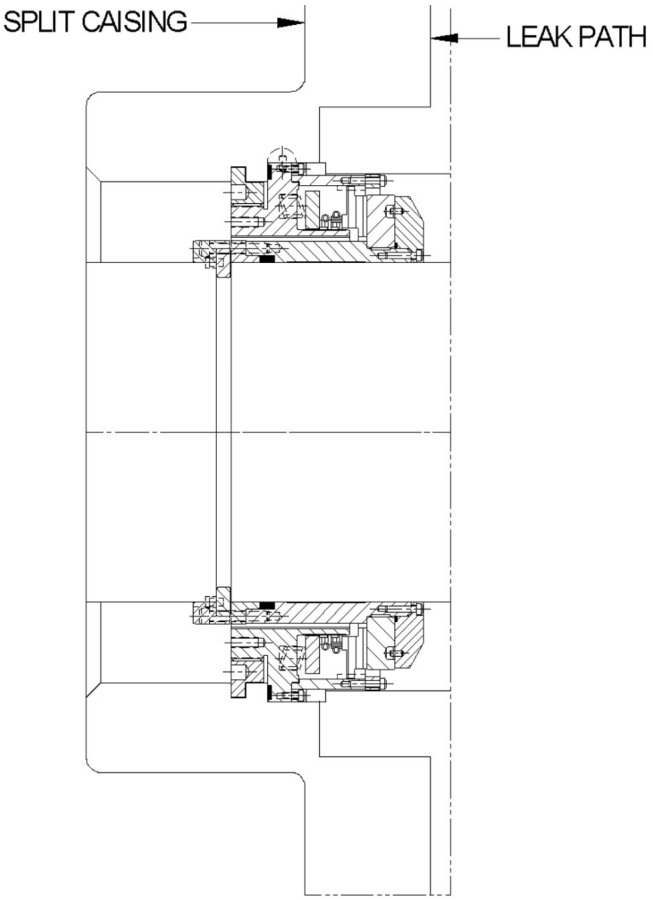
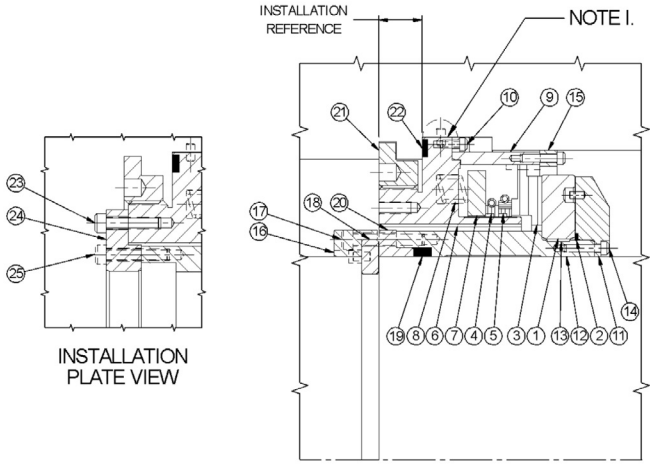


