1. REMARKS FOR DESIGNING CYLINDERS

CYLINDER TUBE MATERIAL

The materials described in **Table F-1** are generally used for cylinders.
Aluminum alloy, bronze, brass, Monel metal and soft stainless steel may be used for low-pressure applications depending on circumstances. They are not recommended for use over long periods of time due to poor wear resistance. The following table shows the materials specified by JIS.

〈Table F-1〉

Kinds	Material
Material for tubes	JIS G 3473 (Carbon steel pipe for cylinder tubes) JIS G 3445 (Carbon steel pipe for mechanical structures)
Material for rods	JIS G 4051 (Carbon steel material for mechanical structures)

INSIDE CYLINDER FACE FINISH AND ROUGHNESS

Generally, a honed finish and a burnishing finish are recommended for the inside face of the cylinder tube. Avoid finishing the face with a pattern aligned in a lateral direction.
Specially, under severe lubricating application, burnishing is required.
NOK uses 0.4 - 3.2μm Rz (0.1 - 0.8μm Ra) as the inside face finish on a cylinder tube as standard.

ROD SURFACE AND ROUGHNESS

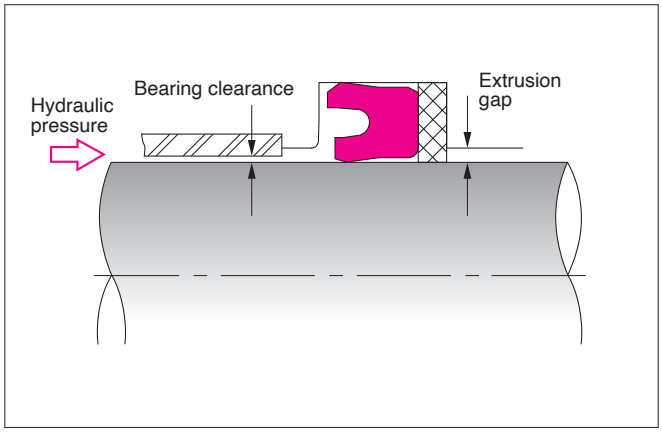
0.8 ~ 1.6μm Rz (0.2 ~ 0.4μm Ra) with buff finish, after heat treatment, plating the steel with hard chrome is recommended for rod surface. Never use decorative nickel plating or chrome.
Cylinder rod used for construction machinery is likely to be scored by sands or pebbles, so minimum hardness should be 60 (HRC)

ROUGHNESS OF INSIDE FACE OF FITTING GROOVE

Since a rough inside face of the fitting groove affects the sealing of a packing, use a finish value mentioned on the Dimensional Table. In fitting the packing, it is easily scratched, so finish the top end of the groove completely removing any burrs, sharp edges and scars.

BEARING CLEARANCE AND EXTRUSION GAP

Since sealing performance is grately affected by extrusion gap and bearing clearance, design should be set as small as possible. (See Dimensional Table for bearing clearance and extrusion gap)
Never use a packing in such a way that the packing replaces a bearing.

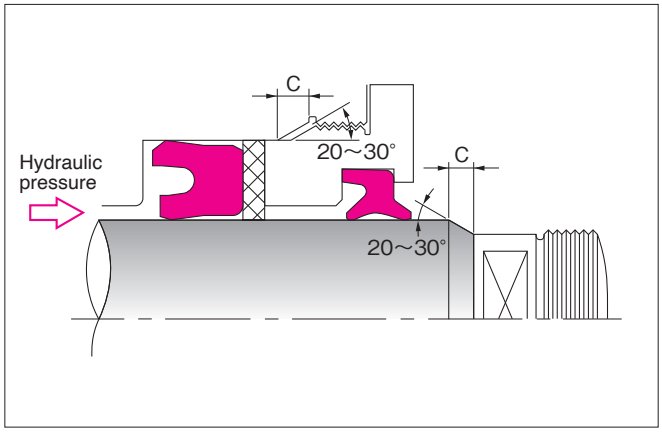


〈Fig. F-1〉

DESIGN OF PACKING INSERTION PORT

There is an interference on the I.D. and O.D. of the packing to achieve sealing performance. When installing a packing in a cylinder, the lip of the packing, its most important part, is easily damaged, if the size and construction of the chamfered edge of the insertion port are poor※.
Especially, apply stepped design to any threaded part as shown in **Fig. F-2**. (See Dimensional Table for size).

※ Key grooves, splines, etc.



〈Fig. F-2〉

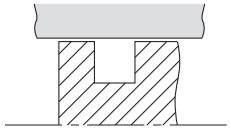
2. INSTALLATION OF PACKINGS

When installing packings, fitting construction differs from one to another depending on the type of packing. The installation method will also vary. It is possible to install a packing with a small profile design and a combination seal in an integral groove, but in other cases, it is necessary to use a split groove construction, the detail of which is mentioned in each page shown in **Table F-2**. See Dimensional Table for construction of the fitting groove.

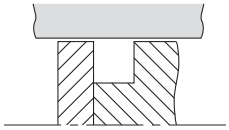
〈Table F-2〉 List of installation methods

Kind	Construction of groove	Iron rubber U packing	Nitrile rubber packing	Combined seal	Other packing
Packings for piston seals (Example of installation 2-1)	Integral groove (Note)	Installation method A (Page F-3)	Installation method B (Page F-3)	Installation method C (Page F-4~6)	C packing : Installation example 2-3 (Page F-8)
	Split groove	A packing can be installed easily. Installation method D (Page F-6)			V packing : Installation example 2-4 (Page F-8)
Packings for rod seals (Example of installation 2-2)	Integral groove (Note)	Installation method E (Page F-6)	Installation method F (Page F-7)	Installation method G (Page F-7)	Buffer ring : Installation example 2-5 (Page F-9)
	Split groove	A packing can be installed easily. Installation method H (Page F-7)			

Example of structure of fitting groove for piston packing

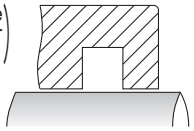


(Split groove)

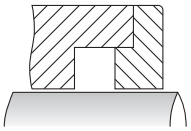


(Integral groove)

Example of structure of fitting groove for rod packing



(Split groove)



(Integral groove)

Note 1) Some of the parts with a small diameter cannot be installed in an integral groove. Kindly check with Dimensional Table.
Note 2) Install the U packing in such a direction that its lip comes to oil pressure side as it is shown on Fig. F-1 and Fig. F-2 at page F-2.
Note 3) If difficult to assemble, soak the rubber in oil (the oil you normally use) at around 60°C for around ten minutes and soak the Rareflon in either hot water or oil at around 60°C for around ten minutes. This will make it easier to assemble.

