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(54) METHOD FOR HOT ROLLING AND FOR HEAT TREATMENT OF A STEEL STRIP

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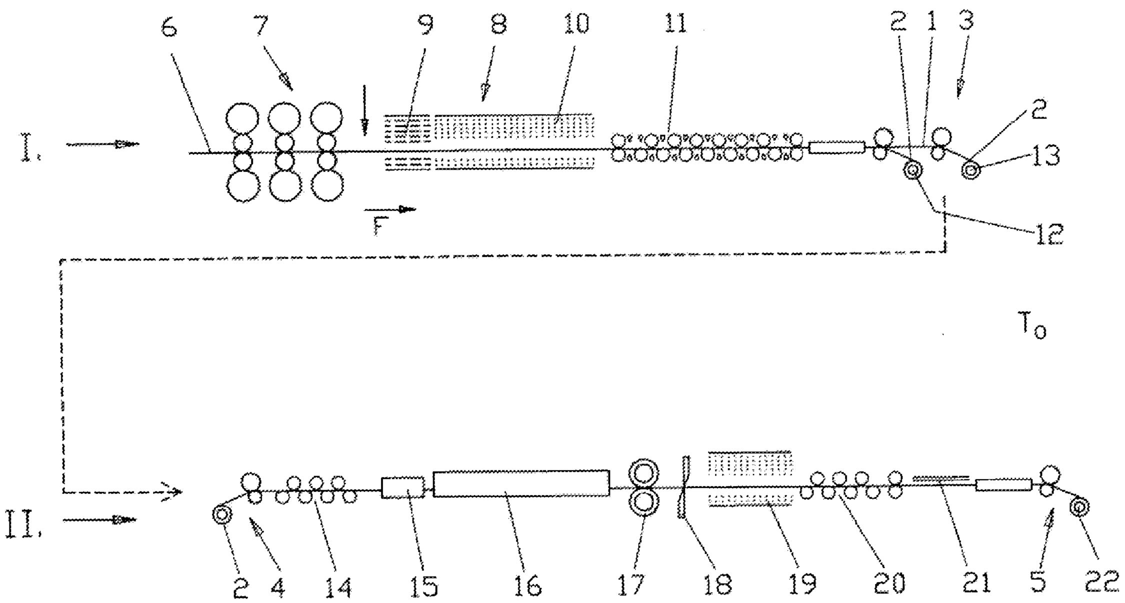
(57) **ABSTRACT**

The invention relates to a process for hot rolling and for heat treatment of a strip (**1**) of steel. To make it possible to produce high-strength and very high-strength strips having satisfactory toughnesses more economically in a continuous production plant, the process provides the steps: a) heating of the slab to be rolled; b) rolling of the slab to the desired strip thickness; c) cooling of the strip (**1**), with the strip (**1**) having a temperature above ambient temperature (T_0) after cooling; d) rolling up of the strip (**1**) to produce a coil (**2**); e) rolling off of the strip (**1**) from the coil (**2**); f) heating of the strip (**1**); g) cooling of the strip (**1**) and h) transport of the strip (**1**) to a further destination, with the strip (**1**) having a temperature above ambient temperature (T_0) before heating as per step T).



