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(54) Method for continuously manufacturing cold-rolled steel

(57) A method for continuously manufacturing cold-rolled steel includes the steps of: providing coils (100) of white steel (400) that are manufactured by hot rolling a cast steel followed by annealing and pickling the cast steel; subjecting the coil (100) of white steel (400) to uncoiling and welding in an uncoiling-welding installation (21); passing the flattened and welded white steel (400) through a first strip accumulator (22) and a cold rolling device (23) for cold rolling the white steel (400) to result in a cold-rolled steel with a predetermined thickness; and processing the cold-rolled steel in sequence using a degreasing device (24), a second strip accumulator (25), an annealing-pickling installation (26), a third strip accumulator (27), a temper rolling device (28), a tension leveling device (29), a fourth strip accumulator (31), and a trimming-recoiling installation (32).

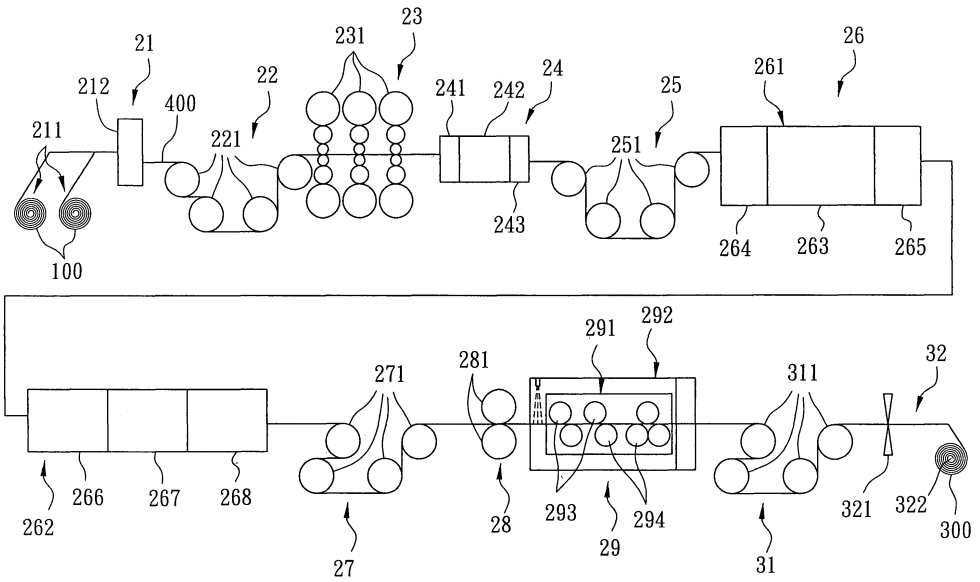

FIG. 2

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Description

[0001] The invention relates to a method for continuously manufacturing cold-rolled steel, more particularly to a method for continuously manufacturing cold-rolled steel from white steel.

[0002] A conventional process for making stainless steel essentially includes casting, hot rolling, and cold rolling. A steel slab obtained from casting is hot rolled to obtain a black steel coil, which is then annealed and pickled to obtain a white steel coil. The white steel coil can be further processed by cold rolling, annealing, pickling, temper rolling, tension leveling, etc., to obtain a steel coil product. The product obtained by cold rolling, annealing, and pickling is known as a 2D steel coil, and the product obtained by further temper rolling and tension leveling the 2D steel coil is known as a 2B steel coil.

[0003] Referring to Figure 1, a conventional process for manufacturing cold-rolled steel is conducted using a multi-stage production line including a steel coil preparation installation 11, a cold rolling installation 12, an annealing-pickling installation 13, a temper rolling installation 14, and a tension leveling installation 15, which are separate from one another.

[0004] The steel coil preparation installation 11 is used for uncoiling a white steel coil 100 into a white steel strip 400, which is welded with guide portions each having a length of 8-10 meters at two ends thereof and is then coiled into a steel coil 200. The steel coil 200 is transported to the cold rolling installation 12.

[0005] The steel coil 200 is uncoiled into a steel strip 400, which passes through the cold rolling installation 12. The cold rolling installation 12 is a 20-high cold rolling mill, and is used for cold rolling the steel strip 400 to have a predetermined thickness. The steel strip 400 after cold rolling is coiled into a steel coil 200, which is transported to the annealing-pickling installation 13.