INSTALLATION EXAMPLE 2-1 PACKINGS FOR PISTON SEALS

■ METHOD A: INSTALLATION OF IRON RUBBER U PACKING INTO INTEGRAL GROOVE (MAIN APPLICABLE TYPES: OSI, OUIS, USI))

Some of the parts with a small diameter cannot be installed in an integral groove. Refer to the Dimension Table.

INSTALLATION METHOD

① Prepare a pivot with an arm which corresponds to the diameter of the piston rod.
② First of all, be sure to apply hydraulic oil to ensure easy installation of the packing on the piston rod.
③ Fit part of a packing into the installation groove as shown in **Fig. F-3**.
④ Hold the packing with the thumb, then install the pivot into the hole as shown in **Fig. F-4**.
⑤ Rotate the packing once pressing down the arm handle as shown in **Fig. F-5**.

〈Fig. F-3〉

〈Fig. F-4〉

〈Fig. F-5〉

■ METHOD B: INSTALLATION OF A NITRILE RUBBER U PACKING IN AN INTEGRAL GROOVE (MAIN APPLICABLE TYPES: OUHR, USH)

Some of the parts with a small diameter cannot be installed in an integral groove. Refer to the Dimension Table.

INSTALLATION METHOD

The packing can be easily installed by inserting it in one side of the groove and stretching the other side of the packing to fit in place. **(Fig. F-6)**

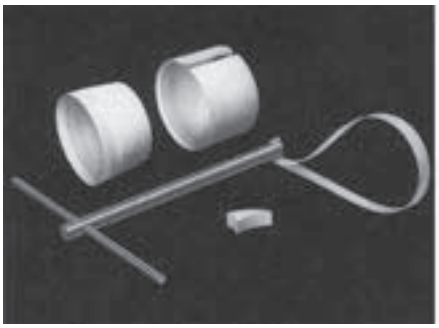
〈Fig. F-6〉

F HANDLING OF NOK PACKINGS

■ METHOD C: INSTALLATION OF COMBINATION SEALS IN AN INTEGRAL GROOVE
(MAIN APPLICABLE TYPES: SPG, SPGO, SPGW)

In case of combined seals, correction of Rareflon ring is necessary after installing the back ring and the Rareflon ring into the integral groove. Installation method and correction method are explained below.

INSTALLATION METHOD

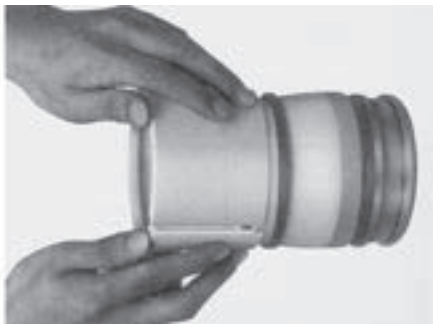


〈Fig. F-7〉

① Prepare a slide tool and push-in tools shown in the figure. Flush clean the inside face of the cylinder and the fitting groove before installation.

〈Fig. F-8〉

② Install the back ring into the fitting groove. Never over stretch or over bend the back ring when installing it.

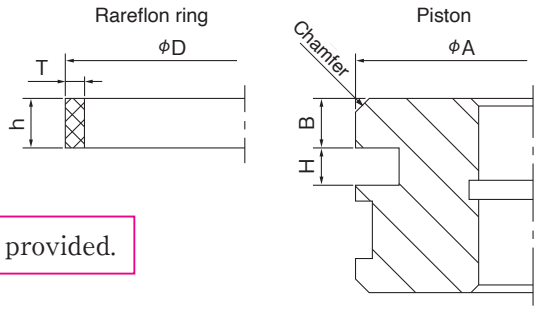


〈Fig. F-9〉

③ Fit the slide tool in the piston. Then quickly push in the Rareflon ring using push-in tool.

[INSTALLATION TOOLS FOR RAREFLON RING]

Shapes of tools used for installation and correction of the Rareflon ring are as follows. Sizes for each part of the push-in and slide tools are according to the sizes of the Rareflon ring (D, T, h) and the piston (øA, B, H, chamfer).

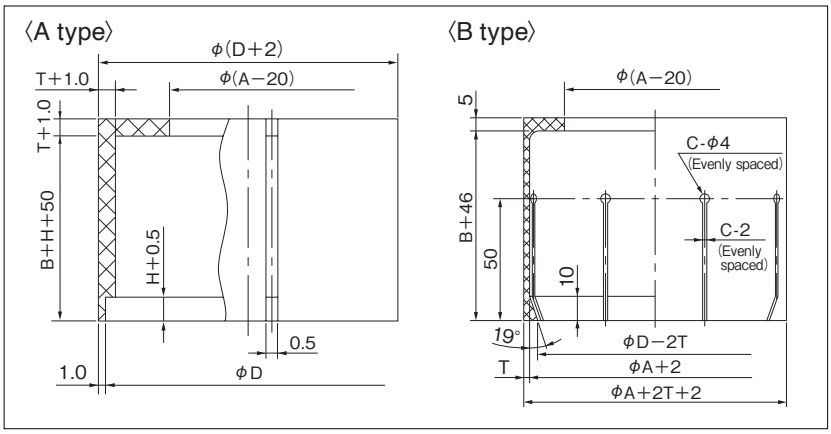


NOK could supply Gigs if ϕA, B, H and chamfer dimension are provided.

