

## DESCRIPTION

TITLE OF INVENTION: FLANGE FASTENING MANAGING METHOD, FASTENING  
MANAGING SYSTEM, FASTENING MANAGING PROGRAM, AND FASTENING MANAGING  
DEVICE

## 5 TECHNICAL FIELD

[0001]

The present invention relates to fastening managing  
technology of a flange for coupling piping, a valve, a pump, etc.

## BACKGROUND ART

10 [0002]

A flange joint is used for coupling of piping and connection  
of a pump, etc. to the piping. A gasket is interposed between  
flanges of the flange joint, and the flanges are fastened by bolts  
and nuts arranged at a plurality of points. For this fastening,  
15 a manual tool such as a torque wrench is used, but instead an  
electrically-powered screw fastening tool may be used.

[0003]

It has been known in relation to this screw fastening tool  
that an electrically-powered motor is used as a rotary drive source,  
20 that a current pulse is intermittently applied to the motor, that  
a current value is controlled in accordance with a detected torque,  
and that the current pulse is stopped when the detected torque  
reaches a target torque (e.g. Patent Literature 1).

## CITATION LIST

25 PATENT LITERATURE

[0004]

Patent Literature 1: JP2002-1676A

## SUMMARY

[0004a] According to an aspect, the present disclosure refers to  
30 a flange fastening managing method in which a computer as well as  
a fastening tool are used, the fastening tool fastening flanges  
with a gasket by a plurality of bolts and nuts, the gasket being  
sandwiched between the flanges, the method comprising the steps

of: acquiring fastening condition information associated with the flanges; acquiring gasket part number information and fastening condition number information from a flange tag attached to the flanges, the gasket part number information and the fastening condition number information conforming to the flanges; collating the gasket part number information acquired from the flange tag with gasket part number information of a gasket to be used, to determine whether the gasket fits the flanges; selecting a fastening condition number based on the fastening condition number information acquired from the flange tag when the gasket selected fits the flanges, selecting a fastening condition associated with the fastening condition number from the fastening condition information, setting the fastening condition in the fastening tool, and applying a fastening torque from the fastening tool to the bolts or the nuts under the fastening condition; acquiring, from the fastening tool, the fastening torque applied from the fastening tool to the bolts or the nuts, to evaluate whether fastening of the flanges conforms to the fastening condition; and stopping a drive of the fastening tool when the fastening of the flanges does not conform to the fastening condition.

[0004b] According to another aspect, the present disclosure refers to a flange fastening managing system comprising: a fastening tool that fastens a plurality of bolts and nuts attached to flanges, a gasket being sandwiched between the flanges; a controller that controls a fastening action of the fastening tool; and a server that is connected to the controller by wire or wireless, wherein the controller acquires, from the server, fastening condition information associated with the flanges, the controller acquires, from a flange tag attached to the flanges, flange information containing gasket part number information and fastening condition number information, the gasket part number information and the fastening condition number information conforming to the flanges and acquires gasket part number information from the gasket or from a gasket tag attached to a gasket case, the controller collates

the gasket part number information acquired from the flange tag with the gasket part number information acquired from the gasket or the gasket tag, to determine whether the gasket fits the flanges, the controller selects a fastening condition number based on the fastening condition number information acquired from the flange tag when the gasket fits the flanges, selects a fastening condition associated with the fastening condition number from the fastening condition information, and sets the selected fastening condition in the fastening tool, the controller acquires, from the fastening tool, a fastening torque applied from the fastening tool to the nuts, to evaluate whether fastening of the flanges conforms to the fastening condition, the controller provides, to the server, fastening result information containing at least the fastening condition and a result of the evaluation in association with the flanges, and the controller stops a drive of the fastening tool when the fastening of the flanges does not conform to the fastening condition.

[0004c] According to another aspect, the present disclosure refers to a flange fastening managing program for making a computer implement functions, the computer being used for control of a fastening tool that fastens flanges with a gasket by a plurality of bolts and nuts, the gasket being sandwiched between the flanges, the functions being: acquiring fastening condition information associated with the flanges; acquiring, from a flange tag attached to the flanges, flange information containing gasket part number information and fastening condition number information, the gasket part number information and the fastening condition number information conforming to the flanges; acquiring gasket part number information from a gasket or a gasket tag; collating the gasket part number information acquired from the flange tag with the gasket part number information acquired from the gasket or the gasket tag, to determine whether the gasket fits the flanges; selecting a fastening condition number based on the fastening condition number information acquired from the flange tag when the gasket fits the

flanges, selecting a fastening condition associated with the fastening condition number from the fastening condition information, and setting the selected fastening condition in the fastening tool; acquiring, from the fastening tool, a fastening torque applied from the fastening tool to the nuts, to evaluate whether fastening of the flanges conforms to the fastening condition; presenting fastening result information containing at least the fastening condition and a result of the evaluation in association with the flanges; and stopping a drive of the fastening tool when the fastening of the flanges does not conform to the fastening condition.

[0004d] According to another aspect, the present disclosure refers to a flange fastening managing device to be used with a fastening tool that fastens flanges with a gasket by a plurality of bolts and nuts, the gasket being sandwiched between the flanges, the device comprising: an information acquiring unit that acquires fastening condition information associated with the flanges, that acquires, from a flange tag attached to the flanges, flange information containing gasket part number information and fastening condition number information, the gasket part number information and the fastening condition number information conforming to the flanges, that acquires gasket part number information from a gasket or from a gasket tag attached to a gasket case, and that acquires, from the fastening tool, a fastening torque applied from the fastening tool to the nuts; a processing unit that collates the gasket part number information acquired from the flange tag with the gasket part number information acquired from the gasket or the gasket tag, to determine whether the gasket fits the flanges, that, when the gasket fits the flanges, selects a fastening condition number based on the fastening condition number information acquired from the flange tag, that selects a fastening condition associated with the fastening condition number from the fastening condition information, and that sets the fastening condition in the fastening tool, to evaluate whether fastening of the flanges conforms to the

fastening condition; and an information presenting unit that presents fastening result information containing at least the fastening condition and a result of the evaluation in association with the flanges, wherein the processing unit stops a drive of the fastening tool when the fastening of the flanges does not conform to the fastening condition.

TECHNICAL PROBLEM

[0005]

Use of such a fastening tool enables uniform and even fastening in spite of different workers, advantageously increasing the work efficiency.

[0006]

However, there are a wide variety of flanges and gaskets as objects, and it is inevitable to select a gasket fitting with a flange. In addition, the fastening procedure of a plurality of bolts is not uniform and, even in the case of using the fastening tool, a skilled worker is desirable for high reliable fastening. Training and experience are required for proficiency. A burden on the worker then becomes excessive and the flange fastening management is extremely rendered important.

[0007]

Thus, in view of the above problem, an object of the present invention is to consistently manage gaskets and fastening conditions from selection to execution by associating them to flanges, to thereby achieve high reliable flange fastening management and reducing the worker's burden.

#### SOLUTION TO PROBLEM

[0008]

In order to achieve the above object, according to an aspect of a flange fastening managing method of the present invention, in a flange fastening managing method, a computer as well as a fastening tool are used. The fastening tool fastens flanges with a gasket by a plurality of bolts and nuts. The gasket is sandwiched between the flanges. The method comprises the steps of: acquiring fastening condition information associated with the flanges; acquiring gasket information conforming to the flanges; collating the gasket information with gasket information representing a gasket to be used, to determine whether the gasket fits the flanges; and applying a fastening torque from the fastening tool to the bolts or the nuts under a fastening condition acquired from the fastening condition information when the gasket selected fits the flanges.

The flange fastening managing method further comprises the steps of acquiring the fastening torque applied from the fastening tool to the bolts or the nuts, to evaluate whether fastening of the flanges conforms to the fastening condition; and presenting fastening result information containing at least the fastening

condition and a result of the evaluation in association with the flanges.

In order to achieve the above object, according to an aspect of a flange fastening managing method of the present invention, 5 in a flange fastening managing method, a computer as well as a fastening tool are used. The fastening tool fastens flanges with a gasket by a plurality of bolts and nuts. The gasket is sandwiched between the flanges. The method comprises the steps of acquiring fastening condition information associated with the flanges; 10 acquiring, from a flange tag, flange information containing gasket information conforming to the flanges; acquiring gasket information from a gasket or a gasket tag; collating the gasket information contained in the flange information with gasket information acquired from the gasket or the gasket tag; selecting a fastening 15 condition from the fastening condition information when the gasket fits the flanges; acquiring a fastening torque applied from the fastening tool to the nuts, to evaluate whether fastening of the flanges conforms to the fastening condition; and presenting fastening result information containing at least the fastening 20 condition and a result of the evaluation in association with the flanges.

