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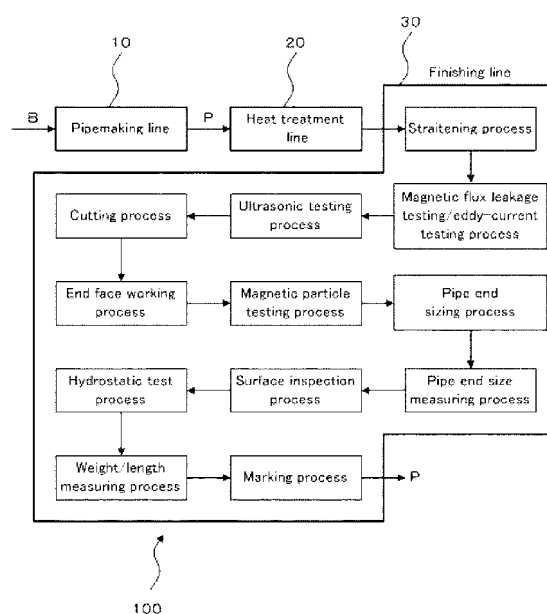
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(54) **STEEL PIPE PRODUCTION EQUIPMENT**

(57) The object of the present invention is to provide manufacturing equipment for steel pipe or tube which is excellent in the manufacturing efficiency of steel pipe or tube and can facilitate appropriate management of the traceability of steel pipe or tube.

Manufacturing equipment 100 for steel pipe or tube P according to the present invention comprises: a pipe-making line 10; a heat treatment line 20 directly connected to the pipe-making line; and a finishing line 30 directly connected to the heat treatment line. In the finishing line 30, at least a straightening process of straightening bends in a steel pipe or tube, an ultrasonic testing process of performing ultrasonic testing on the steel pipe or tube, a surface inspection process of inspecting a surface of the steel pipe or tube, a hydrostatic test process of subjecting the steel pipe or tube to a hydrostatic test, a weight/length measuring process of measuring the weight and length of the steel pipe or tube, and a marking process of applying a marking to the steel pipe or tube by using a stencil are carried out. The steel pipe or tube is not removed out of the lines in the middle of manufacture from the entry side of the pipe-making line to the exit side of the finishing line.

Figure 1



Description

[Technical Field]

[0001] The present invention relates to the manufacturing equipment for steel pipe or tube such as seamless steel pipe or tube. More specifically, the present invention relates to the manufacturing equipment for steel pipe or tube which is excellent in the manufacturing efficiency of steel pipe or tube and can facilitate appropriate management of the traceability of steel pipe or tube. Hereinafter, "pipe or tube" is referred to as "pipe" when deemed appropriate.

[Background Art]

[0002] General manufacturing equipment for seamless steel pipe includes a pipemaking line, a heat treatment line and a finishing line.

In the pipemaking line, steel pipe is manufactured by the Mannesmann-mandrel method. Specifically, in the pipe-making line, a piercing-rolling mill, a mandrel mill and a sizing mill are arranged. A billet heated in a rotary hearth type heating furnace is supplied to the pipemaking line and is first piercing-rolled by the piercing-rolling mill to produce a hollow shell. Next, a mandrel bar is inserted into the inside of the hollow shell and the hollow shell is elongation-rolled by the mandrel mill with the mandrel bar inserted therein, whereby a material pipe whose wall is reduced to a prescribed wall thickness is produced. After that, the mandrel bar is extracted, and the above-described material pipe is sized by the sizing mill to a prescribed outside diameter and a steel pipe is thus manufactured.

In the heat treatment line, the steel pipe manufactured in the pipemaking line is subjected to heat treatment. Specifically, the steel pipe is subjected to quenching in a quenching furnace arranged in the heat treatment line and is thereafter subjected to tempering in a tempering furnace.

In the finishing line, the steel pipe subjected to heat treatment in the heat treatment line is subjected to finishing. Specifically, bends in the steel pipe are straightened by a straightener, the steel pipe is inspected by an ultrasonic testing machine, and a marking in stencil form is applied.

[0003] Generally, in conventional manufacturing equipment of seamless steel pipe of the above-described arrangement, a pipemaking line, a heat treatment line and a finishing line are not directly connected to each other. For this reason, steel pipes manufactured in the pipemaking line are temporarily transferred to an intermediate in-process product warehouse, and are stored there. After that, in general, the steel pipes removed from the intermediate in-process product warehouse are supplied one by one to the heat treatment line and the finishing line.