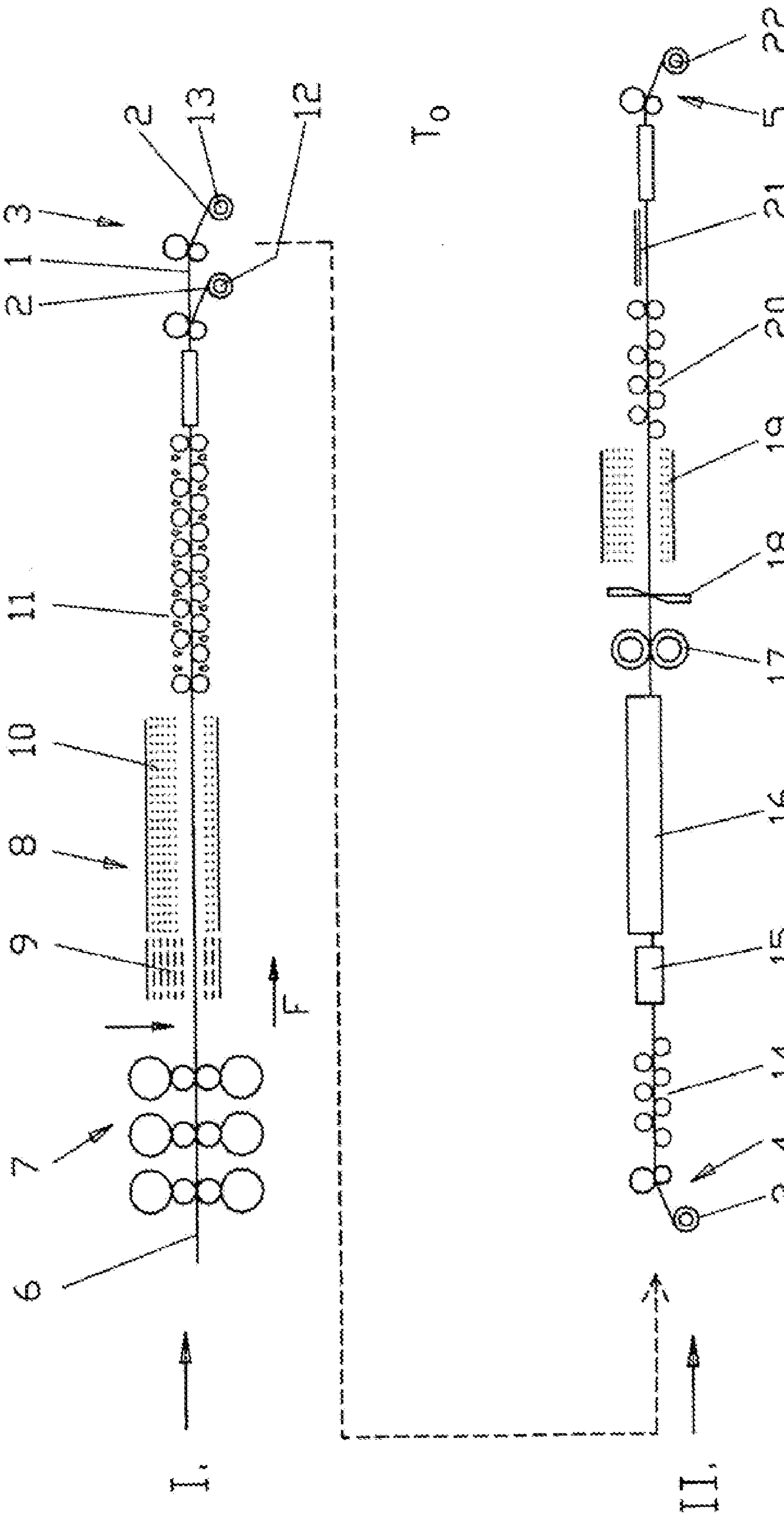
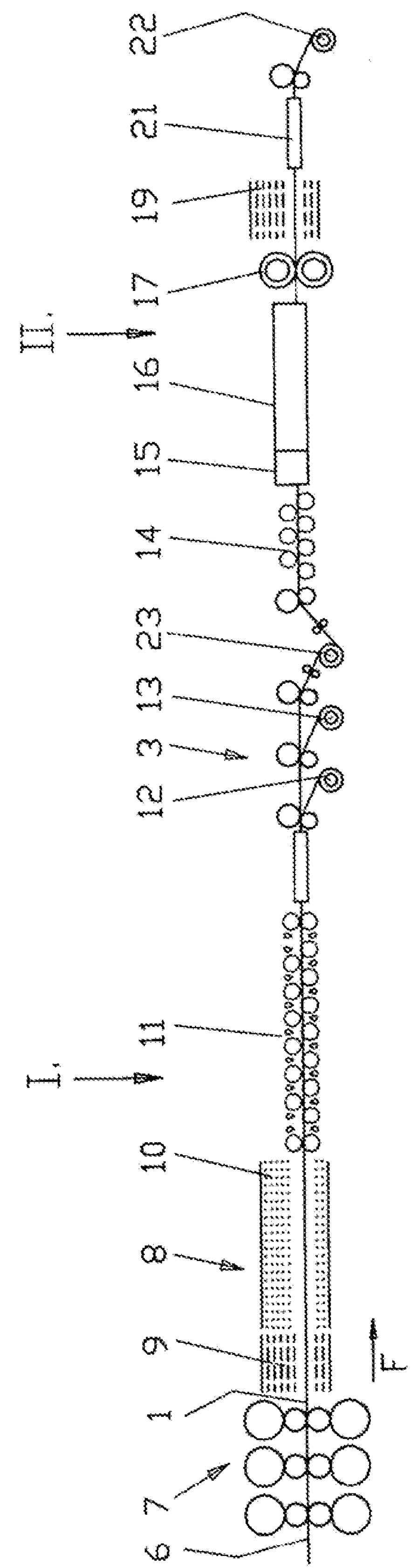


FIG.1


22
21
19
17
II.
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3
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I.
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FIG.2