[0009]

The flange fastening managing method may further comprise the step of outputting presentation information indicative of whether 25 the gasket fits the flanges.

[0010]

The flange fastening managing method may further comprise the steps of making a determination of whether the fastening condition is satisfied during fastening of the flanges; and presenting a 30 result of the determination.

[0011]

The flange fastening managing method may further comprise the steps of acquiring worker information from a worker tag; and presenting the flange information, the fastening condition, and

the result of the evaluation in association with the worker information.

[0012]

5 In the flange fastening managing method, the flange information may contain information indicative at least of a gasket fitting the flanges and of a fastening procedure.

[0013]

10 In the flange fastening managing method, the fastening condition information may contain the flange information and the gasket information.

[0014]

The flange fastening managing method may further comprise the steps of forming a gasket from a gasket material; and attaching, to the gasket, the gasket tag containing information of the gasket.

15 [0015]

In order to achieve the above object, according to an aspect of a flange fastening managing system of the present invention, a flange fastening managing system comprises a fastening tool that fastens a plurality of bolts and nuts attached to flanges, a gasket  
20 being sandwiched between the flanges; a controller that controls a fastening action of the fastening tool; and a server that is connected to the controller by wire or wireless. The controller acquires, from the server, fastening condition information associated with the flanges; acquires, from a flange tag, flange  
25 information containing gasket information conforming to the flanges; acquires gasket information from the gasket or a gasket tag; collates the gasket information contained in the flange information with the gasket information acquired from the gasket or the gasket tag; selects a fastening condition from the fastening  
30 condition information when the gasket fits the flanges; acquires a fastening torque applied from the fastening tool to the nuts, to evaluate whether fastening of the flanges conforms to the fastening condition; and provides, to the server, fastening result information containing at least the fastening condition and a result

of the evaluation in association with the flanges.

[0016]

In order to achieve the above object, according to an aspect of a flange fastening managing program of the present invention, a flange fastening managing program is for making a computer  
5 implement functions. The computer is used for control of a fastening tool that fastens flanges with a gasket by a plurality of bolts and nuts. The gasket is sandwiched between the flanges. The functions are acquiring fastening condition information associated with the flanges; acquiring, from a flange tag, flange  
10 information containing gasket information conforming to the flanges; acquiring gasket information from a gasket or a gasket tag; collating the gasket information contained in the flange information with the gasket information acquired from the gasket or the gasket tag; selecting a fastening condition from the  
15 fastening condition information when the gasket fits the flanges; acquiring a fastening torque applied from the fastening tool to the nuts, to evaluate whether fastening of the flanges conforms to the fastening condition; and presenting fastening result  
20 information containing at least the fastening condition and a result of the evaluation in association with the flanges.

[0017]

In order to achieve the above object, according to an aspect of a flange fastening managing device of the present invention, a flange fastening managing device is to be used with a fastening  
25 tool that fastens flanges with a gasket by a plurality of bolts and nuts. The gasket is sandwiched between the flanges. The device comprises an information acquiring unit that acquires fastening condition information associated with the flanges, that acquires, from a flange tag, flange information containing gasket information  
30 conforming to the flanges, that acquires gasket information from a gasket or a gasket tag, and that acquires a fastening torque applied from the fastening tool to the nuts; a processing unit that collates the gasket information contained in the flange information

with the gasket information acquired from the gasket or the gasket tag, and that, when the gasket fits the flanges, selects a fastening condition from the fastening condition information, to evaluate whether fastening of the flanges conforms to the fastening  
5 condition; and an information presenting unit that presents fastening result information containing at least the fastening condition and a result of the evaluation in association with the flanges.

#### ADVANTAGEOUS EFFECTS OF INVENTION

10 [0018]

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

[0019]

(1) By use of a computer as well as a fastening tool having  
15 a flange fastening function and a fastening monitoring function, there can be implemented consistent management of multi-function processing such as flange and gasket selection, fastening condition setting, fastening status determination, fastening result recording, and its information presentation, thus achieving flange  
20 fastening management not depending on the worker's experience and intuition.

[0020]

(2) With the gasket being adapted to the flanges, fastening can be performed in accordance with the input fastening condition,  
25 to avoid miss fastening, alleviating the worker's burden.

[0021]

(3) Since the fastening condition cannot be input if the gasket does not fit with the flanges, consistent management of the flanges, the gasket, and the fastening condition is achieved so that high  
30 reliable flange fastening management can be implemented.

[0022]

(4) Since it is evaluated based on the fastening result information whether the fastening status conforms to the fastening condition, the degree of dependence on the worker can be reduced

and even fastening with a small error can be implemented.

[0023]

(5) The fastening status is able to be checked from presented fastening information containing the fastening condition and the evaluation result of fastening.

#### BRIEF DESCRIPTION OF DRAWINGS

[0024]

[Fig. 1] Fig. 1 is diagram showing a flange fastening managing system according to one embodiment.

10 [Fig. 2] Fig. 2 is a sequence diagram showing a processing sequence of the flange fastening managing system.

[Fig. 3] Fig. 3 is a diagram showing an example of a flange fastening tool.

15 [Fig. 4] Fig. 4 is a diagram showing a controller and a storing unit.

[Fig. 5] Fig. 5 is a diagram showing a server computer.

[Fig. 6] Fig. 6 is a diagram showing a worker information table, a worker tag, and worker tag information.

[Fig. 7] Fig. 7 is a diagram showing a fastening condition table.

20 [Fig. 8] Fig. 8 is a diagram showing flange information and a flange tag.

[Fig. 9] Fig. 9 is a diagram showing gasket information and a gasket tag.

25 [Fig. 10] Fig. 10 is a diagram showing fastening result information and a first log information table.

[Fig. 11] Fig. 11 is a diagram showing a second log information table.

[Fig. 12] Fig. 12 is a flowchart showing a flange fastening processing procedure.

30 [Fig. 13] Fig. 13 is a flowchart showing a controller's processing procedure.

[Fig. 14] Fig. 14 is a flowchart showing a controller's processing procedure after fastening.

[Fig. 15] Fig. 15 is a diagram showing processing and sorting of

a gasket according to Example 2.

[Fig. 16] Fig. 16 is a diagram showing a gasket sorting example.

[Fig. 17] Fig. 17 is a flowchart showing control of a flange fastening tool according to Example 3.

5 DESCRIPTION OF EMBODIMENTS

[0025]

<Flange Fastening Managing System>

[0026]

Fig. 1 shows a flange fastening managing system according to one embodiment. The configuration shown in Fig. 1 is an example and the present invention is not limited to such a configuration.  
10 [0027]

This flange fastening managing system 2 comprises a flange fastening tool (hereinafter, referred to simply as "fastening tool") 4, a controller 6, and a server computer (hereinafter, referred to simply as "server") 8.  
15 [0028]

The fastening tool 4 is means that generates a torque  $\tau$  needed for fastening and the fastening tool 4 may be a general electric tool such as a fastening tool or a nut runner. In a flange fastening portion 10 as a fastening object, a gasket 14 is sandwiched between flanges 12 of a flange joint, a plurality of bolts 16 is disposed in a flange fastening portion 10, and a nut 18 is fitted to each of the bolts 16. The worker keeps a device body 20 of the fastening tool 4 with a grip 22 to fit the nut 18 into a socket 23 and depresses a trigger 24 to impart the torque  $\tau$  in accordance with fastening conditions from the fastening tool 4 to the nut 18. This fastening of the nut 18 enables the flanges 12 to be fastened.  
20  
25 [0029]

The controller 6 is connected via a cable 26 to the fastening tool 4. The controller 6 is an example of a fastening managing device and is configured by a computer for example. Instead of a wired connection using the cable 26, a wireless connection such as Wi-Fi may be employed. A front panel unit 28 of the controller  
30

6 comprises a plurality of input keys 30 and a display unit 32.  
[0030]

This controller 6 executes, for example, processings which follow:

5       a) Acquisition of fastening condition information associated with the flange 12;

          b) Acquisition of flange information of the flange 12;

          c) Acquisition of gasket information of the gasket 14;

          d) Collation of gasket information contained in the flange  
10       information with gasket information acquired from the gasket 14;

          e) If the flange 12 and the gasket 14 fit together, selection of a fastening condition from the fastening condition information and input of the fastening condition into the fastening tool 4;

          f) Acquisition of fastening information during fastening or  
15       after completion of fastening from the fastening tool 4 and evaluation of whether or not fastening conforms to the fastening condition; and

          g) Presentation of fastening result information containing at least the fastening condition and the evaluation result,  
20       associated with the flange 12.