For this reason, conventional manufacturing equipment is not suitable for manufacturing steel pipe in a short pe-

riod. In addition, in order to manage the traceability (information on manufacturing history) of steel pipe, a marking identifying each steel pipe is applied to the steel pipe surface or a bar code identifying each steel pipe is affixed to the steel pipe before transfer to the intermediate in-process product warehouse. In some cases, however, traceability cannot appropriately be managed because the marking applied to the steel pipe may disappear or the bar code affixed to the steel pipe may become unstuck.

[Summary of Invention]

[Technical Problem]

[0004] The present invention was made to solve such problems with the conventional technology, and the object of the present invention is to provide manufacturing equipment for steel pipe which is excellent in the manufacturing efficiency of steel pipe and can facilitate appropriate management of the traceability of steel pipe.

[Solution to Problem]

[0005] In order to solve the object mentioned above, the present invention provides manufacturing equipment for steel pipe or tube, comprising: a pipemaking line; a heat treatment line directly connected to the pipemaking line; and a finishing line directly connected to the heat treatment line, wherein in the finishing line, at least a straightening process of straightening bends in a steel pipe or tube, an ultrasonic testing process of performing ultrasonic testing on the steel pipe or tube, a surface inspection process of inspecting a surface of the steel pipe or tube, a hydrostatic test process of subjecting the steel pipe or tube to a hydrostatic test, a weight/length measuring process of measuring the weight and length of the steel pipe or tube, and a marking process of applying a marking to the steel pipe or tube by using a stencil are carried out, and wherein the steel pipe or tube is not removed out of the lines in the middle of manufacture from the entry side of the pipemaking line to the exit side of the finishing line.

[0006] According to the manufacturing equipment for steel pipe or tube of the present invention, the pipemaking line, the heat treatment line and the finishing line are directly connected to each other and, therefore, pipes or tubes are not transferred to the intermediate in-process product warehouse in the middle of manufacture. For this reason, the manufacturing equipment for steel pipe or tube of the present invention is excellent in the manufacturing efficiency of steel pipe or tube. In addition, it is unnecessary to apply markings and to affix bar codes before steel pipes or tubes are transferred to the intermediate in-process product warehouse, which has conventionally been carried out, and it is possible to appropriately manage the traceability of steel pipe or tube only by tracking the steel pipe or tube transferred in each line.

Furthermore, if defects are detected in the ultrasonic testing and the like processes which are carried out in the finishing line, it is possible on the basis of the detection result to rapidly adjust the pipemaking line and the heat treatment line.

[0007] Incidentally, the "surface inspection process" in the present invention means that the steel pipe or tube is stopped temporarily on the transfer equipment for steel pipe or tube arranged in the finishing line and the surface of the steel pipe or tube at rest is visually inspected by the worker.

[0008] Preferably, in the finishing line, at least one of a magnetic flux leakage testing process of performing magnetic flux leakage testing on the steel pipe or tube, an eddy-current testing process of performing eddy-current testing on the steel pipe or tube, a cutting process of cutting the steel pipe or tube, an end face working process of machining steel pipe or tube end faces, a magnetic particle testing process of performing magnetic particle testing on steel pipe or tube ends, a pipe or tube end sizing process of straightening the size of steel pipe or tube ends, and a pipe or tube end size measuring process of measuring the size of steel pipe or tube ends is further carried out.

[Advantageous Effects of Invention]

[0009] According to the manufacturing equipment for steel pipe or tube of the present invention, it is possible to ensure high manufacturing efficiency of steel pipe or tube and to appropriately manage the traceability of steel pipe or tube.

[Brief Description of Drawings]

[0010] Figure 1 is a block diagram schematically showing the manufacturing equipment for steel pipe of an embodiment of the present invention.

[Description of Embodiments]

[0011] Hereinafter, referring to the accompanying drawings appropriately, an embodiment of the present invention will be described by taking the case where the steel pipe is seamless steel pipe as an example.

Figure 1 is a block diagram schematically showing the manufacturing equipment for steel pipe of an embodiment of the present invention.

As shown in Figure 1, the manufacturing equipment 100 of steel pipe P of this embodiment is provided with a pipemaking line 10, a heat treatment line 20 directly connected to the pipemaking line 10, and a finishing line 30 directly connected to the heat treatment line 20. In the manufacturing equipment 100 of steel pipe P of this embodiment, the steel pipe P is not removed out of the lines in the middle of manufacture from the entry side of the pipemaking line 10 to the exit side of the finishing line 30.

