

DESCRIPTION

Title of Invention: MECHANICAL SEAL HANDLING PRACTICAL TRAINING EQUIPMENT, HANDLING PRACTICAL TRAINING METHOD, HANDLING PRACTICAL TRAINING SYSTEM, AND MECHANICAL SEAL

5 Technical Field

[0001]

The present invention relates to a technique for assisting handling practical training of a mechanical seal and a mechanical seal.

10 Background Art

[0002]

In various types of rotation devices such as a pump and an agitator, a seal mechanism which prevents fluid leakage and entrance of foreign matter is provided on a rotation shaft. In a mechanical seal, a seal ring which is fixed to the rotation shaft so as to be rotated and a seat ring which is fixed to the side of a casing that covers the rotation shaft are provided, and respective slide faces of the seal ring and the seat ring are brought into contact so as to rotate relative to each other. Although a certain degree of fluid leakage is allowed in terms of the structure, when the wear of the slide faces of the seat ring, the seal ring and the like develops or when foreign matter enters, the fluid leakage becomes remarkable and it becomes necessary to recondition or replace the mechanical seal.

25 As shown in Fig. 25, in a vertical pump 200, a seal mechanism unit 204 is installed on an upper side of a pump body 202 which includes an impeller, and a motor 206 is installed on an upper side of the seal mechanism unit 204. In order to perform maintenance or replacement of a mechanical seal incorporated in the seal mechanism unit 204, it is necessary to remove a casing 208 of the seal mechanism unit 204 so as to expose an internal mechanism and remove the mechanical seal.

[0003]

On the practical training of seal handling as described above,

practical training equipment is known with which engineers involved in seal handling and the like are made to acquire necessary skills (for example, Patent Literature 1). Although this practical training equipment is related to seal handling, it is not related to the handling practical training of a mechanical seal.

Citation List

Patent Literature

[0004]

Patent Literature 1: Japanese Unexamined Patent Application

Publication No. 2015-215473

Summary of Invention

Technical Problem

[0005]

Although an engineer can learn about the seal mechanism and the mechanical seal of a rotation device through product manuals and instruction manuals of a product, lectures provided by educational institutions and the like, it is not easy to reach the skill level necessary for reconditioning or replacement of the mechanical seal. It is required to accurately grasp a phenomenon which occurs in a seal mechanism by long-term use and to take necessary measures, and it is impossible to acquire proficiency in such skills through lectures or simple workshops. Therefore, it is required for a field engineer to avoid an unexpected event such as the operation stop of a pump or the like.

[0006]

For example, in the seal mechanism of a supply/discharge pump for ballast water which is loaded in a vessel such as a tanker, maintenance is periodically performed. Although materials and an engineer necessary for maintenance can be procured when the vessel is anchored in an anchorage site, it is not always possible to secure an engineer having the necessary skill level. In a vessel, it is extremely rational to perform maintenance of a seal mechanism on the sea during navigation, and, for example, in a case where a failure in the seal mechanism is found during navigation, it is

also beneficial to perform maintenance before the vessel arrives at an anchorage site. If maintenance is performed during navigation, it is possible to avoid inconvenience in which the supply and discharge of ballast water is delayed at the anchorage site. In such a case, it is essential that an engineer engaged in navigation of the vessel acquire maintenance techniques.

[0007]

Since a mechanical seal is installed in a rotation device such as a pump, even if replacement or reconditioning of the mechanical seal can be performed, it is troublesome to check an operation mechanism and a function so as to immediately find the cause of a failure. In order to perform maintenance such as reconditioning and replacement of the mechanical seal, it is essential to know the structure and the function of a seal mechanism, and skills to predict the cause of the occurrence of a failure and the like, mastering and experiencing such skills are essential.

Even when the reliability of the seal mechanism and the mechanical seal are high when first installed, it is necessary to avoid deterioration of the functions of the seal mechanism and the mechanical seal due to maintenance as much as possible. In order to maintain the functions of the seal mechanism and the mechanical seal so as to maintain the reliability thereof, it is essential to grasp, by experience, procedures for proper handling of the mechanical seal, understanding of expected abnormal phenomena and the like so as to enhance handling skills based thereon.

[0008]

Therefore, in view of the foregoing problem, an object of the present invention is to assist the handling practical training of a mechanical seal so as to enhance handling skills.

Another object of the present invention is to provide a mechanical seal in which it is easy to check the state of wear and the like caused by normal use during practical training or caused by long-term normal use.

Solution to Problem

[0009]

In order to achieve the objects described above, according to one aspect of mechanical seal handling practical training equipment of the present invention, the mechanical seal handling practical training equipment includes a shaft which can be rotated, a seal ring which is fixed to the shaft and which includes a first slide face, a first casing part which surrounds the seal ring, a seat ring which includes a second slide face that is brought into contact with the first slide face of the seal ring and which is fitted to the shaft, and a second casing part which is combined with the first casing part such that the seat ring is fixed, the seat ring is fixed to a space of the second casing part combined with the first casing part, the second slide face is brought into contact with the first slide face and when handling practical training is provided, the first slide face and the second slide face can be rotated relative to each other by rotating the shaft by a manual operation.

[0010]

The mechanical seal handling practical training equipment described above may further include a handle unit which can be inserted/removed into/from the shaft, and the shaft can be rotated with the handle unit fitted to the shaft.

The mechanical seal handling practical training equipment described above may further include a shaft support unit which is fixed to the first casing part, a first bearing which is attached to the shaft support unit and which rotatably supports the shaft on one end side of the shaft, and a second bearing which is attached to the shaft support unit and which rotatably supports the shaft on an intermediate part of the shaft, and at least either axial runout or play of the shaft can be measured.

In the mechanical seal handling practical training equipment described above, the second casing part may further include a third slide face which is brought into contact with the shaft.

In the mechanical seal handling practical training equipment

described above, the seal ring may include a support ring part which is fixed to the shaft, and the support ring part includes a spring which presses the seal ring to the side of the seat ring and a fixing means which fixes the seal ring to a reference position on the shaft.

5 The mechanical seal handling practical training equipment described above may further include a first port which is provided in the first casing part and which communicates with the seal ring and a second port which is provided in the second casing part and which communicates with the seat ring.

10 In the mechanical seal handling practical training equipment described above, part or all of either or both of the first casing part and the second casing part may be formed of a translucent material through which a visible check can be performed.

15 The mechanical seal handling practical training equipment described above may further include a stand unit which supports or movably supports the first casing part or the shaft support unit.
[0011]

20 In order to achieve the objects described above, according to one aspect of a mechanical seal handling practical training method of the present invention, the mechanical seal handling practical training method includes a step of fixing, to a shaft, a seal ring which includes a first slide face, a step of installing a first casing part which surrounds the seal ring, a step of fitting, to the shaft, a seat ring which includes a second slide face that
25 is brought into contact with the first slide face of the seal ring, a step of fitting the seat ring to a space of a second casing part and combining the second casing part with the first casing part, and a step of relatively rotating the first slide face and the second slide face with a handle unit fitted to the shaft or without fitting
30 the handle unit.

[0012]

 The mechanical seal handling practical training method described above may further include a step of measuring, before the installation of the seal ring, any one or two or more of

eccentricity of the shaft, play of the shaft and an angle or concentricity of a member adjacent to the shaft.

The mechanical seal handling practical training method described above may further include a step of installing the seal
5 ring and the shaft to the first casing part and placing foreign matter at least on a slide face of the seal ring.

