Fig. 10 illustrates an example of measurement results of gaps and gap differences.

Measurement data 70 calculated in the analysis processing is stored in the storage unit 62 as illustrated in Fig. 10, for example. The measurement data 70 contains results of analyzing the data of the thin light images F1 and F2 and the edge data Fx1 and Fx2 contained in the captured image by means of a predetermined calculation algorithm. For example, as illustrated in A of Fig. 10, the measurement data 70 contains the width W of the gap 14 and the gap difference H for each measurement position C.

[0036] Also, the control unit 56 may generate a display screen that allows visual comparison of gaps or gap differences among measurement positions with use of the captured image data, for example. For example, as illustrated in B of Fig. 10, the display monitor 48 displays a measurement result screen obtained by extracting the data of the captured thin light images F1 and F2 and the edge data Fx1 and Fx2 thereof. On this measurement result screen, the data obtained by image capturing and analyses in measurement positions C1 to C3 may be displayed in combination with comparison lines (illustrated by dashed lines) to enable comparison. By displaying the measurement positions so that the measurement positions can be compared with each other in this manner, displacement in the width W of the gap 14 and the gap difference H among the measurement positions can be recognized.

[0037] <Flange-to-Flange Gap Measuring Processing>

Fig. 11 illustrates a processing example of flange-to-flange gap measurement. The processing content and processing procedure illustrated in Fig. 11 are examples of a flange-to-flange gap measuring method or a flange-to-flange measuring program according to the present invention, and the present invention is not limited to such content and procedure.

In flange-to-flange gap measuring processing, the

insertion pieces 36 of the contact arms 34-1 and 34-2 serving as the positioning guide are inserted into the gap 14 at the measurement position C set on the flanges (S11). As a result, the arrangement position of the flange-to-flange gap measuring device 30, the light irradiation direction, the irradiation angle, and the imaging direction are stabilized in predetermined states.

When the control unit 56 detects a pressing operation of the trigger switch 42 (S12), the control unit 56 turns on the light emitting means 50, emits light toward the measurement position C1 (S13), and captures an image containing thin light images formed at the measurement position C by means of the camera 54 (S14).

The control unit 56 performs measuring processing for a gap and a gap difference by means of an image analysis (S15). In this measuring processing, the processing described in S4 of Fig. 3 and the like may be performed, for example. Then, the control unit 56 then causes measurement results of the gap and the gap difference to be displayed on the display monitor 48 (S16).

[0038] [Effects of Second Embodiment]

According to such a configuration, the following effects can be obtained.

(1) In formation of the thin light images used to measure the gap and the gap difference, since the light irradiation direction, the distance, and the imaging angle are determined by the plurality of contact arms 34-1 and 34-2, it is possible to suppress occurrence of variation in the measurement results among operators and to perform highly accurate measuring processing.

(2) Since the number of processes that may cause a human error due to a visual recognition error or an operation skill level of the operator can be reduced, accuracy of measurement of the gap and the gap difference and management of seal

As flange-to-flange gap measuring processing, the flange-to-flange gap measuring device 30 is installed at a set measurement position (S22), and when the trigger switch is pressed, light irradiation and processing for imaging the measurement position are performed (S23). Subsequently, the flange-to-flange gap measuring device 30 or the information terminal device 82 acquires the captured image information and calculates the gap and the gap difference, and a measurement result derived by the calculation is transmitted and received between the flange-to-flange gap measuring device 30 and the information terminal device 82 (S24).

[0044] The information terminal device 82 performs gap management processing for the measurement result at the measurement position and performs image generation processing with use of axial force management information stored in seal handling management processing (S25). Subsequently, the information terminal device 82 causes a gap management image to be displayed on the display unit 88 (S26).

Meanwhile, the gap management image may be transmitted from the information terminal device 82 to the flange-to-flange gap measuring device 30 and displayed on the display monitor 48, for example.

[0045] [Effects of Third Embodiment]

According to such a configuration, the following effects can be obtained.

(1) Since the flange tightening state can be managed in association with the bolt and nut tightening processing, the convenience and reliability of seal handling management can be improved.

(2) It is possible to facilitate the measurement and management processing for the flange tightening state at the tightening position or the measurement position, which improves convenience.

(3) By facilitating the flange-to-flange gap measuring

processing, a check after a tightening operation, further tightening, and a re-tightening operation can be performed quickly, which enables operation efficiency to be improved and which enables operation time to be shortened.

(4) By facilitating the flange-to-flange gap measuring processing, looseness of screws due to a temporal change can be checked, and further tightening and a re-tightening operation can be performed quickly. Accordingly, operation efficiency can be improved, operation time can be shortened, and reliability of the seal handling management can be improved over a long period of time.

[0046] [Other Embodiments]

(1) The flange-to-flange gap measuring device 30 may perform processing for guiding a measuring processing procedure or a measurement procedure with use of the monitor 48, for example.

(2) A function of the monitor 48 of the flange-to-flange gap measuring device 30 is not limited to a function of displaying the measurement results, for example. The monitor 48 may function as a so-called finder that displays image information captured by the camera 54 in real time, for example. As a result, when the flange-to-flange gap measuring device 30 is arranged at the measurement position C1, the operator can arrange the device while actually checking an image to be captured as well as visually recognizing the arrangement position from the outside of the device.

Also, the monitor 48 may display an instruction screen for instructing the operator about the arrangement position, for example. As a result, the device can accurately be arranged at the set position, and the accuracy of gap monitoring can be improved.

[0047] (3) In the above embodiments, although a case in which the arrangement angle θ of the imaging unit 22 with respect to the light irradiation unit 20 is fixed has been

the contact 18 are inserted into the gap 14, to measure the gap and the gap difference has been described. However, the present invention is not limited to this case. In the flange-to-flange gap measuring processing, the flange-to-flange gap measuring processing may be performed without bringing the contact arms 34-1 and 34-2 into contact with the flanges 6-1 and 6-2, for example. In this case, in the flange-to-flange gap measuring device 2 or 30, the contact arms 34-1 and 34-2 may be removed from the housing 16 or 32, for example. Also, in the flange-to-flange gap measuring processing, the flange-to-flange gap measuring device 2 or 30 may be positioned into the gap 14 between the flanges 6-1 and 6-2 by the operator's visual inspection or with use of a not-illustrated positioning jig or the like to set the irradiation distance Lb, for example. Also, the flange-to-flange gap measuring device 2 or 30 may have a function of determining whether the device is located at an appropriate measurement position and whether the device is arranged to have the irradiation distance Lb or the imaging distance Lc with use of the display monitor or the like, for example. Further, the camera 54 may use an auto focus (AF) function to adjust the imaging distance Lc in accordance with a distance from the camera 54 to the thin light images generated on the side surfaces of the flanges 6-1 and 6-2 to be measured or the gap 14, for example.

[0049] As described above, the most preferable embodiments of the present invention have been described. The present invention is not limited to the above description. Various modifications and changes can be made by those skilled in the art based on the summary of the invention described in the claims or disclosed in the description of embodiments. It is to be understood that such modifications and changes are included in the scope of the present invention.

Industrial Applicability

50 Light emitting means
52 Objective lens
54 Camera
55 Front surface
56 Control unit
60 Processor
62 Storage unit
64 Input/output unit (I/O)
66 Touch sensor
68 Communication unit
70 Measurement data
80 Flange-to-flange gap measuring system
82 Information terminal device
84 Processing unit
86 Input unit
88 Display unit