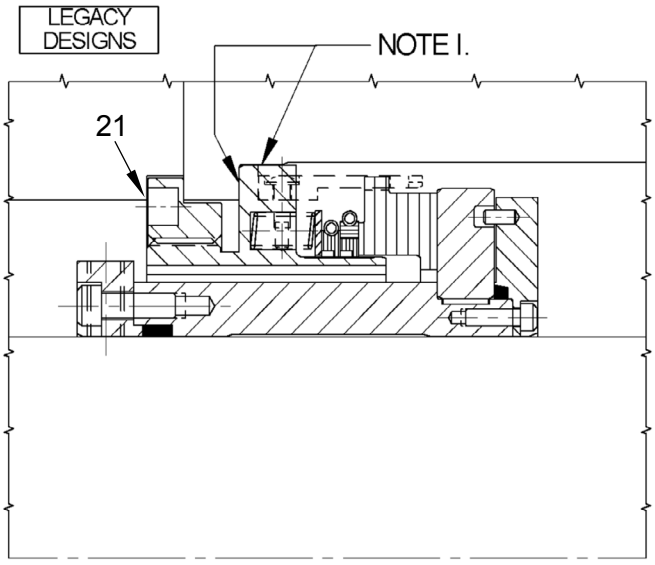
FIGURE 2-3-2



TYPE 28 ST

GAS SEAL

FIGURE 2-3-2-1



Installation of inside mounted seals

FACE SEALS

A. Ensure that the direction of the shaft rotation is correct for the seal being installed. This can be accomplished by checking the directional arrow on the seal, and the bucket orientation on the wheel.

B. Break all shaft edges to avoid damage to seal inner diameter.

C. Slide seals onto their respective end of the turbine rotor. **NOTE: PRIOR TO INSTALLING OTHER COMPONENTS OF THE STEAM TURBINE, ENSURE THAT ALL PARTS FOR THE SEAL ARE ON THE SHAFT.**

D. Remove socket head cap screws (Items #23 & Item #25) and installation plate (Item #24). Refer to Figure 2-3-2.

E. Install packing ring (Item #19) and collar (Item #20).

F. Install the thrust ring assembly (item #18) only if it is required for this configuration. If not applicable, skip this step.

G. Install collar (Item #16) and socket head cap screw (Item #17). **DO NOT TIGHTEN SOCKET HEAD CAP SCREWS AT THIS TIME.**

H. Install other components (such as flingers, and thrust bearings) onto shaft per manufacturer's recommendation.

I. A small bead of high temperature sealant should be applied to the smaller diameter bores (lands) in the lower casing. This sealant will help facilitate a positive seal between the Type 28ST seal and the casing. John Crane recommends the use of Copaltite, as needed, manufactured by National Engineered Products, Birkosit or equivalent.

J. Before lowering the rotor, verify whether the seal configuration includes gasket Item #22.

If gasket Item #22 is present:

Refer to Figure 2-3-2

Lower the rotor into the case and allow it to rest on the bearings. appropriate grooves. Push the seals in far enough to prevent the gasket (Item #22) from being crushed when the top half of the casing is installed. After the top half is in place, installing the locknut (Item #21) will draw the seal back against the gasket (Item #22).

If gasket Item #22 is not present (legacy designs):

Refer to Figure 2-3-2-1

Before lowering the rotor, apply a high-temperature sealant to the metal-to-metal surfaces of the lower casing and repeat the application on the corresponding surfaces of the top casing. Then ensuring seals are aligned and positioned axially to fit into the appropriate grooves. After the top half is in place, installing the locknut (Item #21) will draw the seal back against the metal-to-metal surfaces where the sealant was applied.

K. Tighten screws (Item #17) securing collars (Item #16 & Item #20) to compress packing ring (Item #19). Refer to Figure 2-3-2.

L. Remove locknut (Item #21) and lightly coat with anti-seize compound. Reinstall locknut, but **DO NOT TIGHTEN LOCKNUT AT THIS TIME.**

Part name		Part name	
1	Mating ring	14	Socket head cap screw
2	Packing ring	15	Collar
3	Primary ring	16	Collar
4	Split ring assembly	17	Socket head cap screw
5	Split ring assembly	18	Thrust ring assembly
6	Retainer	19	Packing ring
7	Disc	20	Collar
8	Spring	21	Locknut
9	Collar	22	Gasket
10	Socket head cap screw	23	Socket head cap screw
11	Inner sleeve	24	Installation plate
12	Sleeve end face	25	Socket head cap screw
13	Tolerance ring		

M. The sealant is applied to the split casing joint, it must come into full contact with the retainer and the casing joint. **NOTE: ANY GAP BETWEEN SEALANT, CASING AND SEAL WILL RESULT IN A LEAK PATH.** Refer to Figure 2-5. The sealant should be kept away from the seal, except in the area of the retainer (Item #6).