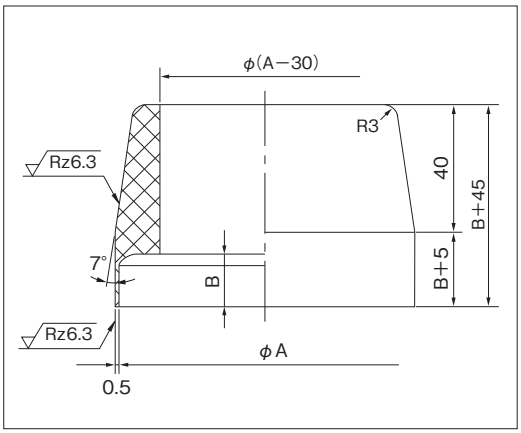
〈Table F-3〉

SPG PACKING※		SPGO PACKING		SPGW PACKING	
ϕ D	T	ϕ D	T	ϕ D	T
30 ～ 35.5	1.6	20 ～ 25	1.0	50 ～ 60	2.3
36 ～ 60	1.9	30 ～ 60	1.25	61 ～ 120	2.5
61 ～ 100	2.4	61 ～ 160	2.0	121 ～ 200	3.5
101 ～ 160	2.9	161 ～ 200	2.5	—	—
161 ～ 250	3.5	—	—	—	—

※For installation tools with packing greater than ø200, consult NOK separately.



〈Fig. F-10〉 Push-in tool（Made of resin）



〈Fig. F-11〉 Slide tool（Made of metallic）

※A type is the standard article.
※B type is easier to assemble.
※Guide to number of slits on B type is provided below.

ϕD	Slits (Evenly spaced)
Up to 50	4
Over 50 to 100	6
Over 100 to 200	8

● CORRECTION METHOD OF RAREFLON RING

CORRECTION METHOD 1.

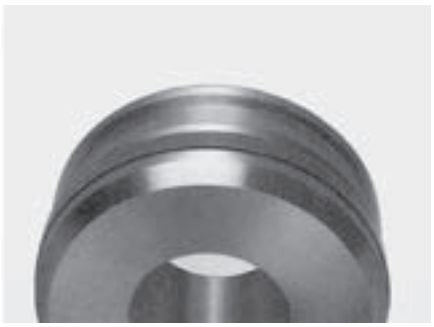
For combination seals, correct the Rareflon ring after installing the back ring and the Rareflon ring in the fitting groove. For SPGW packings, carry out the correction. Where correction method 1 is insufficient, use correction method 2. On the other hand, carry out correction according to the correction method 2 for packings whose nominal numbers exceed 400.

〈Fig. F-12〉

① Prepare a twist bar and adapter as shown in the figure. Set the twist bar and adapter as shown, then set the Rareflon ring in the center of the band.

〈Fig. F-13〉

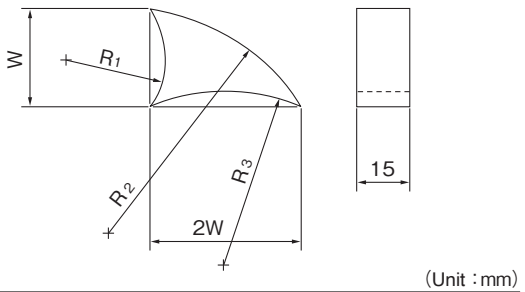
② Hold for 10 seconds or more.



〈Fig. F-14〉

③ Installation is completed by the above steps. The internal and external circumference faces of the Rareflon ring affect sealing performance, so be careful not to scratch the ring.

[JIG FOR CORRECTION METHOD 1]

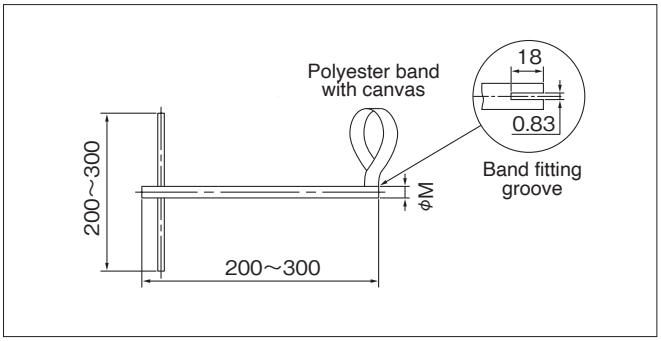


(Unit : mm)

Nominal number of combination seal	20～56	60～90	95～150	160～200
M	10	15	20	30
W	10	15	20	30
R_1	15	20	25	35
R_2	D/2＋3	D/2＋5	D/2＋7	D/2＋10
R_3	D/2			

Note) D : Inside diameter of cylinder tube

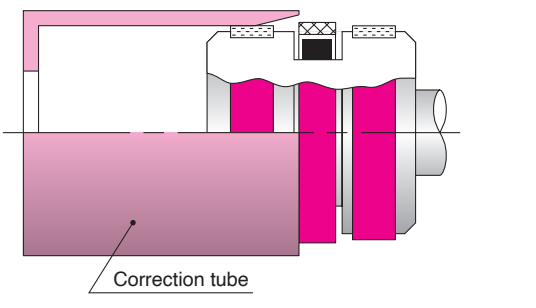
〈Fig. F-15〉 Adapter (Rareflon)



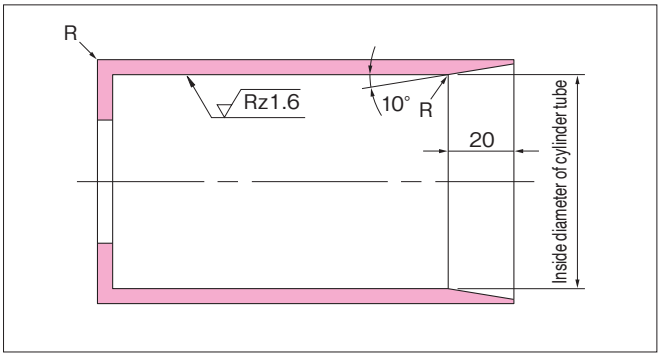
〈Fig. F-16〉 Twist bar (Metal and Polyester band with canvas)

Push-in jig, slide jig, adapter, twist bar, and correction tube are manufactured by NOK. Order with us.