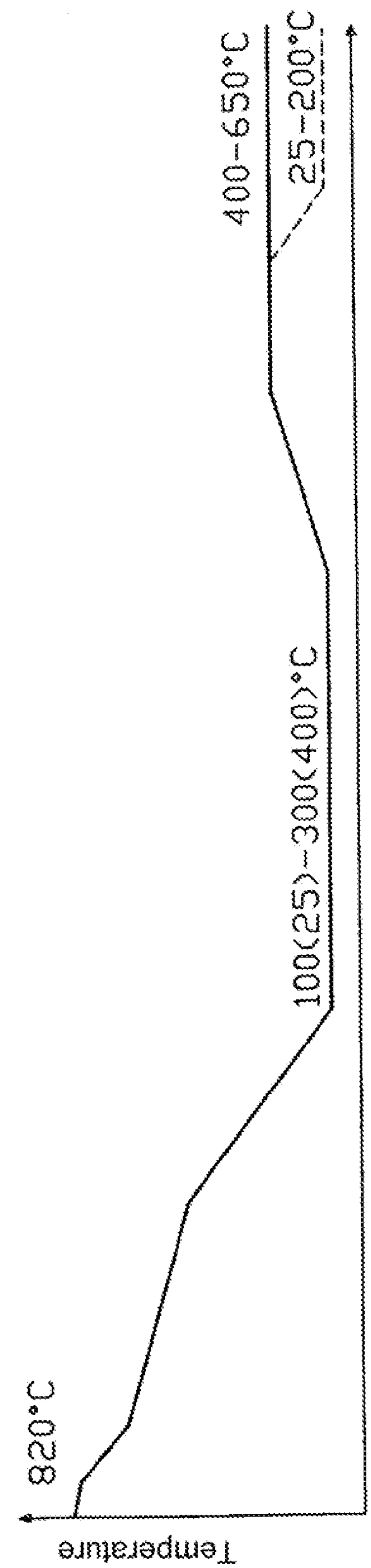

400-650°C
25-200°C
100(25)-300(400)°C
820°C
Temperature

FIG.3

FIG. 4

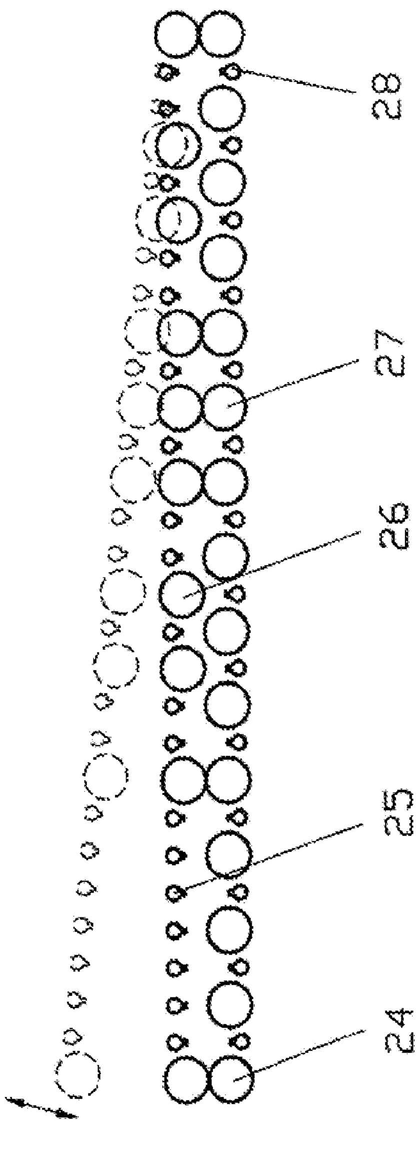
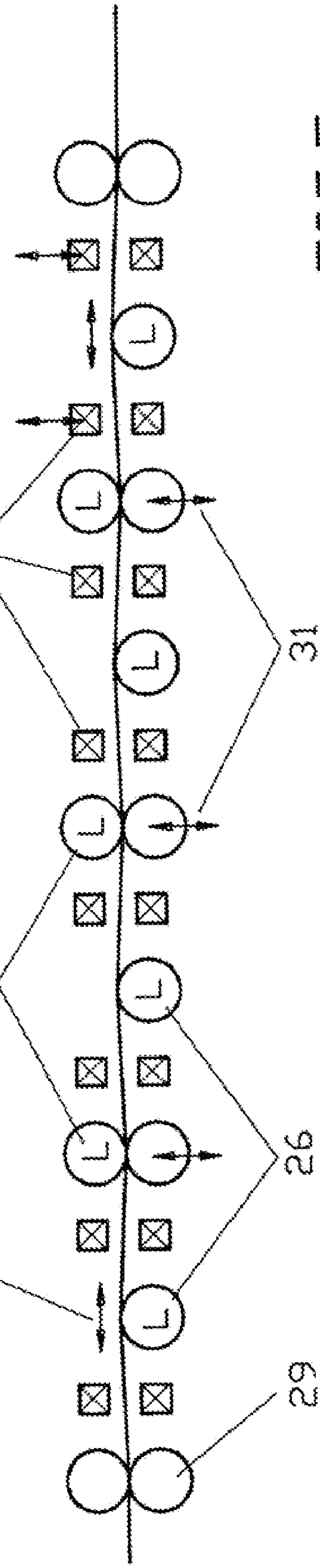


FIG. 5



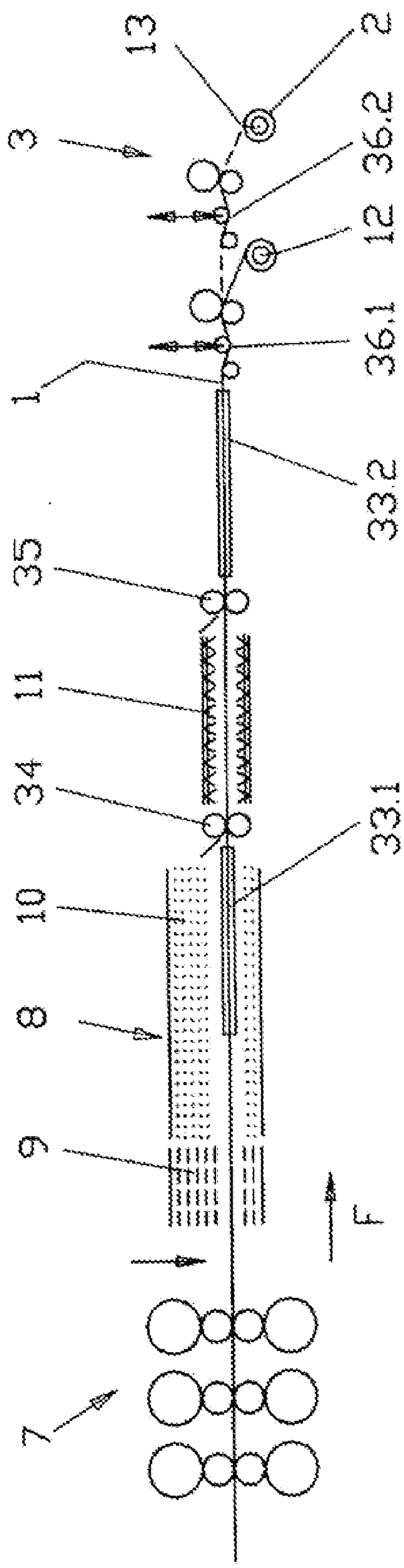


FIG.6

METHOD FOR HOT ROLLING AND FOR HEAT TREATMENT OF A STEEL STRIP

[0001] The invention relates to a method for hot rolling and for heat treatment of a strip of steel.

[0002] The hardening and subsequent tempering of steel components is common practice. This has the result that a desired combination of strength and toughness of the material can be specifically adjusted. This technology is also used in principle in the production of high-strength steel sheet in sheet plants. It is described in EP 1 764 423 [US 2008/0283158]. In this case, after heating the slab and rolling down to the final thickness on the heavy plate stand in a plurality of reversing passes, the sheet is cooled to room temperature at high speed, for example, i.e. the hardening process is carried out. This is followed by the tempering process, i.e. re-heating of the strip to, for example, 600° C. followed by renewed cooling. Thus, sheet having different properties can be produced flexibly in small batch sizes in a sheet stand.