The mechanical seal handling practical training method described above may further include a step of making a pressurized fluid flow in from either a first port in the first casing part
10 or a second port in the second casing part and detecting an outflow or a pressure of the pressurized fluid flowing out from the first port or the second port.

[0013]

In order to achieve the objects described above, according
15 to one aspect of a mechanical seal handling practical training system of the present invention, the mechanical seal handling practical training system includes a sensor unit which includes any one of a sensor for detecting a pressurized state between a seat ring and a seal ring installed on a shaft, a sensor for detecting
20 runout of the shaft, a sensor for detecting vibration or sound generated by rotation of the shaft and a sensor for detecting torque applied to the shaft, a processing means which has a processing function of receiving a sensor signal from the sensor unit so as to convert at least the sensor signal into image information, and
25 an information presentation means which presents a processing output of the processing means with at least the image information.

[0014]

In order to achieve the objects described above, according
to one aspect of a mechanical seal of the present invention, the
30 mechanical seal includes at least a seat ring or a seal ring, for a slide member which includes at least a slide face of either the seat ring or the seal ring, a wearing material is used which is lower in hardness than a seal ring member for actual equipment or a seat ring member for actual equipment and when practical training

is provided, a change in a surface property of the slide face is caused.

[0015]

In order to achieve the objects described above, according
5 to one aspect of a mechanical seal of the present invention, the
mechanical seal includes at least a seat ring or a seal ring, in
a slide member which includes at least a slide face of either the
seat ring or the seal ring, an indication layer is provided which
indicates a degree of wear in accordance with wear, and the degree
10 of wear of the slide face can be indicated by a change in a form
of the indication layer.

Advantageous Effects of Invention

[0016]

According to the mechanical seal handling practical training
15 equipment or the handling practical training method of the present
invention, any one of the following effects can be obtained.

(1) Handling training necessary for the handling of actual
equipment can be provided in a state where a mechanical seal
installed in a rotation device such as a pump is separated from
20 the rotation device, and it is possible to contribute to the
realization of a seal mechanism which is safe and highly reliable.

(2) A trainee can be made to feel rotation, vibration, torque
and the like of the mechanical seal.

(3) An abnormality and a failure and the like that occur in
25 the actual equipment and unexpected events that are assumed can
be simulated, and washing, attachment, an operation check, removal
and the like can be repeated so as to enhance the skills of a handling
engineer.

(4) Handling which is difficult to perform in the actual
30 equipment can also be performed, for example, an abnormality is
forcibly generated or an abnormal member is used, and experience
learning can be provided.

[0017]

According to the mechanical seal handling practical training

system of the present invention, any one of the following effects can be obtained.

(1) Axial runout, vibration, abnormal sound, distortion and the like are quantified, and can be presented as numerical information.

(2) A trainee can compare information presented by an information presentation means and the trainee's senses, and effective handling training can thereby be realized.

[0018]

According to the mechanical seal of the present invention, any one of the following effects can be obtained.

(1) After a rotation operation, the state of wear which occurs in the mechanical seal can be visually checked, and the occurrence of wear and measures therefor can thereby be learned.

(2) Without the need to measure the degree of wear, the wear of the mechanical seal can be checked by a change in an indication material.

Brief Description of Drawings

[0019]

Fig. 1A is a diagram showing a mechanical seal unit of mechanical seal handling practical training equipment according to a first embodiment, and Fig. 1B is a diagram showing a handle unit fitted to a shaft.

Fig. 2 is a diagram showing mechanical seal handling practical training equipment including a shaft support unit according to a second embodiment.

Fig. 3A is a diagram showing mechanical seal handling practical training equipment according to Example 1, and Fig. 3B is a diagram showing a caster part.

Fig. 4A is a plan view showing a shaft, and Fig. 4B is a side view showing the shaft.

Fig. 5A is an exploded cross-sectional view showing a seal ring part, and Fig. 5B is a cross-sectional view showing a support ring part which is cut in a position different from a spring fitting

part.

Fig. 6 is a cross-sectional view showing the seal ring part.

Fig. 7A is a plan view showing a first casing part, Fig. 7B is a cross-sectional view taken along line VIIB-VIIB of Fig. 7A and Fig. 7C is a cross-sectional view taken along line VIIC-VIIC of Fig. 7A.

Fig. 8A is a plan view showing a second casing part, Fig. 8B is a cross-sectional view taken along line VIIIB-VIIIB of Fig. 8A and Fig. 8C is a cross-sectional view taken along line VIIIC-VIIIC of Fig. 8A.

Fig. 9A is a diagram showing a step of indicating a scribing line according to Example 2, Fig. 9B is a diagram showing the shaft on which the scribing line is provided and Fig. 9C is a diagram showing a step of measuring the distance between the scribing line and a support ring part end of the seal ring part.

Figs. 10A and 10B are diagrams showing a step of fixing the seal ring part.

Fig. 11A is a diagram showing a step of fitting the first and second casing parts, Fig. 11B is a diagram showing a step of checking the distance between the first and second casing parts and Fig. 11C is a diagram showing a step of temporarily tightening bolts.

Fig. 12A is a diagram showing a step of tightening the bolts, and Fig. 12B is a diagram showing an order in which the bolts are tightened.

Fig. 13 is a diagram showing a step of checking the operation of a mechanical seal unit.

Fig. 14 is a diagram showing a step of checking the mixing of foreign matter.

Fig. 15A is a diagram showing a step of measuring the lateral runout of the shaft according to Example 3, and Fig. 15B is a diagram showing a measurement position and a dimension.

Fig. 16A is a diagram showing a step of measuring the squareness of the second casing part, and Fig. 16B is a diagram showing a measurement position and a dimension.

Fig. 17A is a diagram showing a step of measuring the concentricity of the second casing part, and Fig. 17B is a diagram showing a measurement position and a dimension.

Fig. 18A is a diagram showing a step of checking the play of the shaft, and Fig. 18B is a diagram showing a check position and a dimension.

Fig. 19 is a diagram showing a step of checking the leakage of a mechanical seal unit according to Example 4.

Fig. 20 is a diagram showing a shaft which includes a step according to Example 5.

Fig. 21 is a diagram showing mechanical seal handling practical training equipment which uses a transparent material for first and second casing parts according to Example 6.

Fig. 22 is a diagram showing a mechanical seal handling practical training system according to Example 7.

Fig. 23 is a diagram showing a mechanical seal unit according to Example 8.

Fig. 24 is a diagram showing a mechanical seal unit according to Example 9.

Fig. 25 is a perspective view showing a pump which includes a general seal mechanism.

Description of Embodiments

[0020]

[First Embodiment]

<Mechanical Seal Unit>

Fig. 1A shows a mechanical seal unit of mechanical seal handling practical training equipment according to a first embodiment. The present invention is not limited to a configuration shown in Fig. 1. The mechanical seal handling practical training equipment 2 is hereinafter simply referred to as practical training equipment 2. In the practical training equipment 2, a shaft 4 and the mechanical seal unit 6 are provided. The shaft 4 corresponds to the rotation shaft of a rotation device such as a pump.

The mechanical seal unit 6 forms an equipment body unit of the practical training equipment 2, and is an example of a shaft seal mechanism unit for the shaft 4. In the mechanical seal unit 6, a seal ring 8, a casing 10 and a seat ring 12 are provided.

5 The seal ring 8 includes a first slide face 14-1, and is fixed to the reference position of the shaft 4 as a fixed ring. The slide face of the first slide face 14-1 is arranged in a direction orthogonal to an axial center O of the shaft 4. The seal ring 8 is covered on the side of a stuffing box 10-1 as the first casing
10 part of the casing 10.