CORRECTION METHOD 2.



〈Fig. F-17〉



〈Fig. F-18〉 Correction tube (metal)

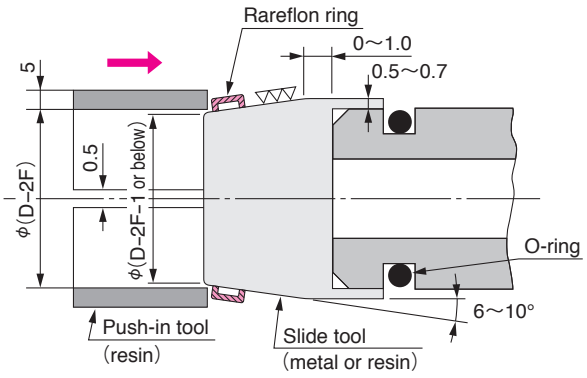
① Prepare a correction tube shown in **Fig. F-17**

② Insert a piston after applying hydraulic oil (oil actually used) and pull the piston mount after having left it there for about 10 seconds.

● SPGC TYPE PACKINGS

For SPGC packings having inside diameter below ø 50, use divided grooves generally. When the divided groove is not available or for inside diameter of the cylinder tube ø 50 or more, first install O-ring in the fitting groove and then install the Rareflon ring with a tool shown in the figure.

D	F
~ Below 56	1.3
58 ~ 160	1.5
165 ~ 400	2.0



Note) For D and F, refer to the above table.

〈Fig. F-19〉

■ METHOD D: INSTALLATION INTO DIVIDED GROOVE

(Applicable to packings for piston seals in general)

No special tool is required for installation into a divided groove. Packings can be easily installed by hand.

> Be careful not to scratch the packing by the fitting groove or angle.

EXAMPLE OF INSTALLING 2-2 PACKINGS FOR ROD SEALS

■ METHOD E: INSTALLATION OF IRON RUBBER U PACKING INTO INTEGRAL GROOVE

(MAIN APPLICABLE TYPES: ISI,IUIS,USI)

Some of the parts with a small diameter cannot be installed in an integral groove. Refer to the Dimension Table.

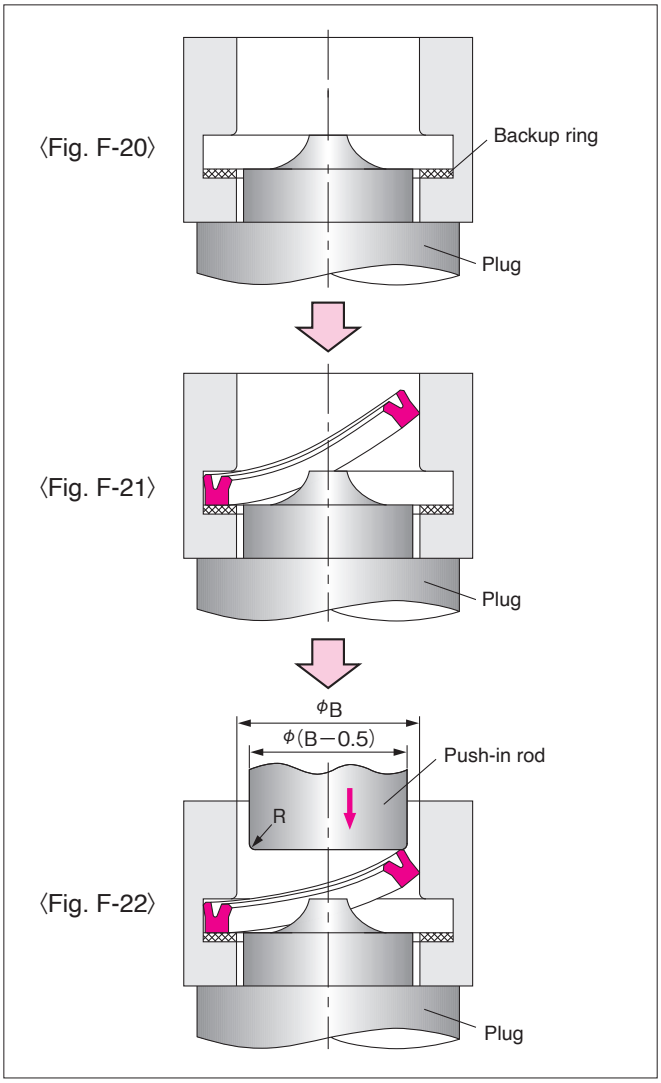
INSTALLATION METHOD

① When using a backup ring together, first install the buffer ring into the fitting groove as shown in **Fig. F-20**.

② Prepare special plugs and push-in rods suitable for respective diameters. Use soft resin for material and it is necessary to make the upper parts of the tools slide into the packings smoothly.
Fit the packing by hand as shown on **Fig. F-21**.

③ When the uppermost part of the packing is pushed in with a special push-in rod, the packing can be installed easily in the fitting groove, making a "Click" noise.

> Processes shown in **Fig. F-21** and **Fig. F-22** should be completed as quickly as possible in order to prevent a permanent deformation of the packing. Be careful not to stop or interrupt the operation in the middle.