[0003] As in the sheet production sector, the demand for types of steel having very high strength is also increasing continuously in strip production, i.e. the demand for so-called high-strength and ultrahigh strength steels. These materials are used, inter alia, in motor vehicles, cranes, containers and in pipes.

[0004] It is thus the object of the present invention to provide a method whereby high-strength and ultrahigh-strength strip having sufficient toughness can be produced more economically in a strip plant. In particular, it should advantageously be possible to produce QT steels by this method.

[0005] The solution of this object by the invention is characterized in that the method comprises the steps:

[0006] a) heating the slab to be rolled;

[0007] b) rolling the slab to the desired strip thickness;

[0008] c) cooling the strip, wherein after cooling the strip has a temperature above the ambient temperature;

[0009] d) coiling the strip into a coil;

[0010] e) uncoiling the strip from the coil;

[0011] f) heating the strip;

[0012] g) cooling the strip and

[0013] h) removing the strip,

[0014] wherein before heating according to step f), the strip has a temperature above the ambient temperature.

[0015] In a preferred embodiment of the invention, when carrying out step d) the coil is located at a coiling station wherein, when carrying out step e) the coil is preferably located at an uncoiling station spatially remote from the coiling station and wherein the coil is transported from the coiling station to the uncoiling station between steps d) and e) in a thermally insulated manner, possibly via a heat-insulating coil store.

[0016] Step e) can directly follow step d).

[0017] During cooling or after cooling according to step c) and/or according to step g), the strip can be subjected to a straightening process. It can also be subjected to a straightening process between the uncoiling according to step e) and the heating according to step f). It can also be subjected to a straightening process between the heating according to step f) and the removal according to step h). Said straightening process can be effected by deflecting the strip around base, deflecting, driving or other rollers.

[0018] The straightening process is usually carried out by means of a roller straightening machine or screwed-down strip deflecting rollers or, according to a special embodiment of the invention, on a so-called skin-pass frame.

[0019] The strip can also be subjected to a straightening process during the heating according to above step f).

[0020] The cooling of the strip according to step c) can comprise a laminar cooling and downstream intensive cooling. The cooling of the strip according to step g) can also comprise a laminar cooling or alternatively or additively air cooling.

[0021] At least parts of the cooling device can be configured as zone cooling which acts in zones over the width of the strip.

[0022] The cooling of the strip can also be carried out by means of a high-pressure bar so that cleaning and/or descaling of the strip is possible at the same time.

[0023] The heating of the strip according to step f) can comprise inductive heating. Alternatively, direct flame impingement of the strip can be effected. In the latter case, it is preferably provided that the direct flame impingement of the strip is effected by a gas jet comprising at least 75% oxygen, preferably comprising almost pure oxygen, in which a gaseous or liquid fuel is mixed.

[0024] A further development provides that the inductive heating of the strip takes place in inert gas (protective gas).

[0025] The removal of the strip according to step h) can comprise coiling the strip. The removal of the strip according to step h) according to claim **1** can also comprise pushing off plate-like cut portions of the strip.

[0026] Before the cooling according to step c) the strip preferably has a temperature of at least 750° C.

[0027] After the cooling according to step c) and before coiling according to step d), the strip preferably has a temperature of at least 25° C. and at most 400° C., preferably between 100° C. and 300° C.

[0028] A further development furthermore provides that after the heating according to step f), the strip preferably has a temperature of at least 400° C., preferably between 400° C. and 700° C. Meanwhile, after the cooling according to step g) and before the removal according to step h), the strip can preferably have a temperature of at most 200° C., preferably between 25° C. and 200° C.

[0029] The heating of the strip can take place at different intensity over the strip width.

[0030] Finally, it can be provided that the steps e) to g) are carried out in reversing mode for which a coiling station located after the cooling according to step g) is used.

[0031] It can furthermore be provided that the flatness of the strip and/or the temperature of the strip (the latter preferably by means of a temperature scanner) is measured at least at two locations in the strip treatment installation for monitoring the quality of the strip.

[0032] The running speed of the strip through the strip treatment installation, the, in particular, zone-related strip heating, the adjustment of the straightening rolls and/or the in particular zone-related cooling can be controlled or regulated by a process model.

[0033] During passage through the strip treatment installation, the strip can be held under a defined strip tension at least in sections by means of drivers. This applies particularly in the area of the intensive cooling section.

[0034] In order to ensure that the strip runs centrally in the driver, in the roller straightening unit or in the intensive cooling section, a strip lateral guide is preferably located in front thereof.

[0035] An alternative embodiment of the method for hot rolling and for heat treatment of a strip of steel comprises the steps:

[0036] a) heating the slab to be rolled;

[0037] b) rolling the slab to the desired strip thickness;

[0038] c) cooling the strip, wherein after cooling the strip has a temperature above the ambient temperature;

[0039] d) coiling the strip on a first coiler;

[0040] e) reversing the strip between the first coiler and a second coiler wherein the strip is subject to heating between the coilers,

[0041] wherein before the heating according to step e), the strip has a temperature above the ambient temperature.

[0042] This method can also be combined with the aforesaid embodiments.

[0043] In the case of materials for which no tempering is required, i.e. for which the strength and toughness properties already meet the requirements after step d), process steps a) to d) can be used by themselves alone.

[0044] The following further developments have proved successful:

[0045] A strip tension can be built up by means of drivers before and after the cooling of the strip.