[0031]

The server 8 links with the controller 6 by wired or wireless connection, as indicated by a broken line 34. The server 8 is a computer supporting or managing the controller 6 and is configured  
25       by a personal computer for example. This server 8 comprises, as an example, a processing unit 36, an input operating unit 38, and a monitor 40.

[0032]

<Processing procedure of Flange Fastening Management>

30       [0033]

Fig. 2 shows a processing sequence of flange fastening management using the fastening tool 4, the controller 6, and the server 8. In these processing processes, each process is represented by step (Step: S) and number. A flange tag 42 is

attached to a pre-fastening flange 12 for example and has gasket information thereon. A gasket tag 44 is attached to a pre-fastening gasket 14 for example and has gasket information thereon.

[0034]

5       The server 8 provides the fastening condition information associated with the flange 12 to the controller 6 (S101).

[0035]

10       The controller 6 acquires flange information from the flange tag 42 (S102). This flange information contains gasket information indicative of a gasket that fits a flange to which the flange tag 42 is attached.

[0036]

15       The controller 6 acquires gasket information from the gasket tag 44 (S103) and collates gasket information contained in the flange information with gasket information acquired from the gasket tag 44 (S104).

[0037]

20       If the gasket 14 fits the flange 12 (YES at S105), the controller 6 selects a fitting fastening condition from the fastening condition information (S106) and inputs the fastening condition to the fastening tool 4 (S107).

[0038]

25       If the gasket 14 does not fit the flange 12 (NO at S105), the controller 6 issues an error indication (S108), to urge the worker to replace the gasket 14 with a fitting gasket 14.

[0039]

30       The fastening tool 4 is enabled to fasten the flange 12 with the input fastening condition (S109). By operating the trigger 24, the worker can cause the fastening tool 4 to generate the torque  $\tau$  in accordance with the input fastening condition and impart the torque  $\tau$  to the nut 18 of the flange fastening portion 10.

[0040]

      The fastening tool 4 detects the torque  $\tau$  imparted to the nut 18 as the fastening information during fastening or after completion

of fastening (S110).

[0041]

The controller 6 acquires fastening information during fastening or after completion of fastening from the fastening tool 4 (S111), to evaluate whether fastening of the flange 12 conforms to the fastening condition (S112).

[0042]

The controller 6 provides fastening information to the server 8, and the provided fastening information contains at least the fastening condition and the evaluation result associated with the flange 12 (S113). The server 8 displays the provided fastening information onto the monitor 40 (S114).

[0043]

According to this processing procedure, the relationships between the above processings a) to g) and the steps are as follow.

a) Acquisition of fastening condition information associated with the flange 12: S101;

b) Acquisition of flange information of the flange 12: S102;

c) Acquisition of gasket information of the gasket 14: S103;

d) Collation of gasket information contained in the flange information with gasket information acquired from the gasket 14: S104;

e) If the flange 12 and the gasket 14 fit together, selection of a fastening condition from the fastening condition information and input of the fastening condition into the fastening tool 4: S105, S106, and S107;

f) Acquisition of fastening information during fastening or after completion of fastening from the fastening tool 4 and evaluation of whether or not fastening conforms to the fastening condition: S111 and S112; and

g) Presentation of fastening result information containing at least the fastening condition and the evaluation result, associated with the flange 12: S113 and S114.

[0044]

<Effect of One Embodiment>

[0045]

(1) The controller 6 receives fastening condition information provided from the server 8 and, from this fastening condition  
5 information, can impart a fastening condition conforming to the flange 12 and the gasket 14 to the fastening tool 4. The fastening tool 4 can perform fastening in accordance with the input fastening condition, miss fastening can be avoided, and the worker's burden can be reduced.

10 [0046]

(2) Flange information acquired from the flange tag 42 contains gasket information indicative of a fitting gasket 14 and this gasket information is collated with gasket information acquired from the gasket tag 44, to determine whether the gasket  
15 fits the flange, whereby miss selection of a gasket for a specified flange can be prevented, and consistent management of the flange, gasket and fastening condition can be implemented. This achieves a high reliable flange fastening management.

[0047]

20 (3) If the selected gasket 14 does not fit the flange 12 to be fastened, selection and input of the fastening condition for the fastening tool 4 cannot be performed, whereby the worker's miss selection or miss setting of the fastening condition can be prevented, the worker's burden can be reduced, and the fastening  
25 reliability can be heightened.

[0048]

(4) Since it is evaluated, by fastening information during fastening or after completion of fastening, whether the fastening status conform to the fastening condition, the dependence on the  
30 worker can be reduced, so that the fastening error can be avoided or reduced.

[0049]

(5) Since fastening information containing the fastening condition and the fastening evaluation result can be recorded and

presented, monitoring and confirmation of the fastening status in course of fastening can be facilitated and, for example, the past fastening status can also be confirmed from the fastening information recorded in the server 8.

5 Example 1

[0050]

<Fastening Tool 4>

[0051]

Fig. 3 shows an example of the fastening tool 4 connectable  
10 to the controller 6. This fastening tool 4 includes a control unit 48, a motor 50, and a torque sensor 52, included in a general electric tool.

[0052]

The controller 6 is connected via the cable 26 to the control  
15 unit 48. In place of such a wired connection, connection between the control unit 48 and the controller 6 may be a wireless connection utilizing Wi-Fi communication.

[0053]

This control unit 48 comprises a computer and a motor driving  
20 unit. This control unit 48 is provided with control information such as fastening condition information from the controller 6 and obtains fastening result information. The motor 50 is driven in accordance with the input fastening condition and is supplied with a driving current when a trigger switch 54 is on.

25 [0054]

In fastening of the flange 12, a rotation torque of the motor 50 is applied from a rotational shaft 56 via the socket 23 to the nut 18 described above. The rotational shaft 56 may comprise a gear mechanism so that the rotation force of the motor 50 is transmitted  
30 to the socket 23 at desired gear ratio.

[0055]

The torque sensor 52 detects the torque  $\tau$  from the motor 50 or the rotational shaft 56. This detected torque  $\tau$  is applied to the control unit 48 and is provided, through the control unit 48,

to the controller 6. This detected torque  $\tau$  is an example of the fastening result information.

[0056]

5 This torque sensor 52 detects a fastening torque  $\tau$  of the bolt 16 and the nut 18 and may be disposed external to the fastening tool 4.

[0057]

<Controller 6>

[0058]

10 Fig. 4A shows an example of the controller 6. The controller 6 is control means of the fastening tool 4 and is an example of the flange fastening managing device.

[0059]

15 The controller 6 is formed from a computer and comprises a processor 74, a storing unit 76, an input/output unit (I/O) 78, an input operating unit 80, a communicating unit 82, and a display unit 84.

[0060]

20 The processor 74 is an example of a processing unit and an information acquiring unit and performs information processing of an OS (Operating System) or a flange fastening managing program existing in the storing unit 76. This information processing includes controls such as acquisition of the fastening condition information from the server 8, input and acquisition of the fastening condition to the fastening tool 4, acquisition of the fastening result information from the fastening tool 4, monitoring and evaluation of the fastening status, display of the evaluation result, and output of the fastening result information.

[0061]

30 The storing unit 76 is used to store the OS, a program, fastening condition information, detection information, etc. and comprises a ROM (Read Only Memory) and a RAM (Random Access Memory). This storing unit 76 comprises a temporary storage area 76-1 and a storage area 76-2. This storing unit 76 can be a storage element

capable of holding storage contents.

[0062]

The I/O 78 is controlled by the processor 74 and is used for input/output of control information. The communicating unit 82 is used e.g. for wireless connection of the server 8, etc. For example, a bar code reader 86 and a removable external memory 88 are connected as external equipment to the I/O 78. The bar code reader 86 is an example of an information acquiring unit that acquires information from bar codes. The external memory 88 is a log information takeout memory and can be a USB (Universal Serial Bus) memory for example.