[0021]

On the side of the first slide face 14-1 of the seal ring 8, the seat ring 12 which is a movable ring is provided. The seat ring 12 includes a second slide face 14-2 which is brought into contact
15 with the first slide face 14-1, and is fitted to the shaft 4. The inside diameter of a through hole 16 of the seat ring 12 is set larger than the outside diameter of the shaft 4. As with the slide face 14-1, the slide face 14-2 is arranged in the direction orthogonal to the axial center O of the shaft 4, and is parallel
20 to the slide face 14-1.

[0022]

The seat ring 12 is fixed to an end plate 10-2 as a second casing part which is combined with the stuffing box 10-1. Two O-rings 18 are attached to the seat ring 12 in a width direction
25 so as to seal the seat ring 12 and the end plate 10-2. The end plate 10-2 is fixed to the stuffing box 10-1 by a plurality of bolts 20, and the combined stuffing boxes 10-1 and 10-2 form one casing 10. In the end plate 10-2, as a seal member including a third slide face 14-3 which is brought into contact with the circumferential
30 surface of the shaft 4, a bush 21 is integrally provided. That is, by combining the stuffing box 10-1 and the end plate 10-2, the seat ring 12 is restrained to the side of the end plate 10-2, and a space 22 which is sealed by the slide faces 14-1, 14-2 and 14-3 is formed.

[0023]

In this embodiment, a flange 24 is provided in the stuffing box 10-1, and the flange 24 is fixed to a base member 26 by a plurality of bolts 28. Thus, the mechanical seal unit 6 is fixed to the base member 26.

5 [0024]

<Handle Fitting Part>

As shown in Fig. 1B, a handle fitting part 30 is provided on the termination part of the shaft 4, and a handle unit 32 can be inserted/removed into/from the handle fitting part 30. In the
10 handle fitting part 30, a prismatic part 34 which is formed to be thinner than the shaft 4 is provided, and a mating part 36 which is mated to the prismatic part 34 is provided in a crank shaft 38 which is arranged in a direction intersecting the prismatic part 34. An operation part 40 is provided in parallel to the shaft 4
15 in the crank shaft 38.

At the time of handling practical training, by fitting the handle unit 32 to the shaft 4, and applying torque in the circumferential direction of the shaft 4 by the operation part 40 to the shaft 4, the shaft 4 can be rotated by a manual operation.

20 [0025]

<Handling Practical Training>

By using the mechanical seal unit 6 described above, the handling practical training of the mechanical seal includes

- A) a step of preparing attachment of the seal ring 8,
- 25 B) a step of positioning the seal ring 8,
- C) a step of attaching the seat ring 12,
- D) a step of fixing the casing 10, and
- E) a step of rotating the shaft 4.

[0026]

- 30 A) Step of preparing attachment of the seal ring 8

After the stuffing box 10-1 to the shaft 4 is attached an indication line indicating the reference position of the seal ring 8 is provided on the shaft 4 with reference to the stuffing box 10-1.

B) Step of positioning the seal ring 8

The seal ring 8 is fitted to the shaft 4 so as to position the seal ring 8 in the reference position described above.

C) Step of attaching the seat ring 12

5 For the attachment of the seat ring 12, a preparation is made by combining the seat ring 12 with the end plate 10-2. The seat ring 12 combined with the end plate 10-2 is fitted to the shaft 4 together with the end plate 10-2.

D) Step of fixing the casing 10

10 The end plate 10-2 is fixed to the stuffing box 10-1 with the bolts 20, the stuffing box 10-1 and the end plate 10-2 are combined together so as to assemble as one casing 10.

E) Step of rotating the shaft 4

15 By rotating the shaft 4, the seal ring 8 integral with the shaft 4 is rotated. Thus, the seal ring 8 and the seat ring 12 can be rotated relative to each other on the slide faces 14-1 and 14-2.

By fitting the handle unit 32 to the shaft 4 and rotating the shaft 4 with the handle unit 32, the seal ring 8 integral with the shaft 4 is rotated. Thus, the seal ring 8 and the seat ring 12 can
20 be rotated relative to each other on the slide faces 14-1 and 14-2.
[0027]

<Effects of First Embodiment>

(1) By experiencing operations such as assembly, disassembly, cleaning and position adjustment of the mechanical seal unit 6
25 installed in a rotation device such as a pump, sliding caused by relative rotation of the slide faces 14-1 and 14-2 of the mechanical seal unit 6 and the like, it is possible to enhance skills for the handling of the mechanical seal.

(2) The shaft 4 can be rotated by the manual operation before
30 the handle unit 32 is fitted, and a trainee can thereby be made to perceive the feeling of torque, the feeling of sliding and the feeling of rotation by the operation of the shaft 4.

(3) By fitting the handle unit 32 to the shaft 4, it is possible to obtain a feeling which cannot be obtained with actual equipment

such as comparison of the states before and after the fitting of the handle unit 32, it is thereby possible to provide beneficial handling practical training.

(4) Unlike the actual equipment, the practical training of assembly, disassembly, cleaning, position adjustment and the like can be repeated in the practical training equipment 2, and the practical training of operation functions which cannot be experienced with the actual equipment can thereby be provided.

[0028]

[Second embodiment]

Fig. 2 shows a shaft support unit of mechanical seal handling practical training equipment according to a second embodiment.

A shaft support unit 42 is provided on the lower side of a stuffing box 10-1 in a mechanical seal unit 6. In the shaft support unit 42, base members 26-1 and 26-2 are provided which include a plurality of pole braces 44 and which are arranged in parallel to each other. A plurality of fixation screws 48 are used to fix a first bearing 46-1 to an upper surface of the base member 26-1 and a second bearing 46-2 to the lower surface of the base member 26-2.

The shaft 4 is inserted through the respective bearings 46-1 and 46-2, the first bearing 46-1 supports an end part side of the shaft 4, and the second bearing 46-2 supports an intermediate part of the shaft 4.

In the respective bearings 46-1 and 46-2, guide parts 50 for guiding the shaft 4 are provided, and in order to fix the shaft 4, fixation screws 52 are provided on the side of the bearings 46-1 and 46-2, and fixation screws 54 are provided in the guide parts 50. Although play is provided between the respective bearings 46-1 and 46-2 and the shaft 4, the shaft 4 can be fixed to the respective bearings 46-1 and 46-2 by tightening the fixation screws 52 and 54.

[0029]

With the shaft support unit 42, by loosening the fixation screws 52 and 54 so as to form play between the bearings 46-1 and

46-2 and the shaft 4, the axial center O of the shaft 4 can be arbitrarily shifted to an axial center O_m , and runout can be forcibly generated in the shaft 4.

The axial runout of the shaft 4 and the play can be measured by fixing measuring equipment such as a dial gauge to the stuffing box 10-1. The levelness of the stuffing box 10-1 and an angle formed between the stuffing box 10-1 and the shaft 4 can likewise be measured.

[0030]

10 <Effects of Second Embodiment>

(1) A relative positional relationship between the shaft 4 supported by the bearings 46-1 and 46-2 attached to the base members 26-1 and 26-2 and the bearings 46-1 and 46-2 can be arbitrarily adjusted, and thus the runout of the shaft 4 can be forcibly generated or a desired runout can be set. A trainee is made to feel this runout, and the amount of runout can be measured with the measuring equipment.

(2) The base members 26-1 and 26-2 are supported by the plurality of pole braces 44, and the shaft 4 and the bearings 46-1 and 46-2 can thereby be visually checked from between the pole braces 44.