■ METHOD F: INSTALLATION OF NITRILE RUBBER U PACKING INTO INTEGRAL GROOVE

(MAIN APPLICABLE TYPES: IUH, USH)

Some of the packings with a small diameter cannot be installed into an integral groove. Kindly check it with the Dimensional Table.

INSTALLATION METHOD

① Deform the packing into a heart-shape with the fingers as shown in **Fig. F-23**. At this moment, be careful not to"scratch" the packing with "nails" .

> Install the packing as quickly as possible in order to prevent permanent deformation.

② The packing inserted in the fitting groove may get a little warped, so correct it with a finger or spatula.

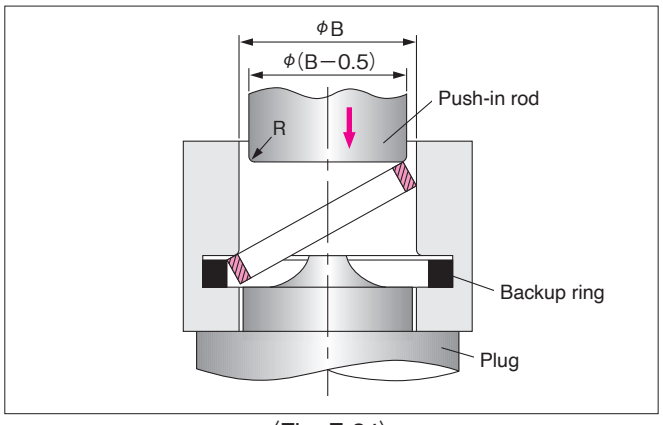
〈Fig. F-23〉

METHOD G: INSTALLATION OF COMBINATION SEAL INTO INTEGRAL FITTING GROOVE
(MAIN APPLICABLE TYPES: SPN, SPNO, SPNS)

Combination seals cannot be installed into an integral groove on a rod having a rod diameter below ø 50 (SPNS, rod diameter under ø 30).
In the case where the rod diameter exceeds ø 50 (SPNS, the rod diameter exceeds ø 30), take the following steps to install the combination seal.

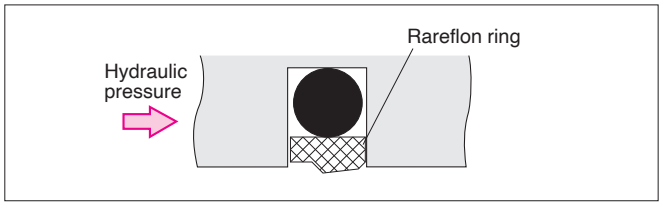
CORRECTION METHOD 2.

① Insert the back ring into the fitting groove.
② Prepare special plugs and push-in rods suitable for respective diameters.
③ Install the Rareflon ring into one side of the fitting groove as shown in the **Fig. F-24** and push it in with the push-in rod.



〈Fig. F-24〉

Since SPNS has the directional property, pay attention to the direction in which the rareflon ring is installed. (**Fig. F-25**)

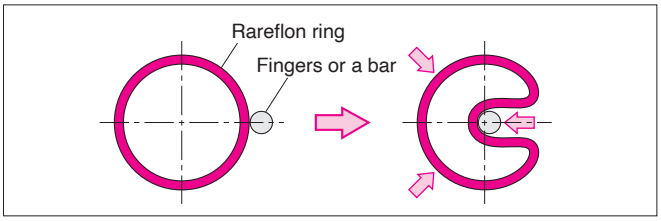


〈Fig. F-25〉

CORRECTION METHOD 2.

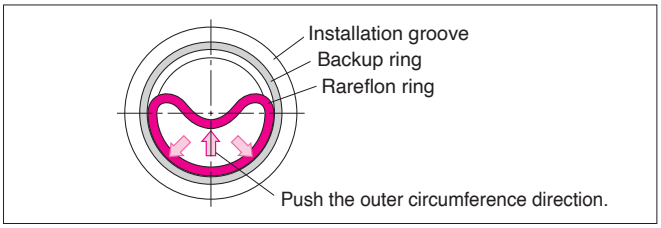
When installing the rareflon ring after squeezing it, install it in the following manner. However, minimize any deformations because it affects the sealing characteristics.

① Install the back ring in the mounting groove.
① Squeeze the rareflon ring into a heart shape as shown in **Fig. F-26**, using fingers or a bar. At this time, be careful not to bend the rareflon ring sharply.



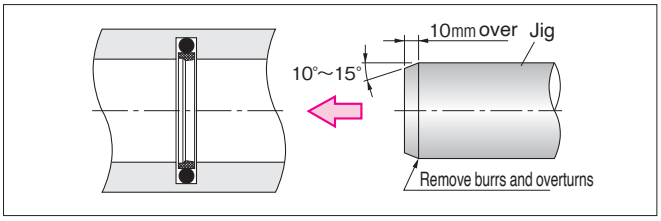
〈Fig. F-26〉

③ Insert the rareflon ring into the groove and then push it from the inside in the outer circumference direction so that it returns to the original shape.



〈Fig. F-27〉

④ Insert the jig (or the rod) several times to correct the deformation of the inner circumference of the rareflon ring.

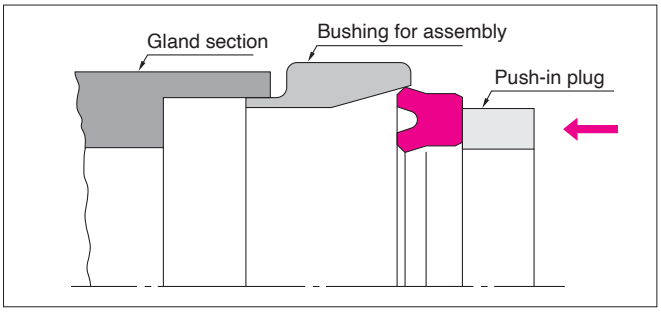


〈Fig. F-28〉

METHOD H: INSTALLATION IN SPLIT GROOVE
(Applicable to packings for rod seals in general)

U PACKINGS

No special tools are required to install U packings from the heel. All packings are easily inserted. When installing U packings from the lip, be particularly careful not to scratch them with the top end of the fitting groove. U packing can be installed by another method using a bushing for assembly and a push-in rod as shown in the **Fig. F-29**.



