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Menetelmä ja laitteisto tasaisuuden kontrolloimiseksi ruostumatonta terästä olevan nauhan jäähdytyksessä
Förfarande och anordning för jämnhetskontrollering vid kylning av ett band som är av rostfritt stål

(57) Tiivistelmä - Sammandrag - Abstract

Keksintö kohdistuu menetelmään ja laitteistoon ruostumattoman teräsnauhan tasaisuuden kontrolloimiseksi hehkutuksen jälkeisen jäähdytyksen yhteydessä viimeistelylinjalla. Nauhaa (1) ensin nauhan kulkusuunnassa (2) jäähdytetään syöttämällä ainakin yhtä jäähdytysväliainetta ainakin yhden poikittaisesti nauhan kulkusuuntaan nähden sijoitetun syöttölaiteryhmän (5,6) kautta nauhan (1) koko leveydelle, jäähdytysväliainemäärän ollessa säädetty käyttäen tallennettua ja ennalta määritettyä tietoa (7) nauhan halutusta lämpötilasta tasaisuudelle, sitten nauhan lämpötila määritetään (8) ja lämpötilamäärittelyn jälkeen lisävaihe jäähdytystä suoritetaan syöttämällä ainakin yhtä jäähdytysväliainetta ainakin yhden nauhan kulkusuuntaan (2) nähden poikittain sijoitetun syöttölaiteryhmän (9) kautta, kun lämpötilan määritetty arvo on erilainen kuin lämpötilan ennalta määritetty arvo, ennen kuin tasaisuutta kontrolloidaan käyttäen kontrollilaitetta (11), joka sisältää useita tasaisuuskontrolliyksikköä (12) ja on sijoitettu poikittain nauhan kulkusuuntaan (2) nähden.
(Fig.1)

Uppfinningen avser ett förfarande och utrustning för kontroll av ett rostfritt stålbandets jämnhet i samband med avkylning efter glödgningen på avslutningslinjen. Bandet (1) avkyls först i bandets rörelseriktning (2) genom att tillföra åtminstone ett kylmedel genom åtminstone en grupp av matningsanordningar (5,6) som är placerad tvärställd i förhållande till bandets rörelseriktning över bandets (1) hela bredd, varvid mängden av kylmedel är reglerad genom användning av lagrade och på förhand fastställda data (7) om bandets önskade temperatur för jämnheten, varefter bandets temperatur fastställs (8) och efter temperaturens fastställande utförs ett extra skede av avkylning genom att tillföra åtminstone ett kylmedel genom åtminstone en grupp av matningsanordningar (9) som är placerad tvärställd i förhållande till bandets rörelseriktning (2), då temperaturens fastställda värde är ett annat än temperaturens på förhand fastställda värde, innan jämnheten kontrolleras med användning av en kontrollanordning (11), vilken innehåller flera jämnhetskontrollenheter (12) och vilken är placerad tvärställd i förhållande till bandets rörelseriktning (2).

METHOD AND EQUIPMENT FOR FLATNESS CONTROL IN COOLING A STAINLESS STEEL STRIP

The present invention relates to a method and an equipment to control flatness
5 in connection with cooling after annealing in a finishing line of a stainless steel strip.

When producing a thin metal strip, such as a thin stainless steel strip, the material for the strip is first hot-rolled to a thickness of 3 mm and then cold-
10 rolled in order to further reduce the thickness. The cold rolling is carried out in several passes through one cold-rolling mill or in several subsequent cold-rolling mills. Cold rolling increases the mechanical strength of the stainless steel, particularly austenitic stainless steel, which mechanical strength is itself desirable for many applications. However, the strips also become practically
15 impossible to work, e.g. to bend, stamp, emboss. It is therefore to anneal the strips upon completion of the cold-rolling process, by heating the strips to a temperature above the recrystallization temperature of the steel, i.e. to a temperature above 1050 °C. The strip is then cooled in a cooling box. When heating the strip in the annealing furnace, oxides form on the sides of the strip,
20 partially in the form of oxide scale. The cooled strip is descaled for instance in a shot-blasting machine and then pickled in a pickling bath. After pickling the terminating cold rolling is then achieved as skin-pass rolling. The strip from skin-pass rolling can be used for instance in welding tube manufacturing. Alternatively, the strip from skin-pass rolling can further be treated in an
25 annealing furnace in order to achieve the individual and desired properties for use of the strip in many applications.

When treating the strip in separate stages the flatness of the strip shall control in order to have a good quality for the strip product. The EP patent application
30 1153673 relates to a metal plate flatness controlling method and device by preventing waviness from occurring at the edge portions of a plate or sheet when it is cooled to the room temperature after completing hot rolling. The

method controls the flatness of the metal sheet or plate by homogenizing the surface temperature distribution of the metal sheet or plate through measuring the surface temperatures of the metal sheet or plate at the edge portions and the centre portion across its width between two rolling stands of a tandem finishing mill or at the entry to and/or exit from a reversing finishing mill or after 5 completing hot rolling or after hot levelling and the cooling the metal sheet or plate after completing the finishing rolling. The object of the EP patent application 1153673 is to lead heat onto the surface of the metal sheet or plate in order to maintain a uniform temperature crosswise to the metal sheet or plate 10 before lowering of the temperature during rolling.