[0046] The strip can be guided transversely to its longitudinal axis by means of a lateral guidance. The lateral guidance can preferably take place in the area of the cooling of the strip, in particular in the area of the laminar cooling of the strip.

[0047] The lateral guidance of the strip can furthermore take place before the driver and can open after passing the strip head and close again at the strip end for the purpose of guidance.

[0048] Measurement of the strip temperature can be made by means of a low-temperature radiation pyrometer. The measurement of the strip temperature can preferably be made before, inside and/or after the cooling and/or heating devices.

[0049] The production spectrum of a hot wide strip mill differs appreciably from that of a heavy plate mill. A plurality of high-strength and ultrahigh strength types of steel newly developed over the last few decades now exist, whose properties can be adjusted by specific rolling and/or cooling strategies. A suitable method for this is quenching of the strip at a high cooling rate after rolling, followed by re-heating to temperatures above the phase-transformation temperature.

[0050] The classical QT steels (Q: quenched; T: tempered) which can be produced in this way are already produced on heavy plate stands. However, they can be produced substantially more economically in hot wide strip mills.

[0051] Moreover, thinner, ultrahigh-strength strips having lower temperature and thickness tolerance as well as strip flatness can be produced more reliably on hot strip mills. It is therefore appropriate and advantageous to shift parts of production from heavy plate stands to strip mills.

[0052] In addition, there are many new types of steel which cannot be produced on heavy plate stands. The method presented here is particularly suitable for the group of multiphase steels. By means of a significantly enlarged spectrum of temperature-time profiles and in particular, by means of the possibility of is interrupting the cooling and temporarily increasing the temperature again, it is possible to produce structures having almost any combinations of phase constituents which cannot be envisaged at the present time. In addition, it is possible to make precipitation processes take place and thus specifically introduce second phases which are a characteristic of modern types of steels.

[0053] In addition, properties required for the higher alloy contents in conventional production can be adjusted by the method presented.

[0054] Advantages of the separate arrangement of the rolling and cooling process on the one hand and the tempering process on the other hand are the flexibility of the method (no mixed rolling is necessary), the flexible adjustment of the temperature time profile of the strip and that one's own coils or coils from other installations can be processed. Coils or plates can also be cut depending on the intended use of the strip or the coilability. The plates are preferably cut at higher temperature, i.e. at the tempering temperature.

[0055] Advantages of the coupled arrangement of the rolling and cooling process and the tempering process are the particularly large energy saving and in the case of coils which are difficult to coil and bind, the use of a special coiler with direct transfer to avoid the so-called watch-spring problem. Furthermore, rapid further processing or delivery of the strip in the case of direct further processing is achieved. Finally, mention should be made of the greater possibility for influencing the microstructure of the strip in the arrangements mentioned.

[0056] Exemplary embodiment of the invention are shown in the drawings. In the figures:

[0057] FIG. **1** shows schematically a hot strip mill for producing a steel strip according to a first embodiment of the invention,

[0058] FIG. **2** shows an alternative embodiment of the hot strip mill to FIG. **1**,

[0059] FIG. **3** shows an exemplary temperature profile of the strip over the conveying direction of the hot strip mill,

[0060] FIG. **4** shows the fundamental structure of a straightening machine with integrated intensive cooling as a section from the hot strip mill according to FIG. **1** or **2**,

[0061] FIG. **5** shows the fundamental structure of a straightening machine with integrated heating as a section from the hot strip mill according to FIG. **1** or **2**,

[0062] FIG. **6** shows schematically a hot strip mill with an alternative embodiment of a first process step.

[0063] FIG. **1** shows a hot strip mill in which a strip **1** is initially processed in a first process stage (given by I) and then in a second process stage (given by II).

[0064] In the first process stage, i.e. in a rolling and cooling process, a slab is first rolled in a multi-stand rolling mill. Of the rolling mill, only the last three finishing stands **7** are shown in which the strip **6** having an intermediate thickness has been rolled. The temperature distribution in the strip or the flatness can then be measured. The strip **1** then passes in the conveying direction F into a strip cooling system **8** which is divided here into an intensive laminar cooling system **9** with so-called edge masking and a laminar strip cooling system **10**. The conveying speed is, for example, 6 m/s. The cooled strip **1** then enters into an intensive cooling system **11** in which, according to a preferred embodiment of the invention, a straightening machine and driver are integrated (details in FIG. **4**). Drivers can be provided before and after the intensive cooling system **11**.

[0065] The intensive cooling system **11** can be followed by another measurement of the temperature distribution and the flatness of the strip. A low-temperature radiation pyrometer is preferably used at these low temperatures. A temperature measurement is also feasible inside the intensive cooling system between two squeeze or driver rolls for the purpose of temperature-coolant regulation.

[0066] The strip **1** is then coiled in a coiling station **3** by a coiler **12** or **13**.

[0067] The coil **2** then enters the second process stage, i.e. the tempering process.

[0068] Here the coil **2** is initially uncoiled in an uncoiling station **4** and then fed to a straightening machine **14** (this can be located before and/or after the following furnace). After a temperature equalization has taken place over the length and width of the strip in a zone **15**, the strip **1** enters into a furnace **16**. It is possible and advantageous to integrate a straightening machine in the furnace **16** similarly to the cooling (details in FIG. **5**). Here the strip **1** can be heated in continuous or in reversing mode. An oxyfuel furnace or an induction furnace are preferably used, the heating time being between 10 and 600 seconds.

[0069] This is followed by trimming shears **17** or shears **18**. The strip **1** then enters into a laminar strip cooling system or alternatively into an air cooling system **19**. This can be followed by a straightening machine **20**. A plate pushing unit **21** or a coiler **22** in a coiling station **5** are then furthermore indicated in FIG. **1**.

[0070] A skin-pass stand can also be arranged here instead of a straightening machine **14** or **20**.