〈Fig. F-29〉

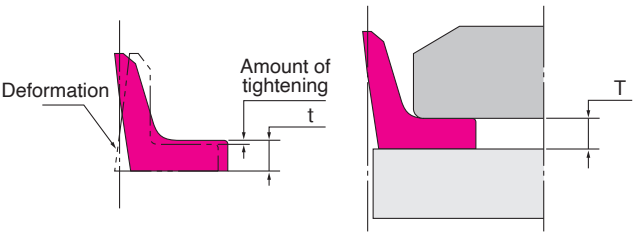
INSTALLATION OF COMBINATION SEAL

For installation of SPNC packing, pre-assemble the back ring (O-ring) and Rareflon ring before installation.
The back ring and rareflon ring can be installed separately with SPN, SPNO and SPNS types.

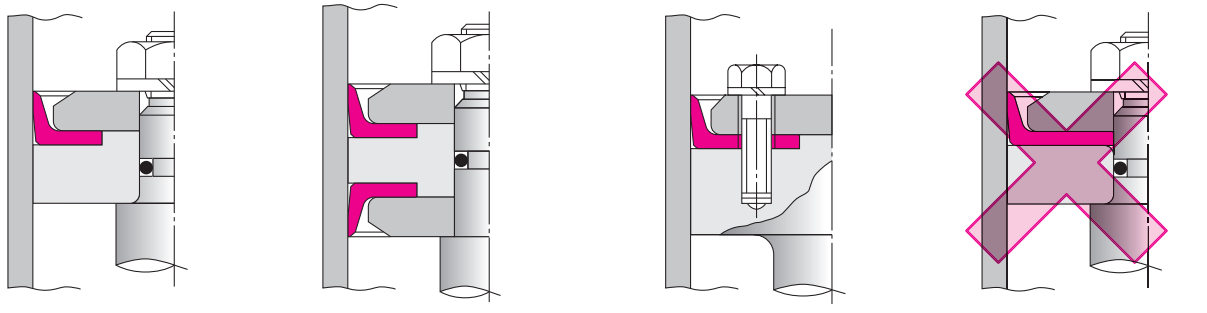
EXAMPLE OF INSTALLING 2-3 C-SHAPE PACKINGS

(Applicable types: CPI, CPH)

Design fitting groove of C-shape packing so that the packing is tightened properly as shown in the **Figs. F-30-1** (a), (b) and (c).
Deformation as shown in **Fig. F-30-2** occurs when the packing is over tightened.



〈Fig. F-30-2〉



〈Fig. F-30-1〉

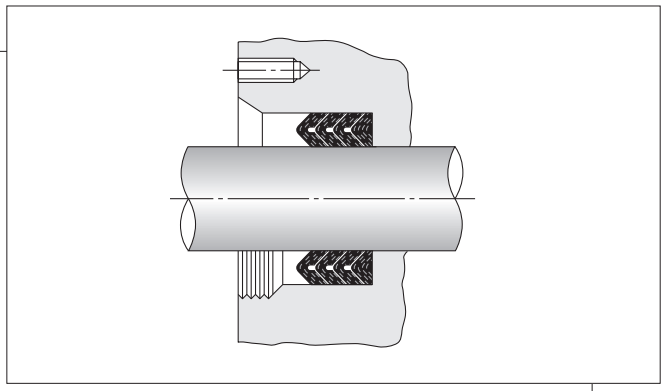
EXAMPLE OF INSTALLING 2-4 V-SHAPE PACKINGS

(Main applicable types: V99F, V96H)

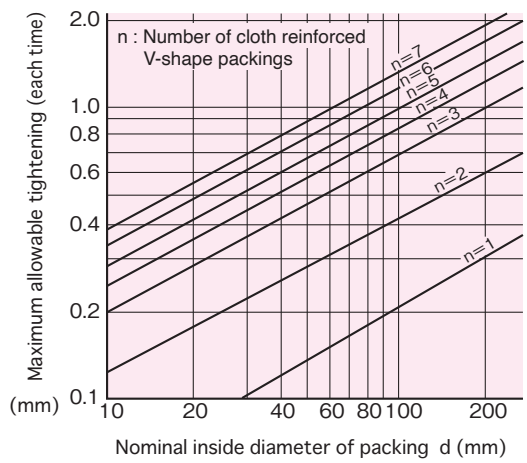
It is not necessary to use Gigs when installing a V-shape packing to the ground.

INSTALLATION METHOD

① Clean inside the gland well and apply grease or hydraulic oil lightly.
② Apply grease or hydraulic oil on the packing face, securely insert packings one by one to avoid twisting or warping.
③ When glands of V-shape packings for rod seals are as shown on the **Fig. F-31**, be careful not to "scratch" the top end of the lip by threads or chamfered part. Make sure there is no "turnover" or "burrs" on the chamfered part and then insert the packing.
④ Tighten the "packing holder" just enough to fix the packing, by adjusting the shim, etc. Over tightening will increase the friction and wear of the packing and shorten its life. See page 159 for the initial tightening amount.
⑤ The fabric reinforced V-shape packing may be compressed by service pressure while in use and shift in the gland to cause leakage. Apply additional tightening of the packing holder and then make adjustment. The amount of tightening must be within the limit given in **Fig. F-32**. When only using rubber V-shape packing, do not apply additional packing.



〈Fig. F-31〉



● When fabric reinforced rubber V-shape packing is used in combination with rubber V-shape packing, do not count the number of rubber V-shape packings.