[0063]

The input operating unit 80 comprises a key switch and a touch sensor and is used e.g. for input trigger of input information, takeout trigger of output information, and mode switching.

[0064]

The communicating unit 82 is an example of an output unit, is controlled by the processor 74, and is used for wireless connection with external equipment such as the fastening tool 4 and the server 8, as well as for Internet connection.

[0065]

The display unit 84 is an example of an information presenting unit and comprises for example a green lamp 84-1 and a red lamp 84-2. This display unit 84 is controlled by the processor 74 and turns on the green lamp 84-1 when the status evaluation result is normal but turns on the red lamp 84-2 when the status evaluation result is abnormal.

[0066]

Fig. 4B shows an example of the storage contents of the storing unit 76. The temporary storage area 76-1 temporarily stores, for example, flange information 90 acquired from the flange 12, gasket information 92 acquired from the gasket 14, worker information 94 acquired from a worker tag 93 (Fig. 6B), and fastening result information 95 acquired from the fastening tool 4.

[0067]

Databases such as a fastening condition table 96 and a log information table 98 are built in the storage area 76-2. The fastening condition table 96 records fastening condition information associated with the flange. The log information table 98 records information such as the fastening result and the fastening determination result.

[0068]

<Server 8>

10 [0069]

Fig. 5 shows an example of the server 8. The server 8 is a support device of the controller 6 and is an example of log information presenting means.

[0070]

15 The server 8 comprises a processor 100, a storing unit 102, an input/output unit (I/O) 104 and a communicating unit 106 in the processing unit 36, and comprises the input operating unit 38 and the monitor 40 described above.

[0071]

20 The processor 100 performs information processing of an OS, a flange fastening managing program, etc., and the OS, the flange fastening managing program, etc. exist in the storing unit 102. This information processing includes processing such as provision of fastening condition information to the controller 6, acquisition of log information indicative of the fastening result from the controller 6, and presentation of the log information table 98.

25 [0072]

The storing unit 102 is used to store the OS, the flange fastening managing program, the fastening condition information, the log information, etc. and comprises a ROM and a RAM. This storing unit 102 can be a storage device such as a hard disc and a semiconductor memory, capable of holding the storage contents.

30 [0073]

The I/O 104 is controlled by the processor 100 and is used

for the input/output of control information. The communicating unit 106 is used e.g. for wireless connection of controller 6, etc. For example, the external memory 88 is connected as external equipment to the I/O 104.

5 [0074]

The communicating unit 106 is controlled by the processor 100 and is used for wireless connection with external equipment such as the fastening tool 4 and the controller 6 and for Internet connection.

10 [0075]

The input operating unit 38 is used for the input of input information, takeout trigger of output information, mode switching, etc.

[0076]

15 The monitor 40 is an example of the information presenting unit and the display unit and is used for the display of the log information table 98 for example. An image display unit of this monitor 40 may comprise a touch panel 108, and may thereby perform input information corresponding to the display information in place  
20 of the input operating unit 38.

[0077]

<Worker Information 94>

[0078]

Fig. 6A shows a worker information table. The worker  
25 information table 110 stores worker information acquired from a worker in charge of fastening by the controller 6. This worker information table 110 contains, as an example of the worker information, information such as a worker identification (ID), a user, and a worker name. The worker ID is identification  
30 information specifying a worker. The user is for example a name of a company to which the worker belongs or a name of a company of a fastened point. The worker name is for example a name of the worker.

[0079]

This worker information table 110 includes, as shown in Fig. 6A, an ID part 110-1, a company name part 110-2, and a worker name part 110-3. The ID part 110-1 stores the worker ID's. The company name part 110-2 stores the name of the company to which each worker belongs. The worker name part 110-3 stores the name of each worker.

[0080]

The worker information to be stored in the worker information table 110 is acquired from a worker tag 93 that a worker 112 wears, as shown in Fig. 6B. If the worker tag 93 has a displayed bar code 116, worker tag information 118 is read out by the bar code reader 86. Fig. 6C shows the read-out worker tag information 118. This worker tag information 118 contains the above-described worker ID, company name, and worker name to be stored in the worker information table 110.

[0081]

By acquiring the worker information from the worker tag 93 by the controller 6 upon the start of fastening to form the worker information table 110, this worker information becomes a fastening record by associating the worker information with the flange information described above.

[0082]

<Fastening Condition Table 96>

[0083]

Fig. 7 shows an example of the fastening condition table 96. This fastening condition table 96 stores fastening condition information which is provided from the server 8 to the controller 6. This fastening condition table 96 contains, as an example of the fastening condition information, applied point information, the flange information 90, the gasket information 92, fastening portion information, and fastening condition information. The applied point information is information of an implementation line etc. The flange information 90 is individual information for use in identification of the flange 12. The gasket information 92 is individual information for use in identification of the gasket 14.

The fastening portion information is information of, e.g. the number of bolts in the flange fastening portion 10. The fastening condition information includes fastening condition identification information and the number of rounds in fastening.

5 [0084]

This fastening condition table 96 includes, as shown in Fig. 7, a line information part 96-1, a flange information part 96-2, a gasket information part 96-3, a bolt information part 96-4, and a fastening condition information part 96-5.

10 [0085]

The line information part 96-1 stores e.g. identification information of fastened points of piping lines, and this identification information is Line A, Line B, etc. The flange information part 96-2 stores e.g. a flange number and flange dimensions for identifying the flange 12. The gasket information part 96-3 stores e.g. a gasket part No. and gasket dimensions for identifying the gasket 14. The bolt information part 96-4 stores e.g. the number of bolts. The fastening condition information part 96-5 stores e.g. a fastening condition number for identifying the fastening condition and Pass 1, Pass 2, ... Pass 13 representative of the number of rounds.

[0086]

Since the fastening condition table 96 is provided as fastening condition information for the controller 6 from the server 8, the controller 6 can grasp the server 8 and required fastening condition information in relation to fastening and can independently utilize this fastening condition information.

[0087]

<Flange Information 90>

30 [0088]

Fig. 8A shows the flange 12 and the flange tag 42. In this example, the flange tag 42 is attached to the flange 12 by a lead 120.

[0089]

The bar code reader 86 reads a bar code 122 displayed on the flange tag 42, so that the flange tag information 124 can be acquired.

[0090]

5        This flange tag information 124 is an example of the flange information and encompasses the flange information and relevant information stored in the fastening condition table 96 described above. This relevant information includes the line information and the gasket information.

10      [0091]

         The flange tag information 124 contains, as shown in Fig. 8B, the applied point information, the flange identification information, the gasket information, and the fastening condition information. A line name 124-1 stores, as the applied point  
15      information, e.g. identification information of fastened points of piping lines, and this identification information is Line A, Line B, etc. Flange information 124-2 stores e.g. a flange number and flange dimensions for identifying the flange 12. Gasket information 124-3 stores a gasket part No. for identifying the  
20      gasket 14. A fastening procedure 124-4 stores fastening condition number for identifying the fastening condition.

[0092]

         Since the flange tag information 124 contains the gasket information having a close relationship with the flange 12 in this  
25      manner, a fitting gasket 14 can automatically be specified by selecting the flange 12. Then, by collating the gasket information contained in the flange tag information 124 with the gasket information obtained from the gasket tag 44, it can promptly be determined whether the gasket 14 fits the flange 12, ensuring a  
30      high reliable fitness determination.

[0093]

<Gasket Information 92>

[0094]

         Fig. 9A shows a gasket case. The gasket case 126 is for

example a synthetic resin case that comprises a case body 128 capable of accommodating the gasket 14 and a openable/closable lid 130 disposed on the case body 128. The lid 130 has a transparent window 132. The gasket 14 can visually be confirmed through the transparent window 132.

[0095]

The gasket case 126 comprises the gasket tag 44 having a disposed bar code 134. The bar code reader 86 reads the bar code 134, so that gasket tag information 136 can be acquired.

10 [0096]

The gasket tag information 136 contains the gasket information 92. This gasket tag information 136 stores, as shown in Fig. 9B, a gasket part No. and dimensions.

[0097]

15 <Fastening Result Information>

[0098]

Fig. 10A shows an example of the fastening result information. This fastening result information 138 contains a fastening condition 138-1, a fastening date and time 138-2, an error determination result 138-3, a first fastening result 138-4, and a second fastening result 138-5.