N. Lower top cover into place using guide pins.

O. Torque case to manufacturer's specifications.

P. Insert spanner wrench into locknut (Item #21). Tighten locknut to draw seal cartridge in until metal to metal contact is made between retainer and turbine casing.

TYPE 28 ST

GAS SEAL

Unit Preparation for outside mounted seals

A. Split the steam turbine casing and remove the rotor.

B. Thoroughly clean the area where the seal will be located. The shaft should be free from scratches and burrs. Ensure there are appropriate chamfers on the shaft.

C. Ensure that the seal envelope dimensions on the stem turbine are in accordance with the appropriate John Crane drawing for the unit in question. Shaft diameter should fall within the given specified dimensions and tolerances.

D. Shaft hardness in the area of the set screw drive collar (Item #16) should not exceed 30 Rc. If there is a chrome or other hard coating on this area, it should be ground off. Refer to figure 3-3.

E. Place shaft with dial indicator attached into the bottom half of the bearings.

F. Measure shaft runout per Figure 3-1.

G. Measure the runout of the abutment face of the housing per Figure 3-2.

H. Spot facing the shaft under two of the set screws is recommended. **NOTE: SET SCREWS SHOULD NEVER BE RE-USED.**

FIGURE 3-1

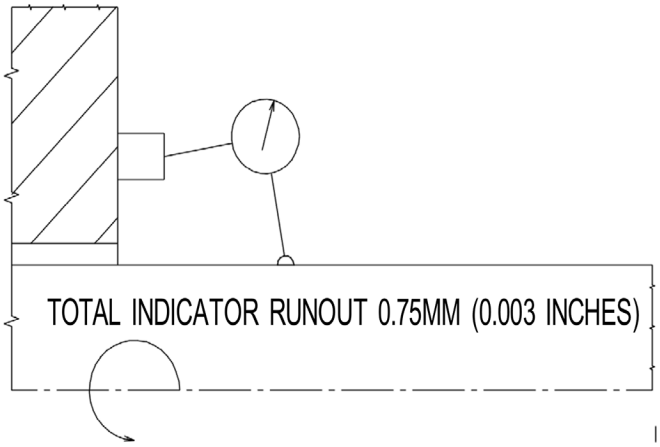


FIGURE 3-2

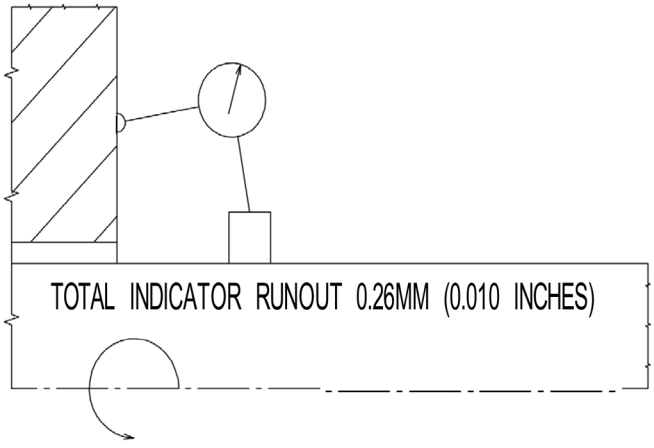
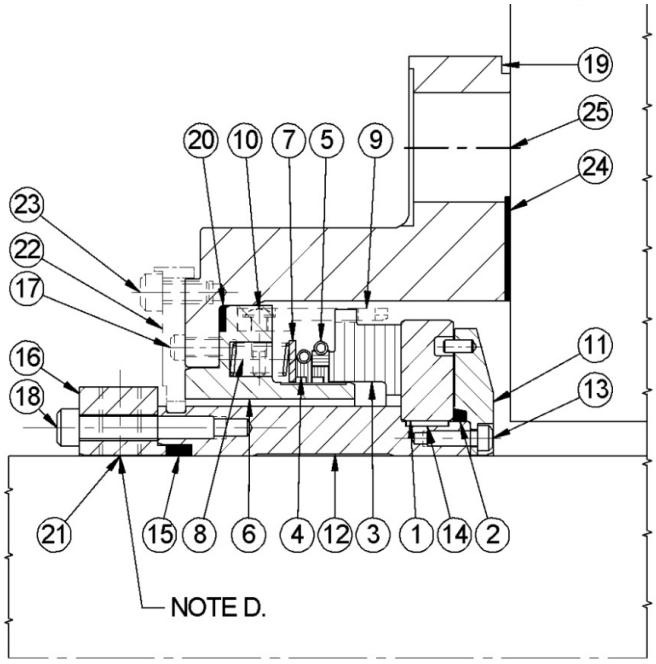