[0006] The steel coil 200 is uncoiled into a steel strip 400, which passes through the annealing-pickling installation 13, in which the steel strip 400 is annealed, and is then pickled to remove scale from the steel strip 400. The steel strip 400 after pickling is coiled into a steel coil 200, which is the 2D steel coil.

[0007] The 2D steel coil 200 can be further transported to the temper rolling installation 14. The steel coil 200 is uncoiled into a steel strip 400, which passes through the temper rolling installation 14. The temper rolling installation 14 is used for imposing gloss on the steel strip 400. The steel strip 400 after temper' rolling is coiled into a steel coil 200, which is transported to the tension leveling installation 15.

[0008] The steel coil 200 is uncoiled into a steel strip 400, which passes through the tension leveling installation 15, in which the steel strip 400 is tension leveled, and is then trimmed and coiled to obtain a steel coil product 300 (i.e., the 2B steel coil).

[0009] Since the installations 11, 12, 13, 14, 15 for performing the conventional process for manufacturing a cold-rolled steel are separate from one another, multiple packaging operations, such as intermediate coiling operations, and transfer of coils from one installation to another are required. Furthermore, it is also costly in terms of energy consumption because of multiple operations of transporting intermediate product (coils) between installations. Additionally, storage of intermediate product takes up space.

[0010] In order to overcome the aforesaid shortcomings encountered in the conventional multi-stage production line, it is desirable in the art to develop a continuous production line for manufacturing cold-rolled steel.

[0011] U.S. Patent No. 6,478,899 discloses a method and an installation for making a cold-rolled stainless steel strip, and consists of continuously executing on a single production line all the process steps for fabricating a cold-rolled stainless strip from a thin strip cast directly from liquid metal, i.e., from the casting step through finishing steps to packaging the strip in the form of a coil. However, since the method and installation disclosed therein start from casting a stainless steel strip directly from liquid metal, the operating units and steps involved are relatively complicated. Therefore, the technique disclosed therein is impractical for use in the industry.

[0012] U.S. Patent No. 6,546,771 discloses a method for manufacturing strips of stainless steel, which comprises rolling in cold condition of strips which in a foregoing process have been manufactured through strip casting and/or have been hot rolled. According to various specific wants of the final product, the stainless steel shall pass once or twice through a rolling mill line. Additionally, the rolling mill line or parts of it also can be used for processes which are aimed at manufacturing strips with various specific features that are of significant importance for some applications. Since parts of the rolling mill line should be stopped in view of the specific requirements for the final product, the utilization rate of the rolling mill line is relatively low.

[0013] It is still desirable in the art to provide an improved method for continuously manufacturing cold-rolled steel.

[0014] Therefore, the object of the present invention is to provide a method for continuously manufacturing cold-rolled steel to overcome the aforementioned shortcomings of the prior art.

[0015] Accordingly, the method for continuously manufacturing cold-rolled steel of this invention includes the steps of:

providing coils of white steel that are manufactured by hot rolling a cast steel followed by annealing and pickling the cast steel;

subjecting the coils of white steel to uncoiling and welding in an uncoiling-welding installation where the coils of white steel are flattened in an uncoiling device and are welded in a welding device;

passing the flattened and welded white steel through a set of tension rollers provided in a first strip accu-

mulator;
moving the white steel from the first strip accumulator to a cold rolling device for cold rolling the white steel to result in a cold-rolled steel with a predetermined thickness;
moving the cold-rolled steel from the cold rolling device to a degreasing device for removing grease from the cold-rolled white steel;
moving the cold-rolled steel from the degreasing device to a second strip accumulator having a set of tension rollers;
moving the cold-rolled steel from the second strip accumulator to an annealing-pickling installation for annealing the cold-rolled steel and for electrolyzing and acid-washing the cold-rolled steel after annealing so as to remove scale from the cold-rolled steel;
moving the cold-rolled steel from the annealing-pickling installation to a third strip accumulator having a set of tension rollers;
moving the cold-rolled steel from the third strip accumulator to a temper rolling device for imposing gloss on the cold-rolled steel;
moving the cold-rolled steel from the temper rolling device to a tension leveling device for leveling the cold-rolled steel;
moving the cold-rolled steel from the tension leveling device to a fourth strip accumulator having a set of tension rollers; and
moving the cold-rolled steel from the fourth strip accumulator to a trimming-recoiling installation for trimming and recoiling the cold-rolled steel.