[0099]

The fastening result information 138 is specified by e.g. Line A as the fastening condition 138-1 and the applied point information. Individual bolt fastening conditions are stored. The fastening date and time 138-2 indicates a fastening date and time or time zone. The error determination result 138-3 indicates the determination result of whether or not the fastening status conforms to the fastening condition. The first fastening result 138-4 indicates a torque measurement value and the second fastening result 138-5 indicates a nut rotational angle.

[0100]

This fastening result information 138 contains, as the fastening result acquired from the fastening tool 4, both result

information lying in a log information table 98-1 (Fig. 4B) as shown in Fig. 10B and result information lying in a log information table 98-2 (Fig. 4B) having additional relevant information such as work date and time and worker, as shown in Fig. 11.

5 [0101]

The log information table 98-1 contains, as shown in Fig. 10B, not only the applied point information, the flange information 90, the gasket information 92, the fastening portion information, and the fastening condition information, similar to the fastening  
10 condition information (Fig. 7) but also a fastening result associated therewith. The fastening result is fastening result information acquired from the fastening tool 4.

[0102]

This log information table 98-1 includes a line information  
15 part 98-11, a flange information part 98-12, a gasket information part 98-13, a bolt information part 98-14, a fastening condition information part 98-15, a fastening result information part 98-16, and a worker ID part 98-17.

[0103]

20 The log information table 98-2 includes, as shown in Fig. 11, a line information part 98-21, a flange information part 98-22, a gasket information part 98-23, a fastening condition information part 98-25, and a worker ID part 98-27, similar to the log information table 98-1 (Fig. 10B) and further includes a fastening  
25 date and time part 98-28, an error determination part 98-29, a first round fastening result part 98-30, a final round fastening result part 98-31, and a round number-of-times part 98-32. The worker ID part 98-27 stores a worker ID similar to the worker ID part 98-17. Consequently, a worker is specified in association with the flange  
30 12. In the log information table 98-2, the bolt information part 98-14 is omitted dissimilar to the log information table 98-1.

[0104]

The fastening date and time part 98-28 stores a date and time of fastening. Consequently, the fastening date is specified in

association with the flange 12. The error determination part 98-29 indicates a determination result of whether the fastening status conforms to the fastening condition, with "OK" being conformable or "NG" being unconformable. The first round fastening result part 5 98-30 indicates a first round fastening result (torque) in round pattern tightening of a plurality of bolts 16 on the flange 12. The final round fastening result part 98-31 indicates a final round fastening result (torque) in the round pattern tightening of the plurality of bolts 16. The round number-of-times part 98-32 10 indicates the number of times of round.

[0105]

<Fastening Procedure>

[0106]

Fig. 12 shows a fastening procedure of the flange fastening 15 managing system 2 (Fig. 1) according to Example 1.

[0107]

In this procedure, as shown in Fig. 12, the worker information 94 is acquired at the time of start of fastening (S201). For the acquisition of this worker information 94, the worker information 20 94 is read from the bar code 116 on the worker tag 93 by the bar code reader 86.

[0108]

After this process, the controller 6 performs determination of whether the worker information 94 is read (S202). If the worker 25 information 94 is not read (NO at S202), the controller 6 makes the display unit 84 provide an error indication (S203), to turn on the red lamp 84-2, for example. This urges the worker 112 to reread the worker information 94 so that the bar code 116 can again be read by the bar code reader 86. As a result, if the worker 30 information 94 can be acquired, the controller 6 makes the display unit 84 turn off the red lamp 84-2 and turn on the green lamp 84-1, to display that the worker information 94 has been acquired.

[0109]

If the worker information 94 is read (YES at S202), the flange

information 90 is acquired (S204). For the acquisition of this flange information 90, similar to the worker information 94, the flange tag information 124 (Fig. 8B) is read from the flange tag 42 by the bar code reader 86. Although the determination is not  
5 made of whether the flange information 90 is read in this example, the read error may be determined similar to the worker information 94 described above.

[0110]

After the read of this flange information 90, the gasket  
10 information 92 is acquired (S205). For the acquisition of this gasket information 92, the gasket tag information is read from the bar code 134 on the gasket tag 44 by the bar code reader 86.

[0111]

After the acquisition of the worker information 94, the flange  
15 information 90, and the gasket information 92, it is determined whether the gasket 14 fits the flange 12 (S206). In other words, it is determined whether the gasket information 92 acquired from the gasket 14 conforms to the gasket information contained in the flange information 90.

20 [0112]

If the gasket 14 does not fit the flange 12 (NO at S206), the display unit 84 is made to provide an error indication (S207). This error indication is for example turning on the red lamp 84-2. This urges the worker 112 to reselect a fitting gasket 14. As a result,  
25 if the fitting gasket 14 is selected, the red lamp 84-2 is turned off and the green lamp 84-1 is turned on.

[0113]

Hence, the gasket 14 conforming to the worker information 94 and the flange information 90 is selected so that the precondition  
30 for fastening is met. At this time, the fastening condition is automatically selected from the fastening condition information (S208) and is set in the fastening tool 4 by the controller 6.

[0114]

When the fastening condition is set, fastening of nuts 18 is

executed using the fastening tool 4 (S209). The controller 6 acquires the fastening result information from the fastening tool 4 (S210). This result information contains the fastening result such as the torque  $\tau$  and the nut rotational angle described above.

5 [0115]

The controller 6 determines from the acquired result information whether the fastening result conforms to the fastening condition (S211). If the fastening result does not conform to the fastening condition (NO at S211), an error indication is provided (S212). The red lamp 84-2 is turned on for the error indication, and thereby informs the worker 112 that the fastening result conforming to the fastening condition has not been obtained.

10 [0116]

The controller 6 then records the fastening result containing the error determination (S213). The fastening result is recorded in the log information table 98-1 (S214). This process is then completed.

15 [0117]

The recorded information can be output to the external memory 88 so that the above-described log information table 98-2 can be displayed on the monitor 40 of the server 8 by mounting the external memory 88 on the server 8.

20 [0118]

<Processing Procedure from Preparation for Fastening to Execution of Fastening>

25 [0119]

Fig. 13 shows a processing procedure from the preparation for fastening to the execution of fastening. Prior to the fastening of the flange, the worker information 94 is acquired from the worker tag 93 (S301), the flange information 90 is acquired from the flange tag 42 (S302), and then the gasket information 92 is acquired from the gasket tag 44 (S303). After them, collation of the gasket information contained in the flange information 90 with the gasket information representing the actual gasket 14 and determination

30

are executed (S304). In this collation and determination (S304), it is determined whether the gasket fits the flange (S305). It is thereby determined whether the selected gasket fits the flange to be fastened.

5 [0120]

If the gasket 14 does not fit the flange 12 (NO at S305), the red lamp 84-2 is turned on as an error indication (S306), returning to S303. That is, the worker 112 is informed by lighting the red lamp 84-2 that the gasket 14 does not fit, and is urged to replace the gasket 14.

10

[0121]

When the gasket 14 is reselected, the gasket information 92 is acquired from the gasket tag 44 on that gasket 14 (S303) and the collation and determination are again executed (S304). As a result, if the gasket 14 fits the flange 12 (YES at S305), the green lamp 84-1 is turned on as a fitness indication (S307), and a selection of the fastening condition is enabled (S308). This means that if the green lamp 84-1 is not turned on, the selection of the fastening condition is blocked.

15

20 [0122]

In the selection of the fastening condition, the fastening condition table 96 lying in the storing unit 76 is referred to so that the fastening condition number is selected from this fastening condition table 96 (S308).

25 [0123]

This fastening condition number is input to the fastening tool 4 (S309) to lead to the execution of fastening (S310). This execution of fastening is carried out by the worker 112 with the fastening tool 4.

30 [0124]

<Processing Procedure from Post-Fastening to Output of Log Information>

[0125]

Fig. 14 shows a processing procedure from the post-fastening

to the output of the log information. The fastening result is acquired from the fastening tool 4 (S401) and is temporarily stored in the temporary storage area 76-1 of the storing unit 76. This fastening result contains a detection torque of the torque sensor 52. The log information table 98-1 is created from this fastening result.

[0126]

For this fastening result, the fastening condition number X in the fastening condition table 96 is referred to, and this fastening result is determined (S402). It is determined in this determination whether the fastening result conforms to the fastening condition (S403).