[0012] In the pipemaking line 10, a piercing-rolling mill,

a mandrel mill and a sizing mill are arranged. A billet B heated in a rotary hearth type heating furnace is supplied to the pipemaking line 10 and is first piercing-rolled by the piercing-rolling mill to produce a hollow shell. Next, a mandrel bar is inserted into the inside of the hollow shell and the hollow shell is elongation-rolled by the mandrel mill with the mandrel bar inserted therein, whereby a material pipe whose wall is reduced to a prescribed wall thickness is produced. After that, the mandrel bar is extracted, and the above-described material pipe is sized by the sizing mill to a prescribed outside diameter and a steel pipe P is thus manufactured. The steel pipe P manufactured in the pipemaking line 10 is transferred by prescribed transfer equipment and supplied to the heat treatment line 20.

[0013] In the heat treatment line 20, the steel pipe P which has been manufactured in the pipemaking line 10 and transferred by prescribed transfer equipment arranged in the heat treatment line 20 is subjected to heat treatment. Specifically, the steel pipe P is subjected to quenching in the quenching furnace arranged in the heat treatment line 20, and then tempered in the tempering furnace arranged in the heat treatment line 20. The steel pipe P subjected to heat treatment in the heat treatment line 20 is transferred by prescribed transfer equipment and is supplied to the finishing line 30.

Here, in general manufacturing equipment for seamless steel pipe, the pipemaking pitch in the pipemaking line is faster than the heat treatment pitch in the heat treatment line. As described above, the steel pipe manufactured in the pipemaking line is temporarily transferred to the intermediate in-process product warehouse and stored there and, therefore, there is no problem even if the pipemaking pitch is faster than the heat treatment pitch. However, in the manufacturing equipment 100 of steel pipe P of this embodiment, the heat treatment line 20 is directly connected to the pipemaking line 10, and the steel pipe P is not removed out of the lines in the middle of manufacture. For this reason, it is necessary to match the pipemaking pitch in the pipemaking line 10 with the heat treatment pitch in the heat treatment line 20. The pipemaking pitch can be matched with the heat treatment pitch, for example, by matching the furnace-unloading pitch, in which a billet B heated in a rotary hearth type heating furnace is delivered from the heating furnace to outside the furnace en route for the pipemaking line 10, with either the quenching pitch in the quenching furnace or the tempering pitch in the tempering furnace of the heat treatment line 20, whichever the slower is.

[0014] In the finishing line 30 of this embodiment, at least the straightening process, the ultrasonic testing process, the surface inspection process, the hydrostatic test process, the weight/length measuring process, and the marking process are carried out for the steel pipe P transferred by prescribed transfer equipment arranged in the finishing line 30.

In the straightening process, bends in the steel pipe P are straightened by a straightener arranged in the finish-

ing line 30. In the ultrasonic testing process, the ultrasonic testing on the steel pipe P is carried out by an ultrasonic testing machine arranged in the finishing line 30. In the surface inspection process, the steel pipe P is stopped temporarily on the transfer equipment for steel pipe P arranged in the finishing line 30, and the surface of this steel pipe P at rest is visually inspected by the worker. In the hydrostatic test process, the hydrostatic test of the steel pipe P is carried out by a hydrostatic testing machine arranged in the finishing line 30. In the weight/length measuring process, the weight and length of the steel pipe P are measured. The weight of the steel pipe P is measured by a load cell arranged in the finishing line 30. The length of the steel pipe P is measured, for example, by using a laser-Doppler type length measuring device arranged in the finishing line 30, or it is also possible that the length of the steel pipe P stopped temporarily on the transfer equipment for steel pipe P is measured by the worker by use of a measuring tape. In the marking process, a marking in stencil form is applied to the steel pipe P by a marking device arranged in the finishing line 30.

[0015] In the finishing line 30 of this embodiment, as a preferable configuration, at least one of the magnetic flux leakage testing process, the eddy-current testing process, the cutting process, the end face working process, the magnetic particle testing process, the pipe end sizing process, and the pipe end size measuring process is further carried out.

In this embodiment, all of these processes are carried out. In the magnetic flux leakage testing process, the magnetic flux leakage testing on the steel pipe P is carried out by a magnetic flux leakage testing machine arranged in the finishing line 30. In the eddy-current testing process, the eddy-current testing on the steel pipe P is carried out by an eddy-current testing machine arranged in the finishing line 30. In the cutting process, the steel pipe P is cut by a cutter arranged in the finishing line 30. In the end face working process, end faces of the steel pipe P are worked (cut) by a facing machine arranged in the finishing line 30. In the magnetic particle testing process, the magnetic particle testing on ends (in particular, beveled faces) of the steel pipe P is carried out by a magnetic particle testing machine arranged in the finishing line 30. In the pipe end sizing process, the size of ends of the steel pipe P (in particular, the inside diameter of the steel pipe P) is corrected by a pipe end sizing machine arranged in the finishing line 30. In the pipe end size measuring process, the sizes of ends of the steel pipe P (in particular, the outside diameter, inside diameter and wall thickness of the steel pipe P) are measured by an optical or contact type pipe end size measuring machine arranged in the finishing line 30.