[0016] Other features and advantages of the present invention will become apparent in the following detailed description of the preferred embodiment with reference to the accompanying drawings, of which:

Figure 1 is a schematic diagram of a conventional process for manufacturing cold-rolled steel conducted using a multi-stage production line;
Figure 2 is a schematic diagram of a preferred embodiment of a method for continuously manufacturing cold-rolled steel according to this invention; and
Figure 3 is a bar chart demonstrating a production efficiency comparison of the preferred embodiment to the prior art of Figure 1.

[0017] Referring to Figure 2, the preferred embodiment of a method for continuously manufacturing cold-rolled steel according to this invention includes the steps of:

1) providing coils of white steel:

Coils 100 of white steel 400 are provided, which are manufactured by hot rolling a cast steel followed by annealing and pickling the cast steel.

2) uncoiling and welding:

The white steel is subjected to uncoiling and welding in an uncoiling-welding installation 21 where the coils 100 of white steel 400 are flattened in an uncoiling device 211 and are welded in a welding device 212. The uncoiling device 211 includes two overhang-mandrel type of uncoilers. The welding device 212 includes a first arc welder for welding a steel strip having a thickness more than 1.5 mm, preferably 1.5-6 mm, and a second arc welder for welding a steel strip having a thickness less than 1.5 mm.

3) passing through a first strip accumulator:

The flattened and welded white steel 400 is passed through a set of tension rollers 221 provided in a first strip accumulator 22.

4) cold rolling:

The white steel 400 is moved from the first strip accumulator 22 to a cold rolling device 23 for cold rolling the white steel 400 to result in a cold-rolled steel with a predetermined thickness. The cold rolling device 23 includes three cold rolling mills 231 arranged in series. The white steel 400 is cold rolled in a rolling ratio ranging from 50 to 70% and to a thickness of about 0.3 mm. The thickness of the white steel 400 as it enters the cold rolling device 23 is measured. The thickness and the shape of the white steel 400 as it exits the cold rolling device 23 are also measured and transmitted to an automatic gauge control and a shape control system so as to monitor the conditions of the cold rolling device 23 and the properties of the white steel 400 after cold rolling.

5) degreasing:

The cold-rolled steel from the cold rolling device 23 is moved to a degreasing device 24 for removing grease from the cold-rolled white steel. The degreasing device 24 includes a base solution spraying region 241 for spraying a base solution on the cold-rolled steel, a water-washing region 242 for washing the cold-rolled steel using water, and a drying region 243 for drying the cold-rolled steel after washing.

6) moving the cold-rolled steel to a second strip accumulator:

The cold-rolled steel is moved from the degreasing device 24 to a second strip accumulator 25. The second strip accumulator 25 is similar to the

first strip accumulator 22 in structure, and has a set of tension rollers 251.

7) annealing and pickling:

The cold-rolled steel is moved from the second strip accumulator 25 to an annealing-pickling installation 26 for annealing the cold-rolled steel and for electrolyzing and acid-washing the cold-rolled steel after annealing so as to remove scale from the cold-rolled steel. The annealing-pickling installation 26 includes an annealing device 261 and a pickling device 262. The annealing device 261 includes a heating region 263 operating at a temperature ranging from 1000 °C to 1200 °C, a preheating region 264 which is disposed upstream of the heating region 263 and in which the cold-rolled steel is preheated by radiation heat generated by the heating region 263, and a cooling region 265 which is disposed downstream of the heating region 263 and in which the cold-rolled steel is cooled to a temperature not higher than 80 °C. The pickling device 262 includes an electrolyzing tank 266 containing a sodium sulfate solution for removing iron oxide scale from the cold-rolled steel, an acid-washing tank 267 containing nitric acid and hydrofluoric acid for removing Fe-Cr-Ni oxide scale from the cold-rolled steel, and a water-washing region 268 for washing the cold-rolled steel. The water-washing region 268 is conducted in five stages so as to ensure that the acid solutions are washed out of the cold-rolled steel completely.

8) moving the cold-rolled steel to a third strip accumulator:

The cold-rolled steel is moved from the annealing-pickling installation 26 to a third strip accumulator27. The third strip accumulator 27 is similar to the first strip accumulator 22 in structure, and has a set of tension rollers 271.

9) temper rolling:

The cold-rolled steel is moved from the third strip accumulator 27 to a temper rolling device 28 for imposing gloss on the cold-rolled steel. The temper rolling device 28 includes a set of work rolls 281 for imposing the gloss on the cold-rolled steel via transfer printing.