(3) The inclination and the runout of the shaft 4 which are forcibly generated or set in the shaft 4 are visually checked from between the pole braces 44 and can be touched, a desired runout can be set by operating the fixation screws 52 and 54 and adjustment to eliminate the runout can be made.

Example 1

[0031]

Figs. 3 to 8 show the configuration of practical training equipment 2 according to Example 1 and each part thereof. Although the practical training equipment 2 simulates a mechanical seal and a seal mechanism which are installed in the rotation device of the actual equipment, the practical training equipment 2 is not limited to the details of known actual equipment. In the practical training

equipment 2 according to this Example 1, as shown in Fig. 3A, a shaft support unit 42 and a mechanical seal unit 6 are installed on a stand unit 56. A bottom frame 58 and a top board 60 are provided in the stand unit 56, and the top board 60 is supported by a plurality of pole braces 62 to the bottom frame 58. The pole braces 62 may be formed of, for example, an angle member. The base member 26-1 of the shaft support unit 42 is fixed to the top board 60 by a plurality of bolts 64 so as to be kept horizontal. The bottom frame 58 is fixed to a floor surface 66 of a training room by anchor bolts or the like.

As shown in Fig. 3B, if a plurality of casters 68 are provided in the stand unit 56, the practical training equipment 2 can be moved to a desired position or can be transported outside of the training room.

[0032]

<Shaft 4>

Figs. 4A and 4B show an example of a shaft 4. In the shaft 4, a handle fitting part 30, a mechanical seal fitting part 70 and a rotary support part 72 are provided from an upper end toward a lower end. As shown in Fig. 4A, the handle fitting part 30 is formed in a prismatic shape so as to engage with the mating part 36 of a handle unit 32. In the handle fitting part 30, a support hole 74 for supporting another member is formed. The mechanical seal fitting part 70 and the rotary support part 72 are formed in a cylindrical shape, and the mechanical seal fitting part 70 is larger in diameter than the rotary support part 72. The rotary support part 72 is fixed to the bearings 46-1 and 46-2 of a shaft support unit 42.

[0033]

<Seal Ring 8 of Mechanical Seal Unit 6>

As shown in Fig. 5A, a seal ring body part 8-1 which includes a first slide face 14-1, an intermediate ring part 8-2 and a support ring part 8-3 are provided in a seal ring 8.

The seal ring body part 8-1 is formed in the shape of a cup,

and a through hole 76, a shaft packing installation part 78 and a plurality of windows 80 are provided at predetermined intervals. The shaft 4 penetrates the through hole 76, shaft packings 82-1 and 82-2 are combined with the shaft packing installation part 78 so as to be installed and part of the intermediate ring part 8-2 is inserted therein.

The intermediate ring part 8-2 is referred to as a comp ring, and is installed between the seal ring body part 8-1 and the support ring part 8-3. In the intermediate ring part 8-2, the shaft 4 penetrates a through hole 84, and a plurality of guide pin threaded holes 86, drive pin threaded holes 88 and spring insertion parts 90 are provided on the side of a side wall. Respective guide pins 92 are attached to the guide pin threaded holes 86, and are exposed from the respective windows 80 of the seal ring body part 8-1. Drive pins 94 serving as fixing means which are fitted to the support ring part 8-3 are attached to the respective drive pin threaded holes 88. Tip end parts of springs 96 are inserted into the respective spring insertion parts 90.

The support ring part 8-3 is a support member which supports the seal ring body part 8-1 with the intermediate ring part 8-2 interposed therebetween, and is fixed to the reference position of the shaft 4. In the seal ring body part 8-1, the shaft 4 penetrates a through hole 98, and a plurality of drive pin fitting parts 100 and spring insertion parts 102 are provided on the side of a side wall. The drive pins 94 are fitted to the drive pin fitting parts 100, and threaded parts 103 which are protruded from the drive pin fitting parts 100 are attached to the drive pin threaded holes 88 in the intermediate ring part 8-2. The other end parts of the springs 96 are inserted into the respective spring insertion parts 102, and the respective springs 96 are held in a compressed state within the two spring insertion parts 90 and 102 according to the tightening of the drive pins 94. By the resilience of the respective springs 96 and the degree of tightening of the drive pins 94, the widths of the support ring part 8-3 and the seal ring body part

8-1 in an axial direction are adjusted.

As shown in Fig. 5B, a set bolt threaded hole 104 is provided in the support ring part 8-3, and a set bolt 106 is attached to the set bolt threaded hole 104. The set bolt 106 is a fixing means
 5 for the support ring part 8-3 which sets and fixes the support ring part 8-3 to the reference position of the shaft 4. The seal ring body part 8-1 coupled to the support ring part 8-3 is fixed with the set bolt 106 to the reference position of the shaft 4 together with the support ring part 8-3. The attachment position of the set
 10 bolt 106 is set to an angular position which is different from the drive pin fitting parts 100 and the spring insertion parts 102.
 [0034]

<Mechanical Seal Unit 6>

Fig. 6 shows a cross section of a seat ring 12 which is installed
 15 to the shaft 4 together with the seal ring 8. The inside diameter of the through hole 16 of the seat ring 12 is larger than the outside diameter of the shaft 4, and a clearance 108 is set between the through hole 16 and the shaft 4. A small-diameter annular part 110 is provided in the seal ring side surface part of the seat ring
 20 12, and an end face of the small-diameter annular part 110 is a second slide face 14-2. The outside diameter and the width of the small-diameter annular part 110 are smaller than the slide face 14-1 of the seal ring 8, and the contact area of the slide face 14-2 and the slide face 14-1 thereby depends on the slide face 14-2.
 25 In the seat ring 12, two O-ring installation parts 112 are provided in the width direction so as to install O-rings 18, and the seal ring 12 is brought into a close contact state within an end plate 10-2 by the O-rings 18.
 [0035]

30 <Stuffing Box 10-1>

Fig. 7A shows the planar shape of a stuffing box 10-1, Fig. 7B shows a cross section taken along line VIIB-VIIB of Fig. 7A and Fig. 7C shows a cross section taken along line VIIC-VIIC of Fig. 7A. The stuffing box 10-1 includes a through hole 114 in the center

thereof, and a mating protrusion 116, an engagement protrusion 118 on the side of a flange 24 and a first port 122-1 on the side of a side wall 120 are provided. The seal ring 8 is installed in the through hole 114 together with the shaft 4. The mating protrusion 116 is combined with the end plate 10-2. The engagement protrusion 118 is engaged with the side of the base member 26 (Fig. 1). The port 122-1 communicates with the through hole 114, and communicates with the circumference of the seal ring 8 within the through hole 114 and the circumferential space of the small-diameter annular part 110 in the seat ring 12. A plurality of bolt insertion through holes 124 through which bolts 28 are passed are provided in the flange part 24. As shown in Fig. 7C, a plurality of threaded holes 126 are provided in the apex part of the side wall 120, and bolts 20 which are passed through the end plate 10-2 are attached to the respective threaded holes 126.

[0036]

<End Plate 10-2>

Fig. 8A shows the planar shape of the end plate 10-2, Fig. 8B shows a cross section taken along line VIIIB-VIIIB of Fig. 8A and Fig. 8C shows a cross section taken along line VIIIC-VIIIC of Fig. 8C. The end plate 10-2 is a cylindrical member which has an outer circumferential surface that is constant in its diameter, and a through hole 128, bolt insertion through holes 129, spaces 130 and 131, a seat ring fitting part 132 and a mating recess 134 are provided. The through hole 128 is defined by the slide face 14-3 of a bush 21. The bush 21 may be formed of a material which is the same as or different from that of the end plate 10-2, and is formed of, for example, carbon. The bolt insertion through holes 129 are used to fit the bolts 20. The seat ring fitting part 132 is an example of a space for fitting the seat ring 12.