The JP patent application 2002-045907 describes a method and a device for controlling flatness of a metal sheet. The surface temperature of the metal sheet is measured between finishing mills of a hot tandem mill or on the outlet 15 of a tandem mill as well as the residual stress of thermal stress, which is generated at the normal temperature, is estimated based on the surface temperature and the residual stress imparted in the width direction with the finishing mill is controlled so that wave shapes are not generated by that residual stress. The object of the JP patent application 2002-045907 is to 20 achieve a flat metal sheet before lowering of the temperature during rolling.

The method and the device described in the JP patent application 2002-045908 is different from the methods and devices of the EP patent application 1153673 and JP patent application 2002-045907 described above that the object of this 25 JP patent application 2002-045908 is to straighten the unflatness, followed from the previous process steps, during hot rolling of thick plates or sheets made of iron, aluminium or titanium using as a cooling medium only water.

The flatness control based on the temperature measurement described in the 30 above mentioned prior art publications, JP patent applications 2002-045907 and 2002-045908 as well as the EP patent application 1153673, relates to the methods to keep the surface temperature distribution of the material before to

be rolled in finishing rolling, such as skin-pass rolling, stable in order that a good and uniform rolling result for the flatness is achieved.

The object of the present invention is to create an improved method and
5 equipment in order to control flatness for a thin metal strip through determining the temperature of a thin metal strip during cooling when the thin metal strip is annealed in a finishing line. The essential features of the present invention are enlisted in the appended claims.

10 In accordance with the present invention a hot thin stainless steel strip from the finishing annealing treatment is conducted through the cooling area, the temperature determination area and the flatness control. The cooling area contains at least two groups of feeding devices for the cooling medium or
15 media, such as nozzles, which are located in an essentially transversal position to the direction of the strip movement so that the cooling effect of one group is extended essentially in the whole area of the strip width. The temperature determination area contains a temperature determination device, which is advantageously located above the stainless steel strip. The temperature
20 determination device is also located so that at least one group of the nozzles is located after the temperature determination device in the direction of the strip movement. The flatness control contains a device, which controls the flatness in the separate areas in the transversal direction of the strip to the direction of
25 the strip movement. The flatness control device is located after the cooling area in the direction of the strip movement and the flatness control device is further located advantageously beneath the strip.

The feeding devices for the cooling medium or media, the temperature
determination device and the flatness control device are electrically connected
with a central processing unit, such as a computer, which controls the operation
30 of the cooling and flatness control of the invention. The central processing unit also records the data received from the temperature determination device and the flatness control device. The central processing unit utilizes this

predetermined and recorded data in the operation control of the feeding devices for the cooling medium or media in the cooling area.

The nozzles, which are used for feeding cooling medium or media to the stainless steel strip in accordance with the invention, are mechanically
5 connected to the source of the cooling medium or to the sources of the cooling media. At least one group of the nozzles located in an essentially transversal position to the direction of the strip movement is located beneath the strip to be cooled. The cooling medium is advantageously water, which is fed onto the
10 strip through the nozzles located beneath the strip. However, the cooling medium is partly also gas, inert gas like nitrogen or argon, and gas is fed onto the strip at least through the nozzles located beyond the strip.

The flatness control according to the invention is carried out using a roll-type
15 control device. This roll-type control device contains a rotatable shaft and the flatness control units are contiguously mounted around the shaft so that the flatness control units are extended at least in the whole area of the strip width. The width of each flatness control unit in the transversal direction of the strip to the direction of the strip movement is preferably essentially the same. The
20 flatness control is divided into zones, which widths represent the widths of the flatness control units. The flatness control units rotate within the rotatable shaft so that the flatness control units have a continuous mechanical contact with the strip.

25 The temperature determination device is advantageously a thermoscanner, which essentially continuously scans the surface of the strip in order to determine the surface temperature of the stainless steel strip. The thermoscanner operates so that the thermoscanner determines the surface temperature of the strip in zones in the transversal direction of the strip to the
30 direction of the strip movement. The widths of the zones for the temperature determination are essentially similar in widths to the zones of the flatness control.

The groups of nozzles in an essentially transversal position to the direction of the strip movement and used for feeding the cooling medium or media onto the surface of the stainless steel strip are located in the width to the strip so that
5 each flatness control zone is provided with one nozzle, and one group of nozzles covers the whole width of the strip. The nozzle is designed so that each nozzle forms an essentially wedge-shaped shower of the cooling medium or media onto that zone whereto the nozzle is directed. Thus each nozzle in one group covers with the cooling medium essentially only one zone on the strip.