10) tension leveling:

The cold-rolled steel is moved from the temper rolling device 28 to a tension leveling device 29 for leveling the cold-rolled steel. The tension leveling device 29 includes a leveling unit 291 for leveling the cold-rolled steel, and a washing-drying device 292 for washing and drying the cold-rolled steel after leveling. The leveling unit 291 includes a set of bending rolls 293 and a set of reverse-bending rolls 294. Additionally, the cold-rolled steel is sprayed with water or lubricant by the washing-drying device 292 before it enters into the leveling unit 291.

11) moving the cold-rolled steel to a fourth strip accumulator:

The cold-rolled steel is moved from the tension leveling device 29 to a fourth strip accumulator 31. The fourth strip accumulator 31 is similar to the first strip accumulator 22 in structure, and has a set of tension rollers 311.

It should be noted that each of the first, second, third, and fourth strip accumulators 22, 25, 27, 31 adjusts the tension of the steel, and enables the speeds at which the steel moves through two adjacent devices to be independent of each other.

12) moving the cold-rolled steel to a trimming-recoiling installation:

The cold-rolled steel is moved from the fourth strip accumulator 31to a trimming-recoiling installation 32, which includes a trimming device 321 for trimming the cold-rolled steel, and a recoiling device 322 for recoiling the cold-rolled steel to obtain a cold-rolled steel product 300 (i.e., 2B steel coil).

Additionally, when 2D steel coil is intended to be produced, it can be obtained merely by shutting down the temper rolling device 28. Therefore, the utilization rate of the production line to perform the method of the present invention can be improved over the prior art.

Referring to Figure 3, a comparison of the cold-rolled steel product made by the method of the present invention to the cold-rolled steel product made by the conventional multi-stage process shown in Figure 1 is made in terms of equipment cost, personnel cost, operating rate, throughput, productivity, and overall production cost. As shown in Figure 3, the personnel cost, the throughput, and the productivity of the method of the present invention are improved over those of the conventional multi-stage process even though the equipment cost of the method of the present invention is relatively high and the operating rate of the method of the present invention is relatively low. Totally, the overall production cost of the method of the present invention is merely 78% of that of the conventional multi-

state process.

Claims

1. A method for continuously manufacturing cold-rolled steel, **characterized by** the steps of:

   providing coils (100) of white steel (400) that are manufactured by hot rolling a cast steel followed by annealing and pickling the cast steel;
   subjecting the coils (100) of white steel (400) to uncoiling and welding in an uncoiling-welding installation (21) where the coils (100) of the white steel (400) are flattened in an uncoiling device (211) and are welded in a welding device (212);
   passing the flattened and welded white steel (400) through a set of tension rollers (221) provided in a first strip accumulator (22);
   moving the white steel (400) from the first strip accumulator (22) to a cold rolling device (23) for cold rolling the white steel (400) to result in a cold-rolled steel with a predetermined thickness;
   moving the cold-rolled steel from the cold rolling device (23) to a degreasing device (24) for removing grease from the cold-rolled white steel;
   moving the cold-rolled steel from the degreasing device (24) to a second strip accumulator (25) having a set of tension rollers (251);
   moving the cold-rolled steel from the second strip accumulator (25) to an annealing-pickling installation (26) for annealing the cold-rolled steel and for electrolyzing and acid-washing the cold-rolled steel after annealing so as to remove scale from the cold-rolled steel;
   moving the cold-rolled steel from the annealing-pickling installation (26) to a third strip accumulator (27) having a set of tension rollers (271) ;
   moving the cold-rolled steel from the third strip accumulator (27) to a temper rolling device (28) for imposing gloss on the cold-rolled steel;
   moving the cold-rolled steel from the temper rolling device (28) to a tension leveling device (29) for leveling the cold-rolled steel;
   moving the cold-rolled steel from the tension leveling device (29) to a fourth strip accumulator (31) having a set of tension rollers (311); and
   moving the cold-rolled steel from the fourth strip accumulator (31)to a trimming-recoiling installation (32) for trimming and recoiling the cold-rolled steel.

2. The method as claimed in Claim 1, **characterized in that** the white steel (400) is cold rolled in a rolling ratio ranging from 50 to 70% and to a thickness of about 0.3 mm.