[0016] Incidentally, in the manufacturing equipment 100 of steel pipe P of this embodiment, for the steel pipe P supplied to the finishing line 30, the straightening process must be carried out first of all. Further, for the steel pipe P for which the straightening process has been carried out, the weight/length measuring process and the

marking process must be carried out in this order and in the last part of the finishing line 30. Other processes may not necessarily be carried out in the order shown in Figure 1.

5 However, it is necessary that the end face working process be carried out later than the cutting process. It is necessary that the magnetic particle testing process be carried out later than the end face working process. It is necessary that the surface inspection process be carried out later than the cutting process, the end face working process and the pipe end sizing process (however, when the surface inspection process is carried out after the cutting process and the end face working process and the pipe end sizing process is thereafter carried out, it is also possible to carry out the surface inspection process for only straightened pipe ends). It is necessary that the pipe end size measuring process be carried out later than the pipe end sizing process.

10 As in this embodiment shown in Figure 1, carrying out the cutting process later than the magnetic flux leakage testing process, the eddy-current testing process and the ultrasonic testing process is preferable in that, by cutting untested regions on the end of the steel pipe P in the cutting process, it is possible to eliminate the occurrence of untested regions in the steel pipe P after cutting. However, it is also possible to carry out the magnetic flux leakage testing process, the eddy-current testing process and the ultrasonic testing process later than the cutting process. In this case, in the magnetic flux leakage testing process, the eddy-current testing process and the ultrasonic testing process, ends of the steel pipe P can be manually tested or testing can be performed by using a testing machine for exclusive use in pipe ends.

15 **[0017]** According to the manufacturing equipment 100 of steel pipe P of this embodiment described above, the pipemaking line 10, the heat treatment line 20 and the finishing line 30 are directly connected, and hence it is not possible that the steel pipe P is transferred to the intermediate in-process product warehouse in the middle of manufacture. For this reason, this manufacturing equipment 100 of steel pipe P is excellent in the manufacturing efficiency of steel pipe P. In addition, it is unnecessary to apply a marking to the steel pipe P and to affix a bar code before the steel pipe P is transferred to the intermediate in-process product warehouse, which has conventionally been carried out, and it is possible to appropriately manage the traceability of the steel pipe P transferred in each of the lines 10 to 30 only by tracking the steel pipe P. Furthermore, if defects are detected in the steel pipe P in the ultrasonic testing process and the like which are carried out in the finishing line 30, it is possible to rapidly adjust the pipemaking line 10 and the heat treatment line 20 on the basis of the detection result.

20 [Reference Signs List]