[0071] Coils from other hot strip mills can also be introduced instead of the uncoiling station **4**.

[0072] In contrast, a direct connection of the two process stages I and II can be seen in FIG. **2** (the installation is not shown fully fitted). The last stands of a hot wide strip mill (finishing mill **7**), the strip cooling system **8**, and the coilers **12** and **13** of the first process stages are shown similarly here. The last coiler **23** is provided for winding the higher-strength strips. In this case, this can advantageously comprise a special coiler for simple winding of the high-strength steels. In this case, the coiler **23** is a so-called transfer coiler. The coil does not need to be bound there. Pivotable pinch rolls hold the strip under tension during turning into the unwinding position. The winding is therefore directly followed by further processing in the tempering line (second process stage). The further transport takes place similarly to the solution according to FIG. **1**.

[0073] Particular advantages here are the energy saving for strips of higher winding temperature and the rapid further transport of the coils from the first to the second process stage. It is thus provided that the strip **1** already has a temperature above the ambient temperature To before the heating in the furnace **16**.

[0074] In addition, for special strip it is also possible to provide reversing of the strip between the two coilers **23** and **22** in to be able to carry desired temperature profiles or treatments of the strip.

[0075] Preferably in the case of shorter strip and/or sufficiently dimensioned component spacings, direct further transport of the strip **1** from the first process stage to the second process stage is provided without intermediate coiling of the strip **1** and/or subsequent reversing from coiler **22** to coiler **23**. In this case, therefore the coiler **23** is not used but after the strip end runs out from the roll mill the tempering process is carried out directly at low or initially high and then lower speed.

[0076] Alternatively, this operating mode is applied to strip independently of the thickness and the speed. Then the coiler **23** is initially not used and the furnace is also not operating. The strip is wound on coiler **22**. The tempering process is then carried out reversingly between coiler **22** and **23**.

[0077] A preferred temperature profile for the strip **1** along the strip mill is shown in FIG. **3** in correspondence with FIG. **2**. The cooling at the end of the line is preferably water or air cooling.

[0078] However, cooling can also be effected by means of a high-pressure beam. Cleaning or descaling of the strip surface is thereby carried out at the same time.

[0079] The production quantity of the rolling plant is usually higher than in the tempering process since the rolling speed of the strip is greater than the tempering speed. A so-called mixing rolling operation is therefore possible to optimally utilize the rolling mill. This means that a number of strips is wound on coilers **12** and **13** whilst the further processing of the higher-strength strip takes place in the tempering line.

[0080] The production of the strip is therefore divided according to the invention substantially into two process stages which will be specified subsequently as an example with further optional steps.

[0081] First Process Stage:

- [0082] Heating of slabs (thick or thin slabs) and subsequent rolling in a multi-stand hot wide strip mill;
- [0083] Intensive cooling of the strip on the delivery roller table;
- [0084] Passing through a straightening machine;
- [0085] Winding the strip into a coil.

[0086] In order to improve the flatness of the high-strength strip, strip edge heating before a conventional finishing train, edge masking in the first cooling section units and a straightening machine are advantageous.

[0087] At higher winding temperatures, fast coil transport to the subsequent second process stage is advantageous to save heating energy during tempering. The coil can then be transported under a heat insulating hood to reduce the temperature loss and ensure more uniform material properties.

[0088] Second Process Stage:

- [0089] Unwinding the coil,
- [0090] Optionally straightening the strip in a straightening machine if lack of flatness is present;
- [0091] Optionally equalizing the strip temperature by zonal cooling or heating before the actual tempering treatment for making the strip temperature uniform over the strip length and width;
- [0092] Tempering the strip, i.e. continuous re-heating by means of induction heating or energetically advantageously in a gas-heated continuous furnace (e.g. oxyfuel furnace using so-called DFI method);
- [0093] Trimming the strip;
- [0094] Subsequent cooling of the strip;
- [0095] Renewed straightening of the strip;
- [0096] Renewed winding of the strip into a coil.

[0097] Alternatively, the strips can be cut into plates before the furnace, after the furnace and/or directly before the plate pushing unit. The cutting of plates is particularly advantageous in the case of strip which is difficult to wind. Cutting at the tempering temperature is advantageous since the strip has a lower strength there.

[0098] In the case of thicker strip and/or high-strength steels which can no longer be cut, a flame cutting machine, a laser cutting machine or a thermal cutting machine can be provided for cutting.

[0099] The said oxyfuel furnace in which the so-called DFI oxyfuel method (direct flame impingement) is carried out for tempering comprises a special furnace in which (almost) pure oxygen instead of air and gaseous or liquid fuel are mixed and the resulting flame is directed directly onto the strip. This not only optimizes the combustion process but also reduces the nitrogen oxide emissions. The scale properties are also favorable or the scale growth is very small (operated with air undershooting). The high flow rate of the gases even has a cleaning effect on the strip surface. This type of heating is particularly advantageous with regard to strip surface quality. High heat densities with as good efficiency as in inductive heating can be achieved with this method.

[0100] Instead of a successively arranged cooling section and inline straightening machine in the first or second process stage, the straightening machine and the strip cooling can also be accommodated combined in one unit. The straightening rollers are then at the same time used as water squeeze rollers and thus ensure a cooling effect which is as uniform as possible over the width of the strip since any strip transverse curvature and lack of flatness is eliminated directly it forms. The straightening rollers are adjusted individually depending on the strip temperature and the material quality with the assistance of a straightening machine model so that overstretching of the strip surface is avoided. Drivers before and after the cooling section unit ensure strip tension for as long as possible even when the stand or the coiler tension is not built up. Part of the strip cooling can be carried is out in the form of strip zone cooling in order to be able to actively influence the temperature distribution. The cooling-straightening unit is indicated in FIGS. **1** and **2**. Details on this are deduced from FIG. **4**. Possible arbitrary combinations for straightening, cooling and squeezing can be seen in this figure. For the secure threading-in process of the strip head particularly in the case of thinner strip, the cooling-straightening unit is executed as raisable and pivotable as indicated in FIG. **4** (see double arrow). The straightening rolls are individually adjustable.