〈Fig. F-32〉 Max. allowable tightening

EXAMPLE OF INSTALLING 2-5 BUFFER RINGS

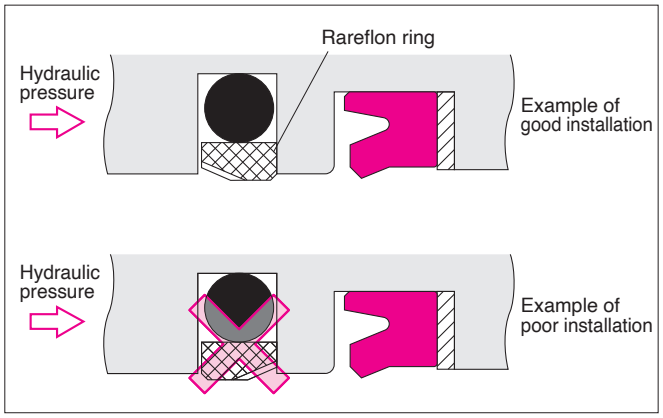
(Applicable types: HBTS, HBY)

Buffer rings can be installed into integral grooves.

● HBTS

As same steps for SPN packing installation, install HBTS packings following to the installation method in **page F-7**.

Pay attention to the direction of the Rareflon ring as shown in **Fig. F-33**.

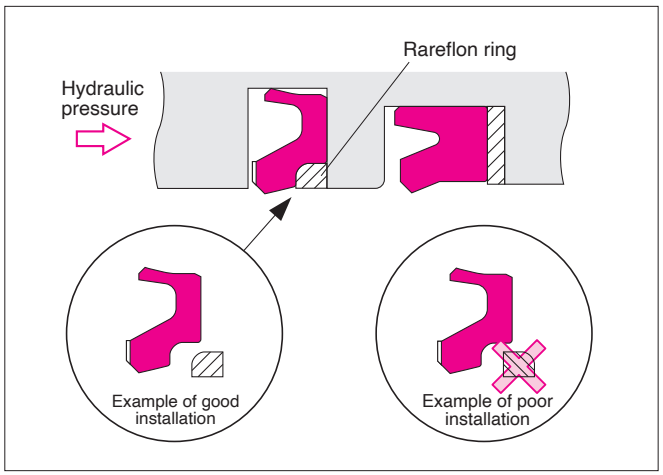


〈Fig. F-33〉

● HBY

Install the packing as deforming into a heart-shape with fingers. Then assembled the back ring.

Pay attention to the direction of the Rareflon backup ring as shown in **Fig. F-34**.



〈Fig. F-34〉

3. INSTALLATION OF DUST SEALS

(Applicable to dust seals in general)

● DSI, LBI, LBH, LBHK

As a dust seal is a single part, squeeze it into a heart shape and install it carefully being careful not to "scratch" it with "fingers" .

When using LBHK outdoor, apply grease sufficiently to the inside of the installation groove, to prevent rust.

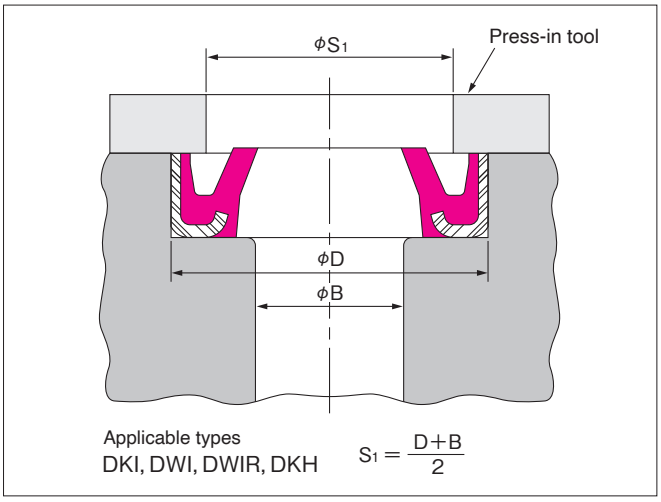
● DKI, DWI, DWIR, DKBI, DKBI3, DKBZ, DKH, DKB

Dust seals are pressed in a fitting groove. Prepare press-in tools as shown in the following figure.

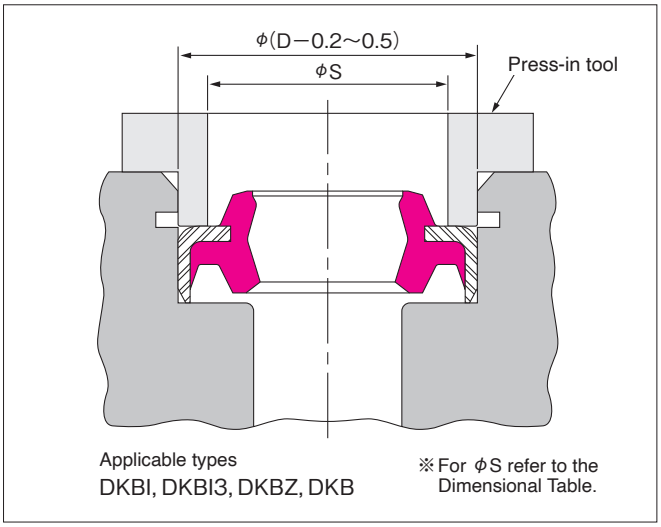
INSTALLATION METHOD

① Set the dust seal horizontally to the housing hole.

② With a press, carefully push in the dust seal using installation tools so as not to deform the dust seal lip nor to incline the dust seal.



〈Fig. F-35〉

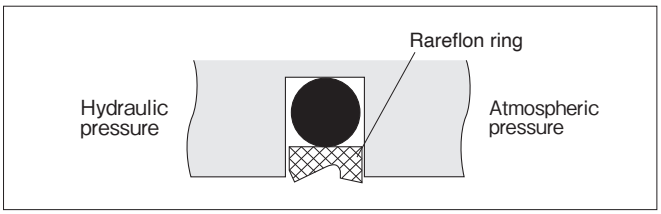


〈Fig. F-36〉

● DSPB

Install LBHK in the same manner as the SPN packing after referring to the installation method described on **page F-7**.