[0127]

If the fastening result conforms to the fastening condition (YES at S403), the green lamp 84-1 is turned on as an indication of fitness (S404), whereas if the fastening result does not conform to the fastening condition (NO at S403), the red lamp 84-2 is turned on as an indication of unfitness.

[0128]

The log information table 98-1 is created from the fastening result, this log information is organized and processed, and the log information table 98-2 is created (S405).

[0129]

This log information table 98-2 is written in the external memory 88 for example and can be provided via the external memory 88 to the server 8 to be presented (S406). This log information table 98-2 may wirelessly be transferred from the controller 6 to the server 8.

[0130]

<Effect of Example 1>

[0131]

(1) Since the manager provides the fastening condition from the server 8 to the controller 6, the fastening condition can strictly be managed so that a good traceability can be built.

[0132]

(2) Since the controller 6 storing the fastening condition information is provided to the worker in charge of the fastening of the flange 12, the management of the fastening condition can be facilitated and the burden on the worker can be reduced.

[0133]

(3) Since the fastening condition information is provided from the server 8 to the controller 6 at the time of fastening of the flange, the execution of fastening can be bound to the fastening condition information lying within the controller 6, to enhance the reliability in the execution of fastening.

[0134]

(4) Since after selection of the flange 12, the gasket information obtained from the selected gasket 14 is collated with the gasket information existing in the flange information to determine the fitness or unfitness, the gasket fitting the flange 12 can be selected.

[0135]

(5) If the gasket 14 does not fit, lighting of the red lamp 84-2 can urge the worker to replace the gasket 14 so that a fitting gasket 14 can be selected.

[0136]

(6) If it cannot be confirmed through the collation of the gasket 14 whether or not the gasket 14 fits, the shift to the step of providing the fastening condition is blocked. Since the fastening condition is selected after decision of the flange 12 and the gasket 14, the consistent management of the flange 12, the gasket 14, and the fastening condition can be implemented.

[0137]

(7) Since the conforming fastening condition can automatically be selected from the fastening condition information through the condition of (6) above, there is no need to force the worker to manage the fastening condition so that the burden on the worker can be reduced from setting the fastening condition. It is

thus possible to obviate and automatize the setting of the fastening condition that relies on the worker's experience and intuition and to prevent a troublesome work with the written instructions and miss input and miss fastening arising from the written instructions.

5 Since this fastening condition can individually and specifically be provided from the server 8 to the controller 6, it is possible to avoid a general work such as fastening all the bolts with the same torque for example, to achieve a precise fastening result. It is possible to perform a high-precision torque management  
10 provided by the fastening condition information and to reliably and effectively perform fastening with a torque  $\tau$  differing from bolt to bolt that is to be fastened. It is thus possible to implement a high-precision flange fastening management that far exceeds the management relying on the worker's personality and intuition.

15 [0138]

(8) Since the flange information is acquired from the flange tag 42 attached to the flange 12 and the gasket information is acquired from the gasket tag 44 attached to the gasket 14, the reliability of the flange information and the gasket information  
20 can be increased and the work for information acquisition can be reduced.

[0139]

(9) By imparting an information code such as bar code and QR code (registered trademark) to the flange tag 42 and the gasket  
25 tag 44 and using an input device such as the bar code reader 86, the rapidity and reliability of the information acquisition can be increased.

[0140]

(10) During the fastening of the flange 12, it can be  
30 determined whether the fastening condition is satisfied. The satisfactoriness judgment of the fastening condition during the fastening may include good or bad judgment of defective members or poor works such as defective fastening, bad bolt 16 or nut 18, failure arising from fastening, improper double fastening of the

same bolt, wrong fastening order, and forgetting of fastening. As a result of these satisfactoriness judgments, OK/NG of the fastening result can be determined and can be recorded as the fastening result into the log information. These determination and recording are performed synchronously and concurrently with the flange fastening, leading to a high reliable working result without impairing the work efficiency.

[0141]

(11) Such a fastening result containing the OK/NG information can be provided from the fastening tool 4 to the controller 6 for recording and then provided as log information from the controller 6 to the server 8. The controller 6 can organize the fastening results, and excerpt and edit necessary pieces of information instead of all pieces of information to create log information.

[0142]

(12) This fastening result information is gathered into the log information tables 98-1 and 98-2, and can be transferred from the controller 6 to the external memory 88. By removing this external memory 88 from the controller 6 and mounting this external memory 88 on the server 8, the log information table 98-2 can be presented.

[0143]

(13) By showing the log information table 98-2, the manager can easily know whether the fastening result conforming to the fastening condition is obtained. From the log information table 98-2, the manager can know the result of error determination as the OK/NG information in the fastening result associated with the flange 12. Since the fastening result contains detailed relevant information such as working date associated with the flange 12, the manager can easily know the details of the working result.

[0144]

(14) Since the worker information is acquired in association with the flange, a worker or an execution company in charge can easily be known from the working result together with the date and

time. Since in particular the OK/NG determination of the gasket information associated with the flange 12 is performed prior to the fastening, use of an unfitting gasket can be obviated.

Example 2

5 [0145]

Fig. 15 shows processing processes of the gasket 14 from formation to sorting. For formation of the gasket 14, there are used, as shown in Fig. 15A, plural types of gasket material plates 140-1, 140-2, ..., and 140-N as raw materials of the gasket 14.

10 [0146]

As an example of forming processing of gaskets 14-11, 14-12, ..., 14-1N, 14-21, 14-22, ..., 14-2N, ..., 14-N1, 14-N2, ..., and 14-NN, the gasket material plates 140-1, 140-2, ..., and 140-N are subjected to punching, to create the gaskets 14-11, 14-12, ..., 14-1N, 14-21, 14-22, ..., 14-2N, ..., 14-N1, 14-N2, ..., and 14-NN of predetermined shapes individually fitting various flanges 14, as shown in Fig. 15B.

[0147]

The gaskets 14-11, 14-12, ..., 14-1N, 14-21, 14-22, ..., 14-2N, ..., 14-N1, 14-N2, ..., and 14-NN are individually stored into the fitting gasket cases 126-1, 126-2, ..., and 126-N as shown in Fig. 15C, and thereafter are sorted and stored in a plurality of gasket racks 142-1, 142-2, ..., and 142-N for exclusive use. The racks 142-1, 142-2, ..., and 142-N are an example of sorting means.

25 [0148]

Rack tags 144-1, 144-2, ..., and 144-N for identification are attached to the racks 142-1, 142-2, ..., and 142-N. The racks or the stored gaskets is identifiable by the rack tags 144-1, 144-2, ..., and 144-N.

30 [0149]

Fig. 16 shows racks 142 that are sorted on a line-by-line basis. In this example, there are disposed a line A rack 142-A, a line B rack 142-B, a line C rack 142-C, and a line D rack 142-D that are set as a plurality of dedicated racks on a line-by-line basis.

The line A rack 142-A is used for the line A and is distinguished from the other line use. The line B rack 142-B to the line D rack 142-D are similarly used for lines B to D respectively and are similarly distinguished from the other line use.

5 [0150]

Each of the racks 142-A to 142-D stores the gasket cases 126 storing gaskets 14 that are used in a corresponding line.

[0151]

<Effect of Example 2>

10 [0152]

(1) The racks 142-1, 142-2, ..., and 142-N can store the sorted gaskets 14-11, 14-12, ..., 14-1N, 14-21, 14-22, ..., 14-2N, ..., 14-N1, 14-N2, ..., and 14-NN and can for example store a predetermined number of gaskets so that the consumed number or the refilled number can be managed.

15 [0153]

(2) The line A rack 142-A, the line B rack 142-B, the line C rack 142-C, and the line D rack 142-D can store the sorted gaskets 14 needed for each of the lines. This can prevent to mix the gaskets 14 for one line with the gaskets 14 for another line, and a high reliable fastening management can be achieved.

20 [0154]

(3) Rack tags 144 are attached to the racks 142-1, 142-2, ..., and 142-N and the line A rack 142-A, the line B rack 142-B, the line C rack 142-C, and the line D rack 142-D so that a use destination and a gasket 14 to be stored can be specified by these rack tags 144.

25 [0155]

(4) The racks 142-1, 142-2, ..., and 142-N and the line A rack 142-A, the line B rack 142-B, the line C rack 142-C, and the line D rack 142-D are recyclable and can provide the required gaskets 14 and the numerical quantity of the required gaskets 14 to an execution site neither too much nor too little.