[0101] A temperature scanner for the strip can be provided before and/or after the joint arrangement of straightening machine and cooling which can be seen in FIG. **4**. A strip head form detector (for detecting a ski or waves) can be positioned in front of the installation shown.

[0102] Drivers **24**, a pure cooler unit **25**, straightening rolls **26** and combined squeeze rolls/drivers **27** can be identified in detail in FIG. **4**. Furthermore, nozzles of intensive cooling system can be seen.

[0103] In this case, an alternating arrangement of cooling, straightening and drive roller units is possible. The amount of straightening is adjusted individually depending on the material of the strip and the temperature. The straightening-cooling unit is raisable and pivotable.

[0104] As can be seen in FIG. **5**, the straightening and heating process **14**, **16** of the second process stage can also be combined with the installation shown. Similarly, the amount of straightening can be adapted to the present strip temperature and the strip material. In this case, the skin effect (higher surface temperature) of the induction heating (or a direct flame impingement in the DFI oxyfuel method) has a positive effect. At the same time, the straightening rolls hold the strip in position and avoid lack of flatness so that (inductive) heating which is as efficient as possible is possible in the long fillet portion of the strip. Drivers **29** before and after the heating-straightening unit hold the strip under tensile stress **30**. For secure threading in of the strip head, the induction coils **32** as well as the straightening and transfer rollers **31** are designed as vertically adjustable.

[0105] The use of the cooling-straightening unit (FIG. **4**) or the heating-straightening unit (FIG. **5**) is not restricted to a strip installation but can also be provided in a heavy plate installation.

[0106] A temperature scanner for the strip can be provided before and/or after the joint arrangement of straightening machine and heating which can be seen in FIG. **5**.

[0107] In order to be able to influence the temperature distribution over the strip width in the second process stage during the inductive heating, transverse field inductors are used, inter alia, which can be displaced transversely to the strip running direction or conveying direction F. By this means, if necessary, the strip edges for example can be heated more strongly or heated less intensively.

[0108] Equalization of the strip temperature over the length and the width of the strip by specific cooling (zone cooling) or heating at warm or cold strip sections can optionally take place before heating the strip to the tempering temperature. This should be provided in particular when coils not completely cooled to ambient temperature are to be handled. By this means the passage of the coil through the coil store can be shortened. A coil tracking system (model) as well as the measured temperature distributions during unwinding of the coil are used for optimum control of the heating or cooling systems.

[0109] Welded-to-order, high wear-resistant roller materials are used for the straightening rolls in order to ensure a long life and good strip quality.

[0110] Temperature scanners and flatness meters within the line indirectly monitor the quality of the strip and serve as a signal for adjusting and regulating members such as, for example, for the throughput speed, the heating power, the adjustment of the straightening rolls and the cooling which are controlled by a process model.

[0111] FIG. **6** shows the first process stage in a somewhat modified embodiment. By analogy with FIG. **1**, FIG. **6** shows the rear part of the finishing train **7**, laminar strip cooling units **9**, **10** as well as an intensive cooling system **11** and the coiling stations **3**. In this embodiment the intensive cooling system **11** and a strip straightening unit **36.1**, **36.2** are located at various positions. Drivers **34** and **35** are located before and after the intensive cooling system **11**. A strip tension can hereby be maintained within the intensive cooling system **11** for almost the entire strip length without the strip being clamped in the stand or coiler system. Thus, any strip waves which may occur are pulled out and a cooling effect which is as uniform as possible is achieved.

[0112] In order to ensure that the strip runs centrally in the drivers **34**, **35** and/or in the intensive cooling system **11**, a strip lateral guide **33.1** is particularly advantageously located in front thereof. After the strip head has passed the driver **33.1** and the intensive cooling system **11**, the lateral guide **33.1** is opened again so that the water flow in the laminar strip cooling system **10** is not hindered. The guide **33.2** then takes over the guiding task for the remainder of the strip. Similarly for the strip end the guide **33.1** is briefly adjusted again after the end has left the finishing train to counteract any straying of the strip end. In order to minimize the cooling section length, the lateral guide **33.1** is therefore preferably located inside the strip cooling unit **10**.

[0113] The straightening rolls **36.1**, **36.2** before the respective coiling stations **3** are dipped into the strip plane after building up the strip tension and provide a strip straightening effect by looping around the base, deflecting or drive rollers.

A similar operating mode is practiced when deflecting rollers **26** (see FIG. **4**) are located inside the intensive cooling section **11**.

REFERENCE LIST

[0114] **1** Strip (after the finishing train with final thickness)
[0115] **2** Coil
[0116] **3** Coiling station
[0117] **4** Uncoiling station
[0118] **5** Coiling station
[0119] **6** Strip (inside the finishing train with intermediate thickness)
[0120] **7** Finishing train
[0121] **8** Strip cooling
[0122] **9** Intensive laminar strip cooling
[0123] **10** Laminar strip cooling
[0124] **11** Intensive cooling
[0125] **12** Coiler
[0126] **13** Coiler
[0127] **14** Straightening machine
[0128] **15** Zone
[0129] **16** Furnace
[0130] **17** Trimming shears
[0131] **18** Shears
[0132] **19** Air cooling or laminar strip cooling
[0133] **20** Straightening machine
[0134] **21** Plate pushing unit
[0135] **22** Coiler
[0136] **23** Coiler
[0137] **24** Driver
[0138] **25** Pure cooling unit
[0139] **26** Straightening roll
[0140] **27** Squeeze roll/driver
[0141] **28** Nozzles of intensive cooling system
[0142] **29** Driver
[0143] **30** Tensile stress
[0144] **31** Transfer roller
[0145] **32** Induction coil
[0146] **33**.**1** Lateral guide before the first driver/before the intensive cooling
[0147] **33**.**2** Lateral guide before the coiler driver
[0148] **34** Driver before the intensive cooling
[0149] **35** Driver after the intensive cooling
[0150] **36**.**1** Straightening roll before the first winding station **36**.**2** Straightening roll before the second winding station
[0151] I. First process stage
[0152] II. Second process stage
[0153] F Conveying direction
[0154] To Ambient temperature