FIGURE 3-3



	Part name		Part name
1	Mating ring	14	Tolerance ring
2	Packing ring	15	Packing ring
3	Primary ring	16	Collar
4	Split ring assembly	17	Socket head cap screw
5	Split ring assembly	18	Socket head cap screw
6	Retainer	19	Housing
7	Disc	20	Gasket
8	Spring	21	Cup point set screw
9	T-bar	22	Holding clips
10	Button head cap screw	23	Socket head cap screw
11	Inner sleeve	24	Gasket
12	Shaft sleeve	25	(Screw (by customer)
13	Socket head cap screw		

TYPE 28 ST

GAS SEAL

Installation, Operation & Maintenance Instructions

Installation of outside mounted seals

A. Ensure that the direction of the shaft rotation is correct for the seal being installed. This can be accomplished by checking the directional arrow on the seal, and the bucket orientation on the wheel.

B. Break all shaft edges to avoid damage to the seal inner diameter.

C. Slide seal on their respective ends of the turbine rotor. **ENSURE THAT GASKET BETWEEN THE HOUSING AND THE CUSTOMER'S CASING IS IN PLACE.** Slide shaft packing ring (Item #15) and rotor collar (Item #16) onto the shaft independently of the seal. Refer to figure 3-3.

EXTREME CARE SHOULD BE TAKEN AS NOT TO DAMAGE THE PACKING RING ON THE SHAFT CORNERS.

D. Install any shrink fit flingers per manufacturer's recommendation.

E. Lower rotor into case and allow to rest on bearings. Axially position rotor. Install upper casing and bolt in place.

F. Bolt seal housing to upper and lower casing. Ensure that the face gasket on the housing is positioned correctly. **NOTE: BOLT HOLE SPACING MAY NOT BE UNIFORM, SEE JOHN CRANE DRAWING FOR PROPER BOLT PATTERN.**

G. Refer to Figure 3-3 and tighten set screws (Item #18) on rotor.

H. Evenly tighten set screws (Item #21) according to the Torque Chart. The seal is designed so that the shaft can be rotated to reach all the set screws.

I. Torque all set screws according to chart. If a torque wrench is not available, a standard hex key wrench can be used as follows. Insert the short arm in the socket and apply a force near the end of the long arm. When the wrench deflects 25-30 degrees, the appropriate torque has been achieved.

J. After gland plate, bearing, seals and shaft are locked in place, loosen cap screw (item #23) securing holding clip (Item #22) ¼ turn and slide holding clip against stop and re-tighten cap screw securely **NOTE: SET SCREWS SHOULD NEVER BE RE-USED.**

Torque chart for set screws

JCI component part number	Screw size	Torque (Nm)	Torque (In-Lb)
1125-20XX-000	1/4	9.83	87
1131-18XX-000	5/16	18.6	165
2104-40XX-000	#4-40	1.7	15
2105-40XX-000	#5-40	2.7	24
2106-32XX-000	#6-32	3.4	30
2108-32XX-000	#8-32	5.65	50
D-0001-937	#8-32	1.7	15

Removal of Type-28ST seal

A. Seal removal can be accomplished by following the reverse of procedure mentioned in section for the inside mounted seals installation and section for outside mounted seals installation.

B. Ensure that the holding clips are installed before removal of the seal failure to do so can result in significant damage to the seal.