30 [0156]

(5) In the racks 142-1, 142-2, ..., and 142-N and the line A rack 142-A, the line B rack 142-B, the line C rack 142-C, and the line D rack 142-D storing a required number of gaskets 14, the increase or decrease change can visually be checked by the execution of fastening, so that forgetting to refill the gaskets 14 can be prevented.

Example 3

[0157]

Fig. 17 shows a processing procedure of action control of a flange fastening tool according to Example 3.

[0158]

Although a fastening torque applied from the fastening tool 4 to the nut 18 is monitored by the torque sensor 52 whose sensor output can be acquired by the controller 6, fastening status information as well as the fastening torque information may contain not only information of the fitness/unfitness of the gasket 14 to the flange 12, but also e.g. information of a) separation of the socket 23 from the nut 18 and b) defect of the bolt 16 and the nut 18.

[0159]

The a) separation of the socket 23 from the nut 18 occurs, e.g. when the socket 23 comes off from the nut 18 during fastening due to incomplete meshing of the socket 23 of the fastening tool 4 with the nut 18. In this case, the torque sensor 52 of the fastening tool 4 is used as detection means. The detection torque  $\tau$  is a proper torque if the detection torque  $\tau$  is e.g. 99.5 to 100.5 [%] of a set torque. Since the detection torque  $\tau$  reduces at the moment that the socket 23 comes off, the worker can know the separation of the socket 23. The b) defect of the bolt 16 and the nut 18 causes insufficient fastening by rust, etc.

[0160]

In processing of the controller 6, during the fastening of the flange 12, the controller 6 acquires fastening status information from the fastening tool 4 as shown in Fig. 17 (S501).

[0161]

The controller 6 makes a determination of whether such the fastening result or the fastening status conforms to the fastening condition (S502). In this determination, it is judged whether the fastening conforms to the fastening condition (S503).

[0162]

If the fastening does not conform to the fastening condition (NO at S503), the controller 6 turns on the red lamp 84-2 as an error indication (S504), instructs to stop supply of power to the motor 50 as an action prohibition proceeding to the fastening tool 4 (S505), and turns to S501. This can prohibit an improper work and require the worker to deal with.

[0163]

If the fastening conforms to the fastening condition (YES at S503), the controller 6 turns on the green lamp 84-1 as a conformity indication (S506), allowing the fastening under the fastening condition to be executed.

[0164]

Such processing can be performed at any time among pre-execution, in-execution, and post-execution of fastening of the flange 12 and is continuously carried out from the pre-execution to the post-execution.

[0165]

<Effect of Example 3>

[0166]

(1) Since the drive of the fastening tool 4 is forcibly stopped if the fastening does not conform to the fastening condition during the execution of fastening, improper fastening processing can be obviated, so that the reliability of the fastening processing can be enhanced.

[0167]

(2) Since the drive of the fastening tool 4 is stopped by the discontinuance of power supply if the fastening is in inconformity with the fastening condition during the execution of fastening,

forced improper fastening can be blocked, so that the occurrence of a contingency can be obviated.

[0168]

(3) Not only the reliability of the execution but also the  
5 worker safety can be enhanced.

[0169]

[Other Embodiment]

[0170]

(1) Although in the above examples the worker information 94  
10 is acquired previous to acquisition of the flange information 90 and the gasket information 92, the flange information 90 and the gasket information 92 may be acquired previous to the acquisition of the worker information 94.

[0171]

(2) Although in the one embodiment and the examples the  
15 controller 6 and the server 8 are described as independent devices, the controller 6 may have the function of the server 8. In other words, the controller 6 and the server 8 may integrally be configured.

20 [0172]

(3) The controller 6 may be a handheld information terminal such as a smartphone.

[0173]

(4) Although in the one embodiment and the examples the  
25 controller 6 and the server 8 are set to a single fastening tool 4 by way of example, the controller 6 and the server 8 may be set to a plurality of fastening tools 4, and a single server 8 may be provided for a plurality of controllers 6.

[0174]

(5) Although in the examples the worker information, the  
30 flange, the fastening condition, and the evaluation result are presented in association with the flange information, the flange, the fastening condition, and the evaluation result may be presented in association with the worker information.

(6) Although in the examples the gasket information is indicated by the gasket tag and the gasket information is acquired from the gasket tag, the gasket information may directly be indicated on the gasket, so that the gasket information is acquired from the gasket.

[0175]

As set forth hereinabove, the most preferred embodiment and examples of the present invention have been described. The present invention is not limited to the above descriptions. Those skilled in the art could variously modify or change the present invention, based on the spirit of the present invention defined in claims or disclosed in description of embodiments or examples. It is natural that such modifications and changes be encompassed within the scope of the present invention.

#### INDUSTRIAL APPLICABILITY

[0176]

According to the flange fastening managing method, fastening managing system, fastening managing program, and fastening managing device of the present invention, by use of the fastening tool with a flange fastening function and the computer there can be implemented consistent management of multi-function processing such as flange and gasket selection, fastening condition setting, fastening status determination, fastening result recording, and their information presentation, thus enabling the flange fastening management not depending on the worker's experience and intuition to be advantageously implemented.

#### REFERENCE SIGNS LIST

[0177]

- 2 flange fastening managing system
- 4 flange fastening tool
- 6 controller
- 8 server computer
- 10 flange fastening portion
- 12 flange

|    |      |                         |
|----|------|-------------------------|
|    | 14   | gasket                  |
|    | 16   | bolt                    |
|    | 18   | nut                     |
|    | 20   | device body             |
| 5  | 22   | grip                    |
|    | 23   | socket                  |
|    | 24   | trigger                 |
|    | 26   | cable                   |
|    | 28   | front panel unit        |
| 10 | 30   | input key               |
|    | 32   | display unit            |
|    | 34   | broken line             |
|    | 36   | processing unit         |
|    | 38   | input operating unit    |
| 15 | 40   | monitor                 |
|    | 42   | flange tag              |
|    | 44   | gasket tag              |
|    | 48   | control unit            |
|    | 50   | motor                   |
| 20 | 52   | torque sensor           |
|    | 54   | trigger switch          |
|    | 56   | rotational shaft        |
|    | 74   | processor               |
|    | 76   | storing unit            |
| 25 | 76-1 | temporary storage area  |
|    | 76-2 | storage area            |
|    | 78   | input/output unit (I/O) |
|    | 80   | input operating unit    |
|    | 82   | communicating unit      |
| 30 | 84   | display unit            |
|    | 84-1 | green lamp              |

|    |                |                                      |
|----|----------------|--------------------------------------|
|    | 84-2           | red lamp                             |
|    | 86             | bar code reader                      |
|    | 88             | external memory                      |
|    | 90             | flange information                   |
| 5  | 92             | gasket information                   |
|    | 93             | worker tag                           |
|    | 94             | worker information                   |
|    | 96             | fastening condition table            |
|    | 96-1           | line information part                |
| 10 | 96-2           | flange information part              |
|    | 96-3           | gasket information part              |
|    | 96-4           | bolt information part                |
|    | 96-5           | fastening condition information part |
|    | 98, 98-1, 98-2 | log information table                |
| 15 | 98-11, 98-21   | line information part                |
|    | 98-12, 98-22   | flange information part              |
|    | 98-13, 98-23   | gasket information part              |
|    | 98-14          | bolt information part                |
|    | 98-15, 98-25   | fastening condition information part |
| 20 | 98-16          | fastening result information part    |
|    | 98-17, 98-27   | worker ID part                       |
|    | 98-28          | fastening date and time part         |
|    | 98-29          | error determination part             |
|    | 98-30          | first round fastening result part    |
| 25 | 98-31          | final round fastening result part    |
|    | 98-32          | round number-of-times part           |
|    | 100            | processor                            |
|    | 102            | storing unit                         |
|    | 104            | input/output unit (I/O)              |
| 30 | 106            | communicating unit                   |
|    | 108            | touch panel                          |
|    | 110            | worker information table             |
|    | 110-1          | ID part                              |
|    | 110-2          | company name part                    |

|    |                          |                              |
|----|--------------------------|------------------------------|
|    | 110-3                    | worker name part             |
|    | 112                      | worker                       |
|    | 116                      | bar code                     |
|    | 118                      | worker tag information       |
| 5  | 120                      | lead                         |
|    | 122                      | bar code                     |
|    | 124                      | flange tag information       |
|    | 124-1                    | line name                    |
|    | 124-2                    | flange information           |
| 10 | 124-3                    | gasket information           |
|    | 124-4                    | fastening procedure          |
|    | 126                      | gasket case                  |
|    | 128                      | case body                    |
|    | 130                      | lid                          |
| 15 | 132                      | transparent window           |
|    | 134                      | bar code                     |
|    | 136                      | gasket tag information       |
|    | 138                      | fastening result information |
|    | 138-1                    | fastening condition          |
| 20 | 138-2                    | fastening date and time      |
|    | 138-3                    | error determination result   |
|    | 138-4                    | first fastening result       |
|    | 138-5                    | second fastening result      |
|    | 142-1, 142-2, ..., 142-N | rack                         |
| 25 | 142-A                    | line A rack                  |
|    | 142-B                    | line B rack                  |
|    | 142-C                    | line C rack                  |
|    | 142-D                    | line D rack                  |