3. The method as claimed in Claim 1, **characterized in that** the degreasing device (24) includes a base solution spraying region (241) for spraying a base solution on the cold-rolled steel, a water-washing region (242) for washing the cold-rolled steel using water, and a drying region (243) for drying the cold-rolled steel after washing.

4. The method as claimed in Claim 1, **characterized in that** the annealing-pickling installation (26) includes an annealing device (261) having a heating region (263) operating at a temperature ranging from 1000 °C to 1200 °C, a preheating region (264) which is disposed upstream of the heating region (263) and in which the cold-rolled steel is preheated by radiation heat generated by the heating region (263), and a cooling region (265) which is disposed downstream of the heating region (263) and in which the cold-rolled steel is cooled to a temperature not higher than 80 °C.

5. The method as claimed in Claim 1, **characterized in that** the uncoiling device (211) includes two overhang-mandrel type of uncoilers.

6. The method as claimed in Claim 1, **characterized in that** the welding device (212) includes a first arc welder for welding a steel strip having a thickness more than 1. 5 mm, and a second arc welder for welding a steel strip having a thickness less than 1.5 mm.

7. The method as claimed in Claim 1, **characterized in that** the annealing-pickling installation (26) includes a pickling device (262) having an electrolyzing tank (266) containing a sodium sulfate solution for removing iron oxide scale from the cold-rolled steel, an acid-washing tank (267) containing nitric acid and hydrofluoric acid for removing Fe-Cr-Ni oxide scale from the cold-rolled steel, and a water-washing region (268) for washing the cold-rolled steel.

8. The method as claimed in Claim 1, **characterized in that** the tension leveling device (29) includes a washing-drying device (292) for washing and drying the cold-rolled steel after leveling.