A plurality of second ports 122-2 and 122-3 are provided in the end plate 10-2. The port 122-2 communicates with the space 131 and the seat ring fitting part 132, and the port 122-3 communicates with the space 130. The mating protrusion 116 of the stuffing box

10-1 is mated to the mating recess 134, and the stuffing box 10-1 and the end plate 10-2 are combined together by this mating.

[0037]

<Effects of Example 1>

5 According to Example 1, the following effects can be obtained.

(1) The same configuration as the actual equipment is provided, the handle unit 32 and the shaft support unit 42 are provided such that the practical training equipment 2 is formed and the practical training equipment 2 can be used for the handling practical training of the mechanical seal by installing the practical training equipment 2 on the stand unit 56.

(2) By using the handle unit 32 and the shaft support unit 42, it is possible to realize the experience of handling of the mechanical seal beyond the actual equipment.

15 Example 2

[0038]

In this Example 2, a mechanical seal handling practical training process will be described using the practical training equipment 2. In the handling practical training process, a mechanical seal which is installed in a rotation device such as a pump (for example, a vertical pump 200 shown in Fig. 25) is assumed and the practical training equipment 2 is used to make a trainee master skills for removal, attachment and the like to enhance skills for the handling of the mechanical seal. The mechanical seal handling practical training process includes: a) abnormality check step, b) washing step, c) attachment step, d) operation check step, e) removal step, a) error mode step and the like.

[0039]

a) Abnormality check step

30 For constituent components obtained from the practical training equipment 2 or the actual equipment, a trainee is made to check abnormal examples and coping methods. Here, as abnormal examples, members in which rust, corrosion, erosion, scratches, dents and the like occur are referenced, and, for example, a scratch

in the stuffing box 10-1 is checked. The degrees of rust, corrosion, erosion, scratches, dents and the like are checked, so that the trainee thoroughly understands repairability and the necessity for replacement.

5 [0040]

b) Washing step

Washing is performed on respective members such as the shaft 4, the stuffing box 10-1, the end plate 10-2 and the mechanical seal unit 6. For slight abnormalities, coping methods are checked.

10 With respect to the shaft 4, the stuffing box 10-1 and the end plate 10-2, for washing grooves and steps, cloth from which fibers do not come off, sandpaper or a sponge is used. Necessary washing agents and abrasive agents are checked. Fine scratches, small rust and the like may be polished with sandpaper, a sponge abrasive agent
15 or the like. Changes before and after the washing and the degrees of the washing are checked.

Fine scratches and small dents in the slide face 14-1 are checked in the seal ring 8 to confirm whether or not the slide face 14-1 can be used. A visual check, a touch and the like are included
20 as confirmation factors. Upon confirming a state where it is not possible to use the member, the replacement thereof is encouraged. If it is possible to use the member, washing is performed by using cloth from which fibers do not come off. After an abnormality is confirmed in the slide face 14-2 of the seat ring 12, if the function
25 can be restored by washing, washing is performed by using cloth from which fibers do not come off.

[0041]

c) Attachment step

In the attachment step, attachment components are checked,
30 attachment procedures and precautions are checked and the accuracy of fitting of each part is checked. The check items include the form of the mechanical seal, the number of seal components, a seal size, presence/absence of an appearance abnormality in the seal ring 8 and the seat ring 12 and the like. The appearance abnormality

includes scratches, chips, dents and the like. Precautions for attachment are checked. As the precautions, for example, prevention of making the slide faces 14-1 and 14-2 which are seal faces brought into contact with other members and prevention of
5 installation on the floor are checked. It is a matter of course to prevent scratches from occurring in the slide faces 14-1 and 14-2 in attachment, and packing material and the like are utilized so as to protect the slide faces 14-1 and 14-2.

The attachment step includes: c-1) scribing step, c-2) measurement step, c-3) step of fixing the seal ring 8, c-4) step of fitting the casing 10 and c-5) step of tightening the bolts 20.
[0042]

c-1) Scribing step

As shown in Fig. 9A, a straightedge 135 is applied to the
15 stuffing box 10-1 and the shaft 4 respectively installed on and fitted to the base member 26, and a scribing line 136 is indicated on the shaft 4 along the reference surface of the straightedge 135. To indicate the scribing line 136, tools of writing 138 may be used. Thus, as shown in Fig. 9B, the scribing line 136 is indicated on
20 the mechanical seal fitting part 70 of the shaft 4.
[0043]

c-2) Measurement step

As shown in Fig. 9C, in order to identify the position where the seal ring 8 is to be fixed, measurement equipment 140 such as
25 a vernier caliper is used to measure a distance between the scribing line 136 and an end part of the seal ring 8.
[0044]

c-3) Step of fixing the seal ring 8

As shown in Fig. 10A, in the fixing of the seal ring 8, the
30 shaft packings 82-1 and 82-2 are installed on the side of the scribing line 136 before the installation of the seal ring body part 8-1, and thereafter the seal ring body part 8-1 is fixed. As shown in Fig. 10B, the set bolt 106 attached to the support ring part 8-3 is tightened by use of, for example, a wrench as a tightening

tool 142. Thus, the seal ring 8 is fixed to the reference position of the shaft 4, and the slide face 14-1 is set on the shaft 4. [0045]

c-4) Step of fitting the casing 10

5 As shown in Fig. 11A, the stuffing box 10-1 which surrounds the seal ring 8 is installed on the shaft 4, and thereafter the end plate 10-2 to which the seat ring 12 is fitted is fitted thereto. Consequently, as shown in Fig. 11B, the end plate 10-2 is installed on an upper side of the stuffing box 10-1, and a distance 144 is provided between the stuffing box 10-1 and the end plate 10-2. 10 Whether or not the distance 144 is provided is checked. It may be checked that the distance 144 is provided by the action of the resilience of the springs 96 on the side of the seal ring 8.

In this state, as shown in Fig. 11C, the bolts 20 are inserted 15 into the bolt insertion through holes 129 on the side of the end plate 10-2 and are tightened manually and temporarily and the stuffing box 10-1 and the end plate 10-2 are engaged with each other. [0046]

c-5) Step of tightening the bolts 20

20 As shown in Fig. 12A, in the step of tightening the bolts 20, the respective bolts 20 are tightened a plurality of times with a tightening tool 146. The distance 144 when the bolts 20 are manually tightened is narrowed from about a few millimeters to near a close contact state, and the stuffing box 10-1 and the end plate 25 10-2 are combined with each other. In this case, by the mating of the mating recess 134 and the mating protrusion 116, the stuffing box 10-1 and the end plate 10-2 are combined with each other.

As shown in Fig. 12B, for example, the bolts 20 are diagonally tightened about ten times such that the distances 144 are uniform 30 at each part while visually checking. Although with respect to the tightening order, as shown in Fig. 12B, the bolts 20 in opposite directions may be tightened in order, when the distances 144 are finely adjusted so as to be uniform, the tightening order may be changed to a tightening order in a circumferential direction. In

any case, a trainee is made to master tightening the bolts 20 so as to avoid uneven tightening between the respective bolts 20.