## CLAIMS

1. A flange fastening managing method in which a computer as well as a fastening tool are used, the fastening tool  
5 fastening flanges with a gasket by a plurality of bolts and nuts, the gasket being sandwiched between the flanges, the method comprising the steps of:

acquiring fastening condition information associated with the flanges;

10 acquiring gasket part number information and fastening condition number information from a flange tag attached to the flanges, the gasket part number information and the fastening condition number information conforming to the flanges;

15 collating the gasket part number information acquired from the flange tag with gasket part number information of a gasket to be used, to determine whether the gasket fits the flanges;

selecting a fastening condition number based on the fastening condition number information acquired from the flange tag when the gasket selected fits the flanges, selecting a  
20 fastening condition associated with the fastening condition number from the fastening condition information, setting the fastening condition in the fastening tool, and applying a fastening torque from the fastening tool to the bolts or the nuts under the fastening condition;

25 acquiring, from the fastening tool, the fastening torque applied from the fastening tool to the bolts or the nuts, to evaluate whether fastening of the flanges conforms to the fastening condition; and

30 stopping a drive of the fastening tool when the fastening of the flanges does not conform to the fastening condition.

2. The flange fastening managing method of claim 1,

further comprising the steps of:

presenting fastening result information containing at least the fastening condition and a result of the evaluation in association with the flanges.

5

3. A flange fastening managing method in which a computer as well as a fastening tool are used, the fastening tool fastening flanges with a gasket by a plurality of bolts and nuts, the gasket being sandwiched between the flanges, the method comprising the steps of:

10

acquiring fastening condition information associated with the flanges;

acquiring, from a flange tag attached to the flanges, flange information containing gasket part number information and fastening condition number information, the gasket part number information and the fastening condition number information conforming to the flanges;

15

acquiring gasket part number information from a gasket or from a gasket tag attached to a gasket case;

20

collating the gasket part number information acquired from the flange tag with the gasket part number information acquired from the gasket or the gasket tag, to determine whether the gasket fits the flanges;

selecting a fastening condition number based on the fastening condition number information acquired from the flange tag when the gasket fits the flanges, selecting a fastening condition associated with the fastening condition number from the fastening condition information, and setting the fastening condition in the fastening tool;

25

acquiring, from the fastening tool, a fastening torque applied from the fastening tool to the nuts, to evaluate whether fastening of the flanges conforms to the fastening

30

condition;

presenting fastening result information containing at least the fastening condition and a result of the evaluation in association with the flanges; and

5        stopping a drive of the fastening tool when the fastening of the flanges does not conform to the fastening condition.

4.     The flange fastening managing method of claim 1 or 3, further comprising the step of:

10       outputting presentation information indicative of whether the gasket fits the flanges.

5.     The flange fastening managing method of claim 1, 3 or 4, wherein

15       the evaluation whether the fastening of the flanges conforms to the fastening condition makes during fastening of the flanges.

6.     The flange fastening managing method of any one of claims 3 to 5, further comprising the steps of:

acquiring worker information from a worker tag; and

presenting the flange information, the fastening condition, and the result of the evaluation in association with the worker information.

25

7.     The flange fastening managing method of any one of claims 3 to 6, wherein

the fastening condition number information is information indicative of a fastening procedure.

30

8.     The flange fastening managing method of any one of claims 3 to 7, wherein

the fastening condition information contains the flange information.

9. The flange fastening managing method of any one of  
5 claims 3 to 8, further comprising the steps of:  
forming a gasket from a gasket material; and  
attaching the gasket tag to the gasket case for the gasket.

10. A flange fastening managing system comprising:  
10 a fastening tool that fastens a plurality of bolts and nuts  
attached to flanges, a gasket being sandwiched between the  
flanges;

a controller that controls a fastening action of the  
fastening tool; and

15 a server that is connected to the controller by wire or  
wireless, wherein

the controller acquires, from the server, fastening  
condition information associated with the flanges,

the controller acquires, from a flange tag attached to the  
20 flanges, flange information containing gasket part number  
information and fastening condition number information, the  
gasket part number information and the fastening condition  
number information conforming to the flanges and acquires  
gasket part number information from the gasket or from a gasket  
25 tag attached to a gasket case,

the controller collates the gasket part number information  
acquired from the flange tag with the gasket part number  
information acquired from the gasket or the gasket tag, to  
determine whether the gasket fits the flanges,

30 the controller selects a fastening condition number based  
on the fastening condition number information acquired from the  
flange tag when the gasket fits the flanges, selects a

fastening condition associated with the fastening condition number from the fastening condition information, and sets the selected fastening condition in the fastening tool,

the controller acquires, from the fastening tool, a  
5 fastening torque applied from the fastening tool to the nuts, to evaluate whether fastening of the flanges conforms to the fastening condition,

the controller provides, to the server, fastening result information containing at least the fastening condition and a  
10 result of the evaluation in association with the flanges, and

the controller stops a drive of the fastening tool when the fastening of the flanges does not conform to the fastening condition.

15 11. A flange fastening managing program for making a computer implement functions, the computer being used for control of a fastening tool that fastens flanges with a gasket by a plurality of bolts and nuts, the gasket being sandwiched between the flanges, the functions being:

20 acquiring fastening condition information associated with the flanges;

acquiring, from a flange tag attached to the flanges, flange information containing gasket part number information and fastening condition number information, the gasket part  
25 number information and the fastening condition number information conforming to the flanges;

acquiring gasket part number information from a gasket or a gasket tag;

30 collating the gasket part number information acquired from the flange tag with the gasket part number information acquired from the gasket or the gasket tag, to determine whether the gasket fits the flanges;

selecting a fastening condition number based on the fastening condition number information acquired from the flange tag when the gasket fits the flanges, selecting a fastening condition associated with the fastening condition number from the fastening condition information, and setting the selected fastening condition in the fastening tool;

acquiring, from the fastening tool, a fastening torque applied from the fastening tool to the nuts, to evaluate whether fastening of the flanges conforms to the fastening condition;

presenting fastening result information containing at least the fastening condition and a result of the evaluation in association with the flanges; and

stopping a drive of the fastening tool when the fastening of the flanges does not conform to the fastening condition.

12. A flange fastening managing device to be used with a fastening tool that fastens flanges with a gasket by a plurality of bolts and nuts, the gasket being sandwiched between the flanges, the device comprising:

an information acquiring unit that acquires fastening condition information associated with the flanges, that acquires, from a flange tag attached to the flanges, flange information containing gasket part number information and fastening condition number information, the gasket part number information and the fastening condition number information conforming to the flanges, that acquires gasket part number information from a gasket or from a gasket tag attached to a gasket case, and that acquires, from the fastening tool, a fastening torque applied from the fastening tool to the nuts;

a processing unit that collates the gasket part number information acquired from the flange tag with the gasket part

number information acquired from the gasket or the gasket tag,  
to determine whether the gasket fits the flanges, that, when  
the gasket fits the flanges, selects a fastening condition  
number based on the fastening condition number information  
5 acquired from the flange tag, that selects a fastening  
condition associated with the fastening condition number from  
the fastening condition information , and that sets the  
fastening condition in the fastening tool, to evaluate whether  
fastening of the flanges conforms to the fastening condition;  
10 and

an information presenting unit that presents fastening  
result information containing at least the fastening condition  
and a result of the evaluation in association with the flanges,  
wherein

15 the processing unit stops a drive of the fastening tool  
when the fastening of the flanges does not conform to the  
fastening condition.