C. Contact your John Crane sales representative for re-conditioning of the seal.

Operational guidelines

A. **REVERSE ROTATION** should be avoided. Short periods of reverse rotation at speeds less than 1000 rpm can be tolerated, however continued occurrences of reverse rotation may shorten the seal life. This restriction does not apply to seals with bi-directional groove designs.

B. **SLOW ROLL** conditions for steam turbines can be tolerated, however, a minimum slow roll speed of 1000 rpm is recommended. This provides a wide safety margin over the speed at which a stable running gap can be maintained.

C. Short durations at a **TURNING GEAR** speed can be tolerated by the seal.

D. The Type-28ST seal has a high tolerance level for **VIBRATION**. Experience has shown that the seals can survive vibration levels exceeding 0.13 mm (5 mils).

Maintenance

The Type-28ST seals are essentially maintenance free. Proper care should be utilised to keep the steam seals in their optimum performance condition.

CLEANING

If the Type-28ST seal is exposed to oil or other contaminants, it is recommended that they be cleaned.

Although the seals are robust in operation, they can be damaged by incorrect assembly, fitting or handling. It is, therefore recommended that the seals are returned to the repair facility or cleaned by a John Crane representative.

STORAGE

If the seals need to be stored after removal from the turbine, they must be assembled with the appropriate holding clips in order to hold the rotating and stationary elements in alignment.

The original packing crates, foam, and plastic seal covering should be used. Grease paper, oil paper, or waxed cotton should not be used. The crates, with seals, should then be kept in a warm and dry atmosphere.

If the seals are to be stored in the turbine, it is necessary to ensure that the seal faces are not contaminated with oil. This is necessary to prevent the seal faces from wringing together.

TYPE 28 ST

GAS SEAL

During any storage period, it is necessary to keep the seals free from all solid and liquid contaminants either can damage the seal faces during steam turbine start-up and operation.

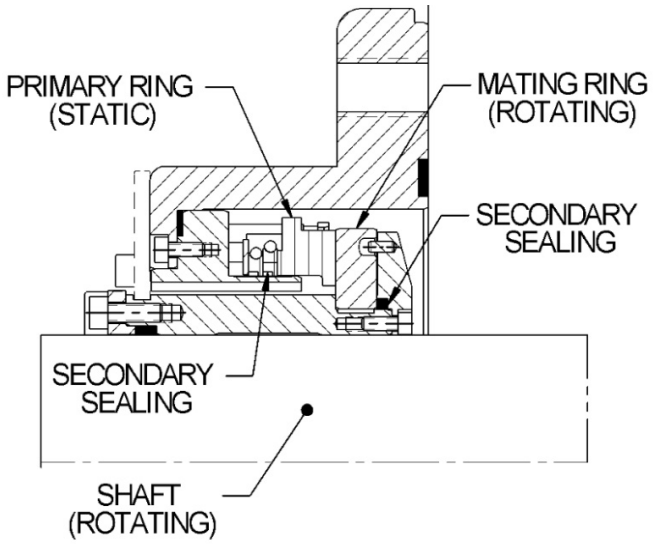
CUSTOMER REPAIR SERVICE

Contact your local John Crane representative for instructions.

APPENDIX I. Principle of operation

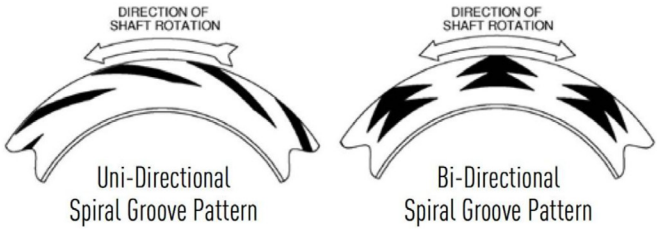
Simply explained, the gas seal typically comprises of a secondary sealed primary ring, located in a static retainer, spring loaded against a rotating mating ring mounted in the seal rotor and fixed to the steam turbine shaft, as shown in Figure I.A below.