[0047]

d) Operation check step

5 In the operation check step, after the completion of the assembly of the mechanical seal unit 6, as shown in Fig. 13, the handle unit 32 is fitted to the handle fitting part 30, and a trainee grips the handle unit 32 and performs a rotation operation three to four times. The trainee is made to perceive the feeling of torque and vibrations transmitted from the handle unit 32, and, in a case
10 where abnormal torque occurs, the components are replaced and reattachment is performed.

[0048]

e) Removal step

15 The removal step may be performed by procedures reverse to the attachment step. Then, steps from the attachment step to the operation check step are performed.

[0049]

f) Error mode step

20 In the error mode step, as shown in Fig. 14, powdery foreign matter 148 and/or water are applied to an upper surface of the slide face 14-1 of the seal ring 8, and thereafter the mechanical seal unit 6 is assembled as in the assembly step described above. In a state where the foreign matter 148 is entered, as shown in Fig.
25 13 described above, the handle unit 32 is operated, and the shaft 4 is rotated. That is, a trainee is made to rotate the shaft 4 in a state where the foreign matter 148 is caught between the slide faces 14-1 and 14-2, and thereafter the trainee is made to check how the slide faces 14-1 and 14-2 are affected.

30 [0050]

<Effects of Example 2>

According to this Example 2, the following effects can be obtained.

(1) The abnormality which occurs in the actual equipment can

be realized with the practical training equipment 2.

(2) A trainee can be practically trained for a series of steps such as abnormality check, washing, attachment, operation check and removal by use of a single piece of practical training equipment 2 or a plurality of pieces of practical training equipment 2, the respective items can further be repeated as necessary, an abnormal state which cannot be realized by the actual equipment is induced and can be realized as the error mode step, and highly reliable handling practical training can be realized while securing safety.

10 Example 3

[0051]

The attachment step described above includes, as accuracy checks of the mechanical seal fitting part 70, g) step of measuring the lateral runout of the shaft 4, h) step of measuring the squareness of the stuffing box 10-1, i) step of measuring the concentricity of the stuffing box 10-1, j) step of checking the play in the axial direction of the shaft 4 and the like.

[0052]

g) Step of measuring the lateral runout of the shaft 4

20 In the step of measuring the lateral runout of the shaft 4, as shown in Fig. 15A, as an example of a lateral runout measuring means, a dial gauge 150 is supported by the stuffing box 10-1 via a support arm 152, and a contactor 154 of the dial gauge 150 is brought into contact with the wall surface of the shaft 4 exposed from the stuffing box 10-1 and is maintained. When the shaft 4 is rotated, the lateral runout and the eccentricity of the shaft 4 indicating the state of eccentricity of its rotation diameter d1 can be measured with the dial gauge 150. It is possible to check, from the measurement values thereof, presence/absence of eccentricity of the shaft 4 and presence/absence of a lateral runout of the shaft 4.

For example, when the rotation diameter of the shaft 4 is assumed to be d1, the allowable range of the lateral runout may be set as follows.

[Formula 1]

$$\text{Lateral runout} < \sqrt{d1} / 120 \text{ [mm]} \dots (1)$$

In this lateral runout measurement, as shown in Fig. 15B, the dial gauge 150 may be supported by the stuffing box 10-1 via a support member 156 instead of the support arm 152, and the contactor 154 thereof may be brought into contact with the wall surface of the shaft 4.

[0053]

h) Step of measuring the squareness of the stuffing box 10-1

In the step of measuring the squareness of the stuffing box 10-1, as shown in Fig. 16A, as an example of a squareness measuring means, the dial gauge 150 is supported by the shaft 4 via the support arm 152, and the contactor 154 of the dial gauge 150 is brought into contact with an upper surface of the stuffing box 10-1 and is maintained. When the shaft 4 is rotated in this state, the lateral runout and the eccentricity of the shaft 4 indicating the state of eccentricity of its rotation diameter d1 can be measured with the dial gauge 150. It is possible to check, from the measurement values thereof, presence/absence of eccentricity of the shaft 4 and presence/absence of a lateral runout of the shaft 4. In this case, the allowable range of the squareness may be set in advance to determine whether or not the squareness falls within the allowable range.

In the squareness measurement, as shown in Fig. 16B, the dial gauge 150 may be supported by the shaft 4 via the support member 156 instead of the support arm 152, and the contactor 154 thereof may be brought into contact with the upper surface of the stuffing box 10-1.

[0054]

i) Step of measuring the concentricity of the stuffing box 10-1

In the step of measuring the concentricity of the stuffing box 10-1, as shown in Fig. 17A, the dial gauge 150 is supported by the shaft 4 via the support arm 152, the contactor 154 is brought

into contact with an inner wall surface of the stuffing box 10-1 and the shaft 4 is rotated. As the shaft 4 is rotated, the measurement is performed by making the contactor 154 slide on the inner wall surface of the stuffing box 10-1. Likewise, the measurement is performed by making the contactor 154 of the dial gauge 150 slide on an outer wall surface of the stuffing box 10-1. The concentricity of the stuffing box 10-1 can be measured by comparing the respective measurement values with each other at the same position

In the concentricity measurement, as shown in Fig. 17B, a dial gauge 150-1 is held by a support member 156-1, and a dial gauge 150-2 is likewise held by a support member 156-2, and the concentricity of the inner and outer surfaces of the stuffing box 10-1 may be measured with the respective dial gauges 150-1 and 150-2. In this case, for the allowable range of the concentricity, reference to the formula (1) may be made.

[0055]

j) Step of checking the play in the axial direction of the shaft 4

In the step of checking the play in the axial direction of the shaft 4, as shown in Fig. 18A, the dial gauge 150 is supported by, for example, the handle fitting part 30 for the shaft 4 via the support arm 152, the contactor 154 of the dial gauge 150 is brought into contact with the upper surface of the stuffing box 10-1 and the shaft 4 is rotated. It is possible to measure play in the axial direction of the shaft 4 with the dial gauge 150. The play in the axial direction may be equal to or less than, for example, 0.5 [mm].

In this case, as shown in Fig. 18B, the dial gauge 150 is supported by the wall surface of the shaft 4 via the support member 156, the contactor 154 is brought into contact with the upper surface of the stuffing box 10-1, the shaft 4 is rotated, and thus it is possible to check play indicated by an arrow m.

[0056]

<Effects of Example 3>

According to Example 3, the following effects can be obtained.

(1) Sites which are difficult to measure with the actual equipment can be realized with the practical training equipment 2, and extremely important items such as axial runout can be checked with the measurement values.

(2) In these measurement steps, a trainee can be swiftly and accurately trained for places where the dial gauge and the like are installed, how to apply the contactor and the like, and this can contribute to the enhancement of the skills of the trainee.

Example 4

[0057]

Fig. 19 shows a leakage check step of the mechanical seal unit 6 according to Example 4. By connecting a pressurized fluid source to the casing 10 from the port 122-1, making a pressurized fluid 158 flow in and connecting pieces of measuring equipment 160-1 and 160-2 for detecting fluid leakage to the ports 122-2 and 122-3, it is possible to detect the outflow or the pressure of the pressurized fluid 158 from the mechanical seal unit 6, specifically, it is possible to measure the leakage amount of the leakage. In this case, by blocking either the port 122-2 or the port 122-3, making the pressurized fluid 158 flow in from an open side and connecting the pieces of measuring equipment 160 to the ports 122, the leakage thereof and the amount of leakage may be measured.