1. A method for hot rolling and for heat treatment of a strip of steel, the method comprising the steps of:

a) heating the slab to be rolled;
b) rolling the slab to the desired strip thickness;
c) cooling the strip, wherein after cooling the strip has a temperature above the ambient temperature;
d) coiling the strip into a coil;
e) uncoiling the strip from the coil;
f) heating the strip;
g) cooling the strip and
h) removing the strip,

wherein before the heating according to step f), the strip has a temperature above the ambient temperature and wherein when carrying out step d), the coil is located at a coiling station and that when carrying out step e), it is located at an uncoiling station spatially remote from the coiling station, wherein the coil is transported from the coiling station to the uncoiling station between steps d) and e) in a thermally insulated manner.

2. (canceled)

3. The method according to claim **1** wherein step e) directly follows step d).

4. The method according to claim **1** wherein during cooling or after cooling according to step c) and/or according to step g), the strip is subjected to a straightening process.

5. The method according to claim **1** wherein between the uncoiling according to step e) and the heating according to step f), the strip is subjected to a straightening process.

6. The method according to claim **1** wherein between the heating according to step f) and the removal according to step h), the strip is subjected to a straightening process.

7. The method according to claim **4** wherein the straightening process is effected by deflecting the strip around base, deflecting, driving or other rollers.

8. The method according to claim **5** wherein the straightening process is carried out by means of a skin-pass frame.

9. The method according to claim **1** wherein the strip is subjected to a straightening process during the heating according to step f).

10. The method according to claim **1** wherein the cooling of the strip according to step c) comprises a laminar cooling and intensive cooling.

11. The method according to claim **1** wherein the cooling of the strip according to step g) comprises a laminar cooling.

12. The method according to claim **1** wherein the cooling of the strip according to step c) and/or according to step g) takes place in zones over the width of the strip.

13. The method according to claim **1** wherein the cooling of the strip according to step g) comprises air cooling.

14. The method according to claim **1** wherein the cooling of the strip according to step g) is carried out by means of a high-pressure bar so that cleaning and/or descaling of the strip takes place at the same time.

15. The method according to claim **1** wherein the heating of the strip according to step f) comprises inductive heating.

16. The method according to claim **15** wherein the inductive heating of the strip takes place in an inert gas atmosphere.

17. The method according to claim **1** wherein the heating of the strip according to step f) is effected by direct flame impingement of the strip.

18. The method according to claim **17** wherein the direct flame impingement of the strip is effected by a gas jet comprising at least 75% oxygen in which a gaseous or liquid fuel is mixed.

19. The method according to claim **18** wherein the direct flame impingement is effected by a gas jet comprising pure oxygen.

20. The method according to claim **1** wherein the removal of the strip according to step h) comprises coiling the strip.

21. The method according to claim **1** wherein the removal of the strip according to step h) comprises pushing off plate-like cut portions of the strip.

22. The method according to claim **1** wherein before the cooling according to step c) the strip has a temperature of at least 750° C.

23. The method according to claim **1** wherein after the cooling according to step c) and before coiling according to step d), the strip has a temperature of at least 25° C. and at most 400° C., preferably between 100° C. and 300° C.

24. The method according to claim **1** wherein after the heating according to step f), the strip has a temperature of at least 400° C., preferably between 400° C. and 700° C.

25. The method according to claim **1** wherein the heating of the strip according to step f) is effected so that the strip has different temperatures over its width.

26. The method according to claim **1** wherein after the cooling according to step g) and before removal according to step h), the strip has a temperature of at most 200° C., preferably between 25° C. and 200° C.

27. The method according to claim **1** wherein the steps e) to g) are carried out in reversing mode for which a coiling station located after the cooling according to step g) is used.

28. The method according to claim **1** wherein the flatness of the strip and/or the temperature of the strip is measured at least at two locations in the strip treatment installation for monitoring the quality of the strip.

29. The method according to claim **1** wherein the running speed of the strip through the strip treatment installation, the in particular zone-related strip heating, the adjustment of the straightening rolls and/or the in particular zone-related cooling are controlled or regulated by a process model.

30. The method according to claim **1** wherein during passage through the strip treatment installation, the strip is held under a defined strip tension at least in sections by means of drivers.

31. (canceled)

32. The method according to claim **1** wherein a strip tension is built up by means of drivers before and after the cooling of the strip.

33. The method according to claim **1** wherein a strip is guided transversely to its longitudinal axis by means of a lateral guidance.

34. The method according to claim **33** wherein the lateral guidance takes place in the area of the cooling of the strip.

35. The method according to claim **34** wherein the lateral guidance takes place in the area of the laminar cooling of the strip.

36. The method according to claim **32** wherein lateral guidance of the strip takes place before the driver and opens after passing the strip head and closes at the strip end.

37. The method according to claim **1** wherein a measurement of the strip temperature is made by means of a low-temperature radiation pyrometer.

38. The method according to claim **1** wherein a measurement of the strip temperature is made before, inside and/or after the cooling and/or heating devices.

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