FIGURE I.A



Sealing of the fluid is achieved at the radial interface of the rotating and stationary rings by a unique and ingenious method. The sealing surfaces are lapped to a high degree of flatness, but the rotating mating ring has a series of logarithmic spiral groove patterns printed onto the running face (see Figure I.B).

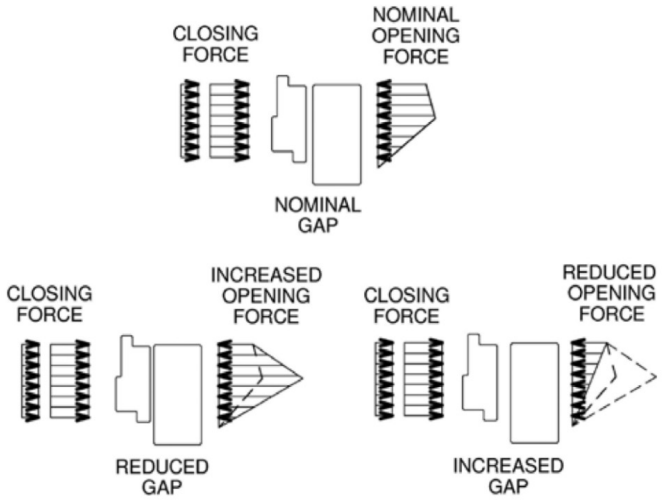
FIGURE I.B



With shaft rotation, gas is drawn inwards towards the root of the groove, called the sealing dam. The sealing dam provides resistance to flow, increasing the pressure. The generated pressure lifts the primary ring out of contact with the mating ring by a small amount typically between 1µm to 10µm (39µinch to 390µinch). The gap between the radial faces is set when the closing forces, hydrostatic pressure and spring load, equate to the opening forces generated within the fluid film. It is this very thin sealing gap that allows very high speeds to be accommodated, yet provides sufficient restriction to limit gas flow to acceptable limits of leakage. The gas seal film stiffness is very high providing robust performance and allowing very high pressures to be sealed.

Under equilibrium and a normal operating gap, opening forces = closing forces as illustrated in Figure I.C.

FIGURE I.C



If a disturbance occurs that results in a reduced sealing gap, then the pressure generated by the spiral grooves considerably increases and exceeds the closing force. This will very quickly result in the sealing gap increasing until equilibrium i.e., opening force = closing force and the normal operating gap is restored.

Similarly if an upset causes the gap to increase, there is a reduction in the pressure generated by the spiral groove resulting in closing force being greater than opening force. This will result in the sealing gap closing until equilibrium and a normal sealing gap is again restored.

The result of this mechanism is a highly stable yet thin fluid interface between the static primary ring and the rotating mating ring that keeps the two sealing surfaces apart under normal dynamic operating conditions. In turn this leads to a reliable seal with long life as there is no wear at the interface.

To achieve this John Crane has invested heavily in advanced technologies and has built up a considerable and unsurpassed fund of knowledge and experience in rotary shaft gas sealing applications.

There are many principles governing the seal's performance only a few of which are explained in the previous paragraphs. Further information is available from John Crane.

TYPE 28 ST

GAS SEAL

Installation, Operation & Maintenance Instructions

APPENDIX II. Returning seals to John Crane

All gas seals should be returned to John Crane for any refurbishment. Prior to refurbishment, customers must confirm in writing that the specific seals being returned are safe to handle and provide any additional safety-critical information on request. John Crane can provide a suitable form for this purpose.

The following information must be made available on the shipping documentation.

1. Installation drawing numbers
2. Cartridge numbers
3. Value (for insurance only)
4. Commodity code 84842000000

For refurbishment, contact your local John Crane sales representative for shipping details of your nearest John Crane Turbomachinery Service Centre.

North America
United States of America
Tel: 1-847-967-2400

Europe
United Kingdom
Tel: 44-1753-224000

Latin America
Brazil
Tel: 55-11-3371-2500

Middle East & Africa
United Arab Emirates
Tel: 971-481-27800

Asia Pacific
Singapore
Tel: 65-6518-1800