Example 5

[0058]

Fig. 20 shows the shaft 4 and the stuffing box 10-1 according to Example 5. A large-diameter part 164 which includes a step 162 may be provided in the shaft 4. In this case, a step 166 which corresponds to the position of the step 162 may be provided in the stuffing box 10-1.

In the configuration described above, the reference position of the mechanical seal unit 6 with respect to the shaft 4 can be easily identified, and the same function as that of the scribing

line 136 described above can be achieved with the step 162 or the large-diameter part 164.

Example 6

[0059]

5 Fig. 21 shows mechanical seal handling practical training equipment which includes a casing 10 according to Example 6. Although in the embodiments and the examples described above, for example, stainless steel material is used for the casing 10, the casing 10 is opaque with such a metal material, and it is impossible
10 to visually check the interior thereof.

 In this Example 6, the casing 10 is formed of a transparent synthetic resin or a translucent material such as glass through which the interior can be visually recognized. By forming the casing 10 with such a translucent material, the interior of the
15 casing 10 can be checked during the operation.

 Although in this Example, the entire casing 10 is formed of a translucent material, part of either or both of the stuffing box 10-1 and the end plate 10-2 may be formed of a translucent material, and, for example, from a window formed of the translucent material,
20 the interior of the casing 10 can be visually recognized.

Example 7

[0060]

 Fig. 22 shows a mechanical seal handling practical training system according to Example 7. A handling practical training
25 system 170 includes a mechanical seal unit 6, an information processing unit 172 and an information presentation unit 174.

 In the mechanical seal unit 6, a sensor unit 176 is provided, and the sensor unit 176 includes, as a plurality of sensors, sensors 176-1, 176-2, 176-3, 176-4,

30 The sensor 176-1 is, for example, a pressure sensor which detects a pressurized state between the slide faces 14-1 and 14-2 of the seal ring 8 and the seat ring 12. The sensor 176-2 is, for example, an axial runout sensor which detects runout of the shaft 4. The sensor 176-3 is, for example, a vibration sensor or a

microphone which detects vibration or sound which is generated by the rotation of the shaft 4. The sensor 176-4 is, for example, a torque sensor which detects torque which is applied to the shaft 4.

5 [0061]

The information processing unit 172 includes a data collection unit 178, a control unit 180 and a memory unit 182. The data collection unit 178 is controlled by the control unit 180, and the sensor outputs of the respective sensors 176-1, 176-2, 176-3, 176-4,
10 ... in the sensor unit 176 are received by the control unit 180.

The control unit 180 is formed with a personal computer or the like which is an example of a processing unit, and includes a processor and the like so as to perform data processing on sensor signals from the sensor unit 176, for example, a processing function
15 of converting at least the sensor signals into image information.

The memory unit 182 includes a storage means such as a ROM (Read-Only Memory), a RAM (Random-Access Memory) and an EEPROM (Electrically Erasable Programmable Read-Only Memory). Various types of information such as an OS (Operating System), practical
20 training control programs and a handling practical training method are stored in the ROM. The RAM forms an information processing area.

The information presentation unit 174 is controlled by the control unit 180 and can present various types of information such as the results of respective detections of the respective sensors
25 176-1, 176-2, 176-3, 176-4, ... in the sensor unit 176, the results of computation processing and the results of determinations.

The sensor unit 176, the information processing unit 172 and the data collection unit 178 may have a wireless communication function so as to exchange data wirelessly or a trainee may input
30 data with an operation terminal. The communication function of the information processing unit 172 may be utilized so as to transmit the results and evaluations of the practical training to a portable terminal of the trainee.

[0062]

<Effects of Example 7>

According to Example 7, the following effects can be obtained.

(1) The training steps can be automated.

(2) The results of the processing and the results of the
5 performance can be presented as the image information.

(3) The transition of the results of the evaluations can be
tracked by information processing, and efficient handling practical
training can thereby be provided.

Example 8

10 [0063]

Fig. 23A shows a seal ring 8 according to Example 8. As an
example of a slide member which includes the slide face 14-1 of
the seal ring 8, a slide face layer 184 formed of a wearing material
which is lower in hardness than the actual seal ring body part may
15 be installed on the seal ring body part 8-1.

Fig. 23B shows a seat ring 12 according to Example 8. As an
example of a slide member which includes the slide face 14-2 of
the seat ring 12, a slide face layer 186 formed of a wearing material
which is lower in hardness than the actual seat ring may be installed
20 on the small-diameter annular part 110.

[0064]

<Effects of Example 8>

According to this Example 8, the following effects can be
obtained.

25 (1) The slide face layers 184 and 186 are different from those
of the actual equipment, the progress of wear is remarkable, and
thus a trainee can check the state of wear and can easily check
changes in the surface properties of the slide faces 14-1 and 14-2.

(2) With respect to measures corresponding to these changes
30 in the surface properties, when practical training is provided,
the same handling training as in the actual equipment can be provided
so as to enhance the skills of handling personnel.

Example 9

[0065]

Fig. 24A shows part of the side of the slide face 14-2 of the seat ring 12 according to Example 9. In this Example, as a constituent member of the small-diameter annular part 110, an indication layer 188 serving as an indication material for indicating the state of wear is embedded. In this Example, as an example, the indication layer 188 is annular, and its cross section is formed in a trapezoidal shape. That is, the short side of the trapezoidal shape is set to the side of the end face of the small-diameter annular part 110, and the state of wear progresses to the long side by wear.

In this configuration, as shown in Fig. 24B, when the exposure width of the indication layer 188 before use or in use is assumed to be W_1 , as the wear progresses, for example, in the state of wear M, the exposure width W_1 of the indication layer 188 is increased to W_x . This ratio of increase can be easily and visually recognized by a trainee.

Although in this Example 9, disclosure is made with regard to the seat ring 12, the same configuration may be applied to a constituent member of the slide face 14-1 of the seal ring 8.

[0066]

<Effects of Example 9>

According to this Example 9, the following effects can be obtained.

(1) Although it is not easy to visually recognize the surface properties such as unevenness, scratches and wear, it is possible to quantitatively grasp the state of wear, the use time and the like from the size and change of the exposure width W appearing in the indication layer 188 described above.

(2) The arrival of the replacement time of the seat ring 12 and the seal ring 8 can be checked according to the size of the exposure width W of the indication layer 188 so as to enhance the reliability and economy of the mechanical seal unit 6.

[0067]

[Other Embodiments]

(1) Although in the embodiments and the examples described above, the mechanical seal unit 6 shown in the figure is illustrated, the present invention is not limited to the configurations described above. As the mechanical seal unit 6, there are several types of forms such as a balanced type and an unbalanced type, and the practical training equipment of the present invention can be applied to these forms, and the skills of a trainee can be enhanced.

(2) Although Example 9 is described as an example of the practical training equipment 2, not only to the practical training equipment 2, it can be widely applied to mechanical seals, and it is not limited to the practical training equipment 2 of the Example described above.

Although as discussed above, the most preferred embodiments of the present invention and the like have been described, the present invention is not limited to the description above, it is a matter of course that based on the gist of the invention described in the scope of claims or disclosed in the description of embodiments, a person skilled in the art can make various variations and modifications, and it is needless to say that such variations and modification are included in the scope of the present invention.

Industrial Applicability

[0068]

The present invention is applied to, for example, handling practical training of a mechanical seal used in a rotation device such as a pump or an agitator, engineers involved in handling of a mechanical seal including a handling trainee and the like can be made to acquire handling techniques such as attachment, removal, replacement, cleaning and maintenance of members related to the mechanical seal, and the present invention contributes to the realization of a seal mechanism which is safe and highly reliable.