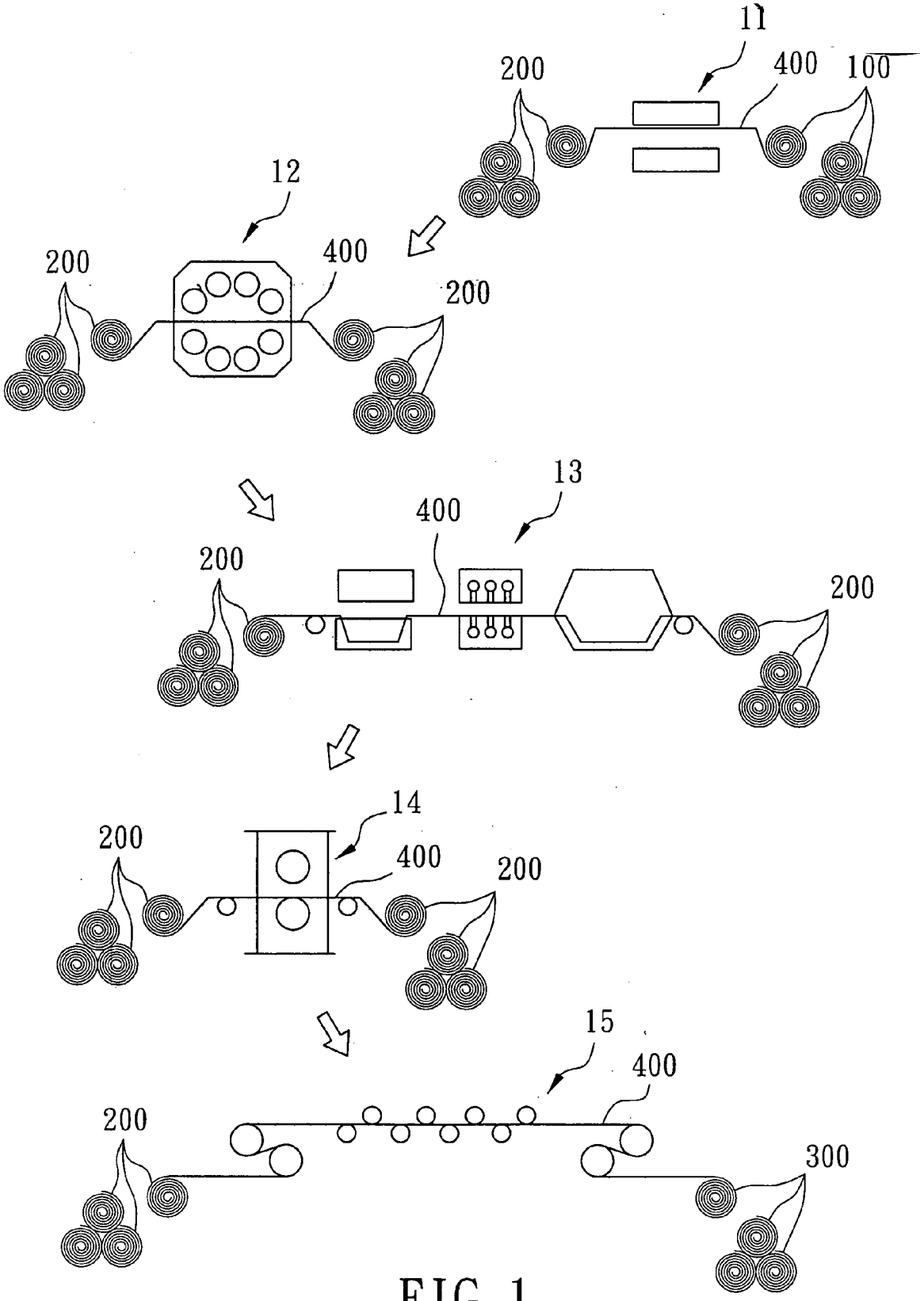

FIG. 1
PRIOR ART

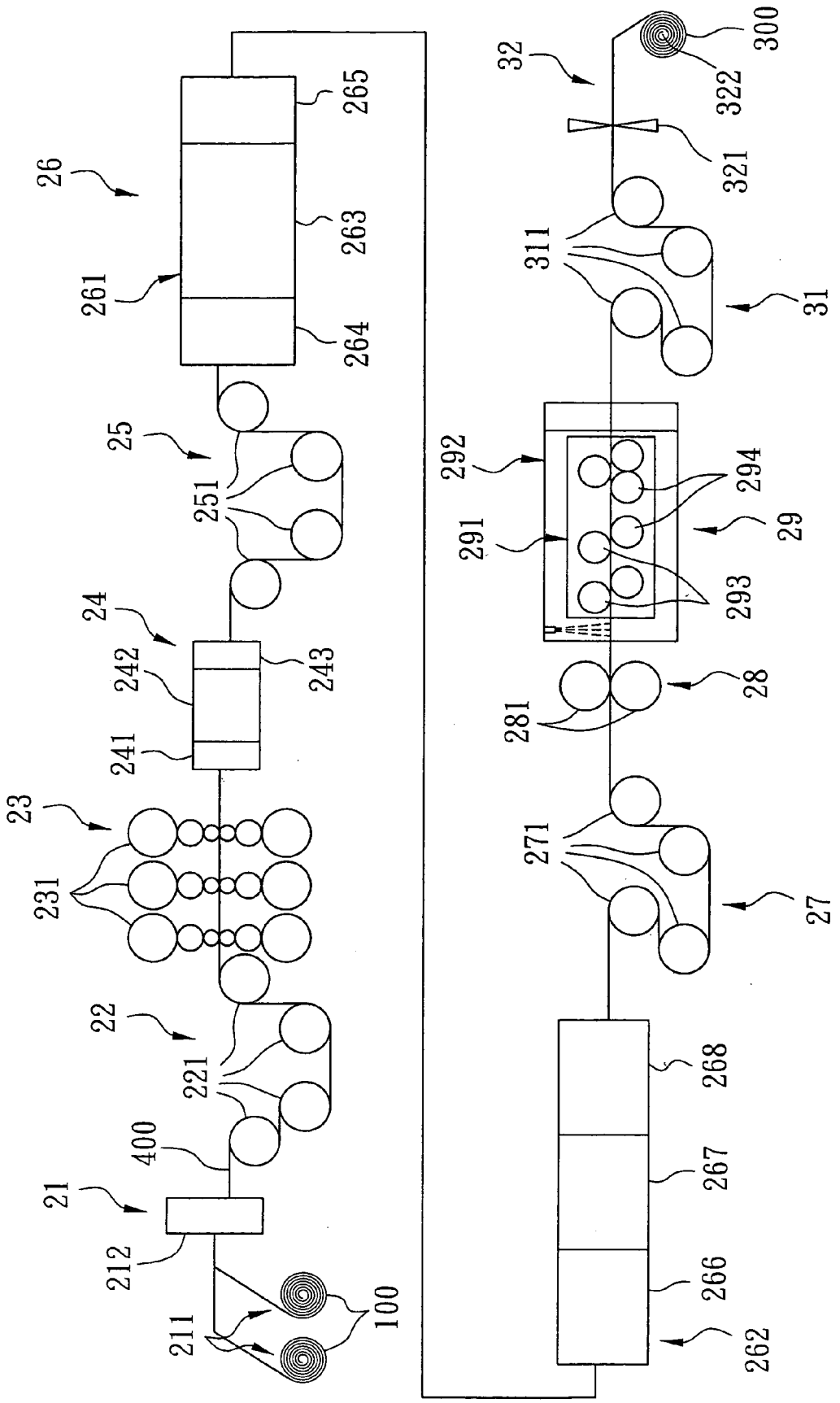
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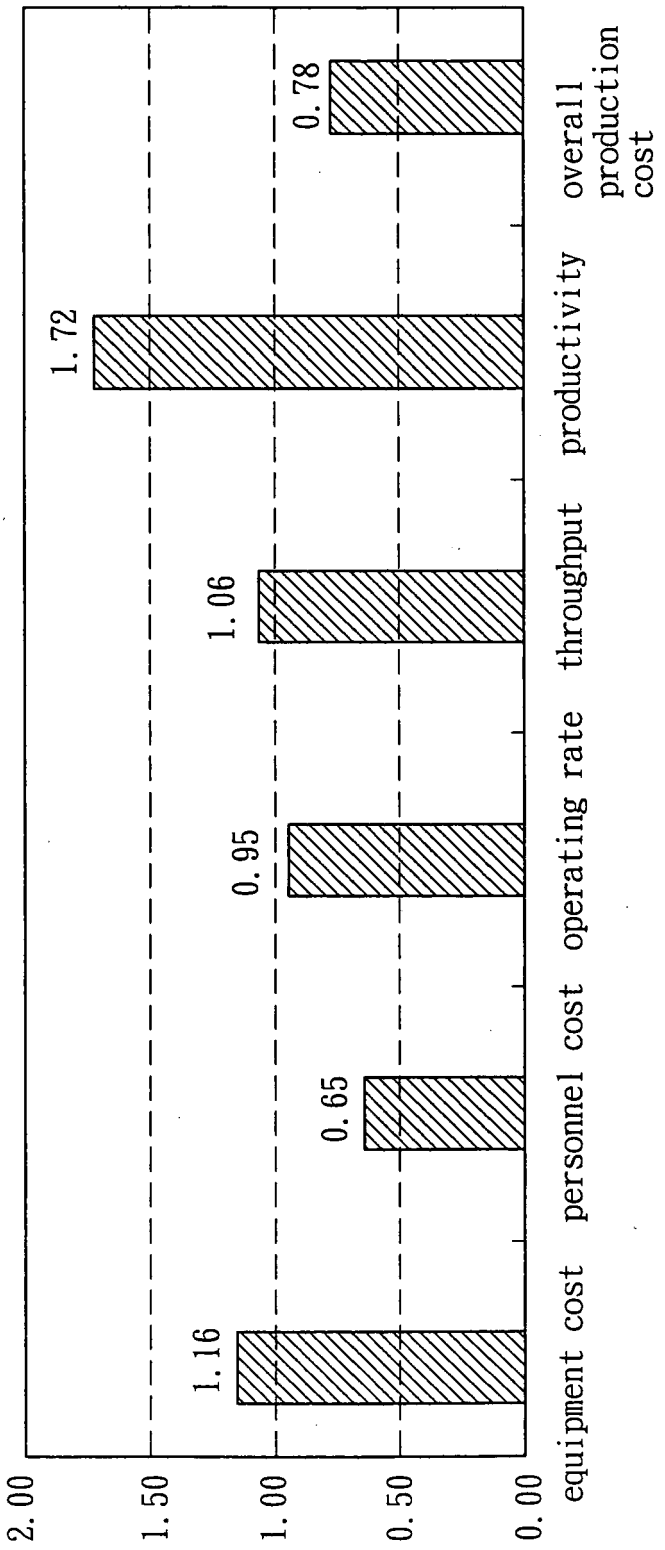
FIG. 2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0.78
equipment cost
personnel cost
operating rate
throughput
productivity
overall production cost

FIG. 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 25 4712

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	4 March 2008	Forciniti, Marco

CATEGORY OF CITED DOCUMENTS

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