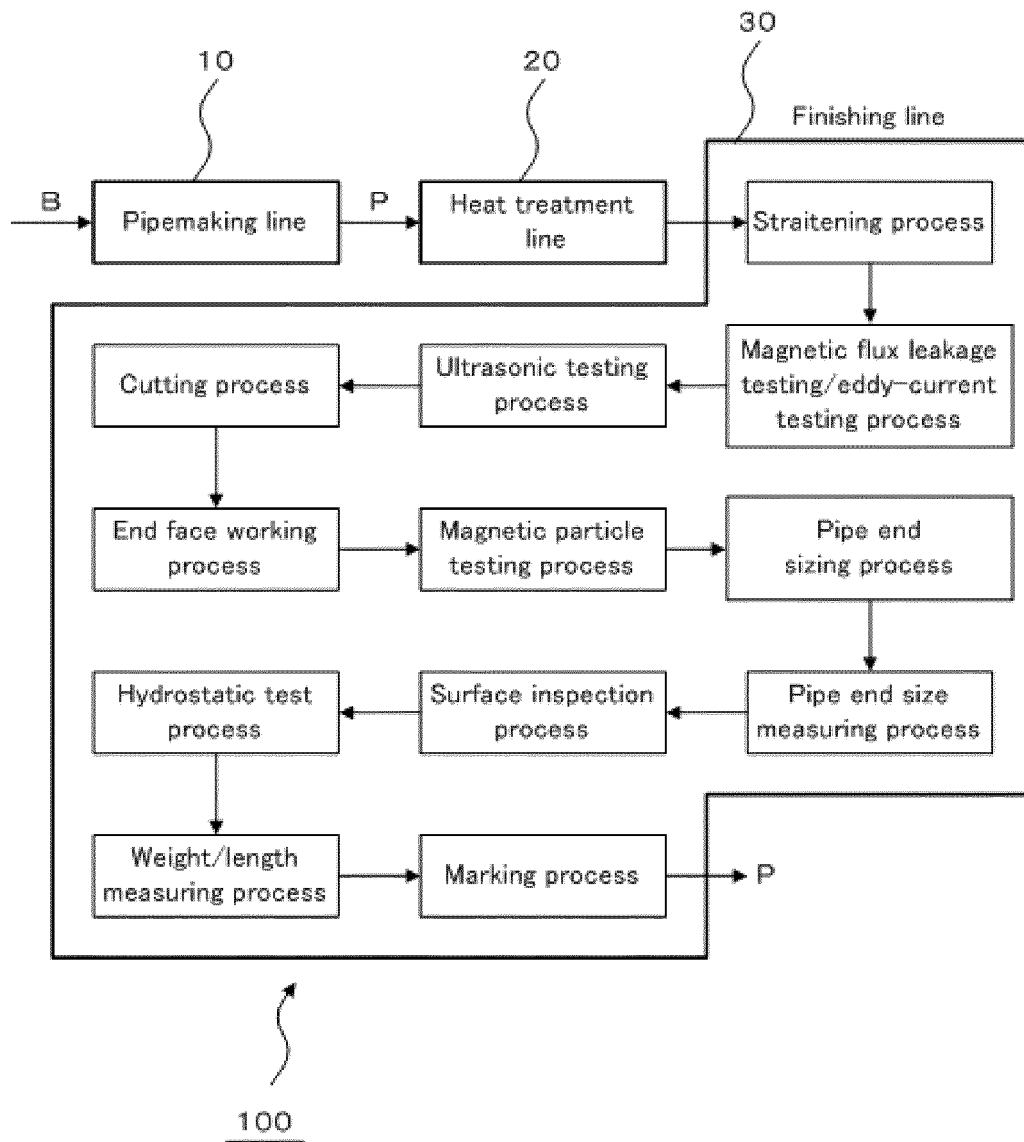
[0018]

10	Pipemaking line	
20	Heat treatment line	
30	Finishing line	
100	Manufacturing equipment	
B	Billet	5
P	Steel pipe	

Claims

- 10
1. Manufacturing equipment for steel pipe or tube, comprising:
- a pipemaking line;
- a heat treatment line directly connected to the pipemaking line; and 15
- a finishing line directly connected to the heat treatment line,
- wherein in the finishing line, at least a straightening process of straightening bends in a steel pipe or tube, an ultrasonic testing process of performing ultrasonic testing on the steel pipe or tube, a surface inspection process of inspecting a surface of the steel pipe or tube, a hydrostatic test process of subjecting the steel pipe or tube to a hydrostatic test, a weight/length measuring process of measuring the weight and length of the steel pipe or tube, and a marking process of applying a marking to the steel pipe or tube by using a stencil are carried out, and 20
- wherein the steel pipe or tube is not removed out of the lines in the middle of manufacture from the entry side of the pipemaking line to the exit side of the finishing line. 25
- 30
- 35
2. The manufacturing equipment for steel pipe or tube according to claim 1, wherein in the finishing line, at least one of a magnetic flux leakage testing process of performing magnetic flux leakage testing on the steel pipe or tube, an eddy-current testing process of performing eddy-current testing on the steel pipe or tube, a cutting process of cutting the steel pipe or tube, an end face working process of machining steel pipe or tube end faces, a magnetic particle testing process of performing magnetic particle testing on steel pipe or tube ends, a pipe or tube end sizing process of straightening the size of steel pipe or tube ends, and a pipe or tube end size measuring process of measuring the size of steel pipe or tube ends is further carried out. 40
- 45
- 50
- 55

Figure 1



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/057103

A. CLASSIFICATION OF SUBJECT MATTER

B21B23/00(2006.01)i, B21C37/30(2006.01)i, B21C51/00(2006.01)i, B23Q41/08(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B21B23/00, B21C37/30, B21C51/00, B23Q41/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2011

Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 11-70444 A (Sumitomo Metal Industries, Ltd.), 16 March 1999 (16.03.1999), fig. 1; paragraph [0010] (Family: none)	1-2
Y	WO 2009/122613 A1 (Sumitomo Metal Industries, Ltd.), 08 October 2009 (08.10.2009), entire text (Family: none)	1-2



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T"

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"

document member of the same patent family

Date of the actual completion of the international search
14 April, 2011 (14.04.11)Date of mailing of the international search report
26 April, 2011 (26.04.11)Name and mailing address of the ISA/
Japanese Patent Office

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