Reference Signs List

[0069]

	2: mechanical seal handling practical training equipment
	4: shaft
5	6: mechanical seal unit
	8: seal ring
	10: casing
	10-1: first casing part
	10-2: second casing part
10	12: seat ring
	14-1: first slide face
	14-2: second slide face
	14-3: third slide face
	16: through hole
15	18: O-ring
	20: bolt
	22: space
	24: flange
	26, 26-1, 26-2: base member
20	28: bolt
	30: handle fitting part
	32: handle unit
	34: prismatic part
	36: mating part
25	38: crank shaft
	40: operation part
	42: shaft support unit
	44: pole brace
	46-1: first bearing
30	46-2: second bearing
	48: fixation screw
	50: guide part
	52: fixation screw
	54: fixation screw

	56: stand unit
	58: bottom frame
	60: top board
	62: pole brace
5	64: bolt
	66: floor surface
	68: caster
	70: mechanical seal fitting part
	72: rotary support part
10	74: support hole
	76: through hole
	78: shaft packing installation part
	80: window
	82-1, 82-2: shaft packing
15	84: through hole
	86: guide pin threaded hole
	88: drive pin threaded hole
	90: spring insertion part
	92: guide pin
20	94: drive pin
	96: spring
	98: through hole
	100: drive pin fitting part
	102: spring insertion part
25	103: threaded part
	104: set bolt threaded hole
	106: set bolt
	108: clearance
	110: small-diameter annular part
30	112: O-ring installation part
	114: through hole
	116: mating protrusion
	118: engagement protrusion
	120: side wall

	122-1: first port
	122-2: second port
	122-3: second port
	124: bolt insertion through hole
5	126: threaded hole
	128: through hole
	129: bolt insertion through hole
	130, 131: space
	132: seat ring fitting part
10	134: mating recess
	135: straightedge
	136: scribing line
	138: tools of writing
	140: measurement equipment
15	142, 146: tightening tool
	144: distance
	148: foreign matter
	150, 150-1, 150-2: dial gauge
	152: support arm
20	154: contactor
	156, 156-1, 156-2: support member
	158: pressurized fluid
	160-1, 160-2: measuring equipment
	162: step
25	164: large-diameter part
	170: handling practical training system
	172: information processing unit
	174: information presentation unit
	176: sensor unit
30	176-1, 176-2, 176-3, 176-4: sensor
	178: data collection unit
	180: control unit
	182: memory unit
	184, 186: slide face layer

188: indication layer
200: vertical pump
202: pump body
204: seal mechanism unit
5 206: motor
208: casing

CLAIMS

[Claim 1]

Mechanical seal handling practical training equipment comprising:

5 a shaft which can be rotated;

 a seal ring which is fixed to the shaft and which includes a first slide face;

 a first casing part which surrounds the seal ring;

 a seat ring which includes a second slide face that is brought
10 into contact with the first slide face of the seal ring and which is fitted to the shaft; and

 a second casing part which is combined with the first casing part such that the seat ring is fixed,

 wherein the seat ring is fixed to a space of the second casing
15 part combined with the first casing part, the second slide face is brought into contact with the first slide face and when handling practical training is provided, the first slide face and the second slide face can be rotated relative to each other by rotating the shaft by a manual operation.

20 [Claim 2]

 The mechanical seal handling practical training equipment according to claim 1 further comprising:

 a handle unit which can be inserted/removed into/from the shaft,

25 wherein the shaft can be rotated with the handle unit fitted to the shaft.

[Claim 3]

 The mechanical seal handling practical training equipment according to claim 1 or 2 further comprising:

30 a shaft support unit which is fixed to the first casing part;

 a first bearing which is attached to the shaft support unit and which rotatably supports the shaft on one end side of the shaft; and

 a second bearing which is attached to the shaft support unit

and which rotatably supports the shaft on an intermediate part of the shaft,

wherein at least either axial runout or play of the shaft can be measured.

5 [Claim 4]

The mechanical seal handling practical training equipment according to any one of claims 1 to 3,

wherein the second casing part further includes a third slide face which is brought into contact with the shaft.

10 [Claim 5]

The mechanical seal handling practical training equipment according to any one of claims 1 to 4,

wherein the seal ring includes a support ring part which is fixed to the shaft, and

15 the support ring part includes a spring which presses the seal ring to a side of the seat ring and a fixing means which fixes the seal ring to a reference position on the shaft.

[Claim 6]

20 The mechanical seal handling practical training equipment according to any one of claims 1 to 5 further comprising:

a first port which is provided in the first casing part and which communicates with the seal ring; and

a second port which is provided in the second casing part and which communicates with the seat ring.

25 [Claim 7]

The mechanical seal handling practical training equipment according to any one of claims 1 to 6,

30 wherein part or all of either or both of the first casing part and the second casing part is formed of a translucent material through which a visible check can be performed.

[Claim 8]

The mechanical seal handling practical training equipment according to any one of claims 1 to 6 further comprising:

a stand unit which supports or movably supports the first

casing part or the shaft support unit.

[Claim 9]

A mechanical seal handling practical training method comprising:

5 a step of fixing, to a shaft, a seal ring which includes a first slide face;

a step of installing a first casing part which surrounds the seal ring;

10 a step of fitting, to the shaft, a seat ring which includes a second slide face that is brought into contact with the first slide face of the seal ring;

a step of fitting the seat ring to a space of a second casing part and combining the second casing part with the first casing part; and

15 a step of relatively rotating the first slide face and the second slide face with a handle unit fitted to the shaft or without fitting the handle unit.

[Claim 10]

20 The mechanical seal handling practical training method according to claim 9 further comprising:

a step of measuring, before installation of the seal ring, any one or two or more of eccentricity of the shaft, play of the shaft and an angle or concentricity of a member adjacent to the shaft.

25 [Claim 11]

The mechanical seal handling practical training method according to claim 9 or 10 further comprising:

30 a step of installing the seal ring and the shaft to the first casing part and placing foreign matter at least on a slide face of the seal ring.

[Claim 12]

The mechanical seal handling practical training method according to any one of claims 9 to 11 further comprising:

a step of making a pressurized fluid flow in from either a

first port in the first casing part or a second port in the second casing part and detecting an outflow or a pressure of the pressurized fluid flowing out from the first port or the second port.

[Claim 13]

5 A mechanical seal handling practical training system comprising:

 a sensor unit which includes any one of a sensor for detecting a pressurized state between a seat ring and a seal ring installed on a shaft, a sensor for detecting runout of the shaft, a sensor
10 for detecting vibration or sound generated by rotation of the shaft and a sensor for detecting torque applied to the shaft;

 a processing means which has a processing function of receiving a sensor signal from the sensor unit so as to convert at least the sensor signal into image information; and

15 an information presentation means which presents a processing output of the processing means with at least the image information.

[Claim 14]

 A mechanical seal which includes at least a seat ring or a seal ring,

20 wherein, for a slide member which includes at least a slide face of either the seat ring or the seal ring, a wearing material is used which is lower in hardness than a seal ring member for actual equipment or a seat ring member for actual equipment, and when practical training is provided, a change in a surface property of
25 the slide face is caused.

[Claim 15]

 A mechanical seal which includes at least a seat ring or a seal ring,

 wherein, in a slide member which includes at least a slide
30 face of either the seat ring or the seal ring, an indication layer is provided which indicates a degree of wear in accordance with wear, and the degree of wear of the slide face can be indicated by a change in a form of the indication layer.