Be careful of the direction in which the rareflon ring is installed, as shown in **Fig. F-37**.

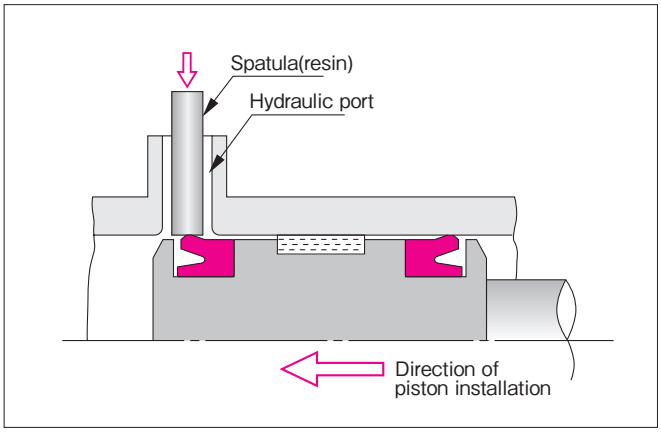


〈Fig. F-37〉

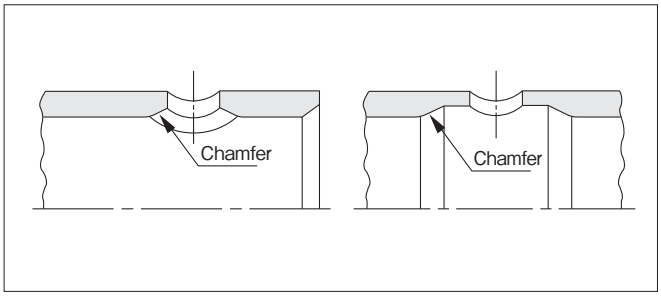
4. REMARKS ON ASSEMBLING CYLINDERS

Sealing performance of a packing is greatly influenced by the method of assembling a cylinder. Please check the following points.

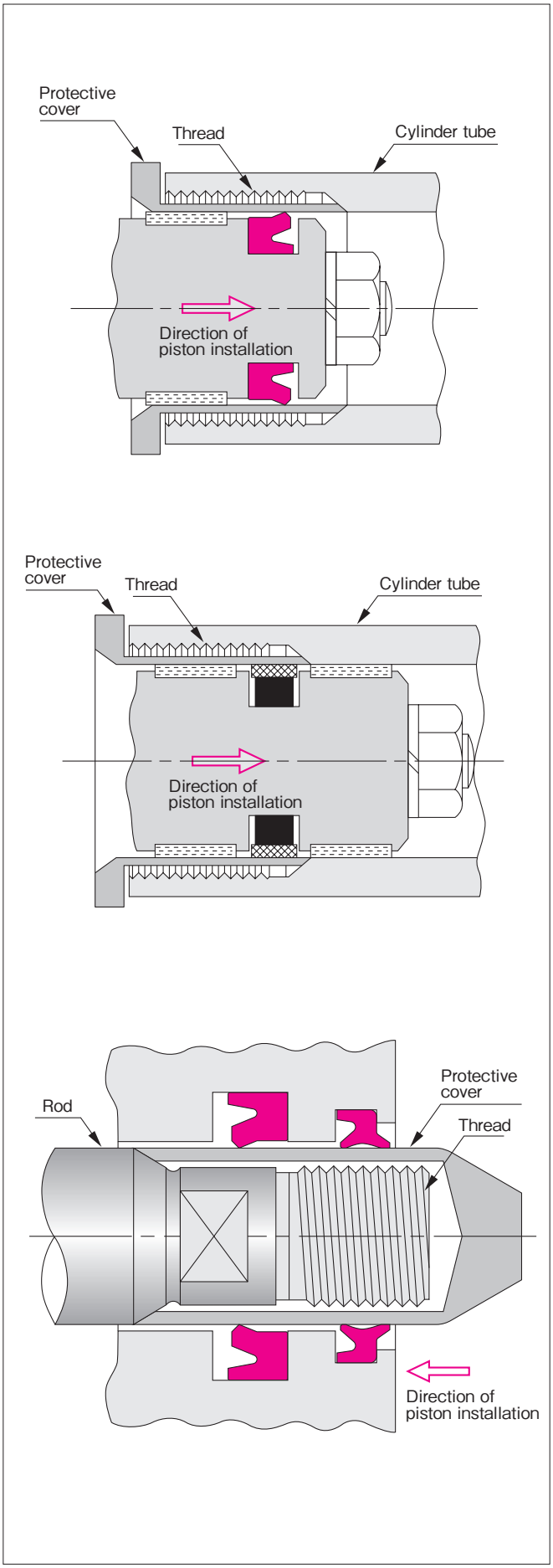
1. Eliminate foreign materials from the internal surface of the cylinder tube and interior of pipes.
2. When using packings from storage, do not use those that have foreign material such as dust, sand, etc., as this will cause leakage.
3. Apply hydraulic oil (the same oil used in the machine) to the packing, gland, rod surface and internal face of the cylinder, then assemble the cylinder.
4. Put a protective cover over the lip of the packing so that it does not directly contact the "thread" and steps. **(Fig.F-38)**
5. When it is necessary to let the lip of the packing pass through a hydraulic pressure port as in **Fig. F-39**, lightly push the lip with a spatula (resin). This prevents damage to the lip of the packing by the chamfer of the port. Chamfer as shown in **Fig. F-40** when drilling a hole directly on the cylinder for a hydraulic port.



〈Fig. F-39〉



〈Fig. F-40〉



〈Fig. F-38〉