10

When the method and equipment of the invention is in the operation, the hot strip is first precooled in the cooling area wherein by means of a plurality of groups of nozzles inert gas is blasted onto the surface of the strip. In the precooling area at least one group of nozzles is advantageously installed for
15 blasting water as cooling medium on the surface of the strip to be cooled. Then the thermoscanner determines the temperature in separate zones of the strip and the value of the temperature determination in each zone is compared with the data recorded in the central processing unit for the flatness of the strip. When the value of the temperature is essentially different from the
20 predetermined desired value of flatness, the strip is further cooled blasting water through at least one group of nozzles onto the surface of the strip before the flatness control. The value of the flatness control is recorded in the central processing unit and the data is used for adjusting the nozzles at least in the precooling area in order to achieve the desired temperature for the prospective
25 flatness of the whole width of the strip.

The method and equipment of the invention is particularly suitable for the strip which thickness is below 1 millimeter. When desired flatness is achieved within the invention, the speed of the strip in the finishing line is increased and
30 therefore the capacity of the finishing line is also greater.

The present invention is described in more details in the following referring to the drawings wherein

Fig. 1 illustrates one preferred embodiment of the invention in schematical manner as a beyond view in lancing position,

5 Fig. 2 illustrates the embodiment of Fig. 1 in schematical manner seen in glancing underarm position.

In accordance with Figs. 1 - 2 the hot strip 1 to be cooled is moving to the direction, which is illustrated by the arrow 2. The strip 1 is by an illustration
10 manner divided into zones 3 and partly illustrated as transparency in order to better clarify the invention. The strip 1 goes first through a precooling area 4, which contains groups of nozzles 5 and 6. The nozzles 5 and 6 are mechanically connected with sources of cooling media (not illustrated), and the groups nozzles 5 and 6 are in individual manner, nozzle by nozzle, electrically
15 connected 10 to a central processing unit, a computer 7. The groups of nozzles 5 and 6 are located in a transversal position to the movement direction 2 of the strip 1 in such a way that cooling medium is blasted through one nozzle 5 and 6 in the group to one zone 3 of the strip 1. The nozzles 5 and 6 are constructed so that the cooling media forms a wedge-shaped blast as illustrated in the
20 drawings. The nozzles 5 and 6 are located to the strip 1 so that each nozzle 5 and 6 has the peak angle for the wedge-shaped blast between 20 and 30 degrees. The cooling medium fed through nozzles 5 is gas and fed through nozzles 6 the cooling medium is water. The amount of cooling media is adjusted for each separate nozzle 5 and 6 utilizing the predetermined values
25 recorded in the computer 7.

After moving through the precooling area 4 the temperature of the separate zones 3 of the strip 1 is determined with a thermoscanner 8, which is electrically
connected 14 with the computer 7. The determined temperature values from
30 the separate zones 3 are recorded into the computer 7, and these new determined temperature values are compared with the predetermined and desired temperature values in each separate zone 3 in the computer 7. When

the determined and predetermined desired values of the temperature are different from each other, the group of nozzles 9 having a nozzle for each zone 3, located in a transversal position and after the thermoscanner 8 to the movement direction 2 of the strip 1, is utilized to even the differences in the temperature values. The group of nozzles 9 is electrically connected 15 with the computer 7 so that each nozzle 9 is adjusted in individual manner, nozzle by nozzle, to blast water as cooling medium onto the strip 1, when the blast is necessary because of the difference between the predetermined and determined temperature values. The strip 1 is further moved to the flatness control 11. The flatness of the strip 1 is determined utilizing flatness control units 12, which are installed around a rotatable shaft 13 of the flatness control 11. The flatness control units 12 are unit by unit electrically connected 16 with the computer 7 and the flatness control values determined by each unit 12 are recorded in the computer 7. The flatness control units 12 have the same width 15 as the zones 3 which are illustrated in longitudinal direction to the strip 1.

CLAIMS

1. Method for controlling flatness of a stainless steel strip in connection with cooling after annealing in a finishing line, **characterized** in that the strip (1) is first in the direction of the strip movement (2) cooled feeding at least one cooling medium through at least one group of feeding devices (5,6) located transversally to the direction of the strip movement for the whole width of the strip (1), the amount of the cooling medium being adjusted utilizing the recorded and predetermined data (7) of desired temperature of the strip for flatness, the temperature of the strip is then determined (8) and after the temperature determination a further step of cooling is carried out feeding at least one cooling medium through at least one group of feeding devices (9) located transversally to the direction of the strip movement (2), when the determined value of temperature is different from the predetermined value of temperature, before the flatness is controlled using a control device (11) containing a plurality of flatness control units (12) and locating transversally to the direction of the strip movement (2).
2. Method according to the claim 1, **characterized** in that the temperature is determined utilizing a thermoscanner (8), which is movable transversally to the direction of the strip movement (2), and using the thermoscanner (8) the temperature is determined in longitudinal zones (3) of the strip and which zones (3) are defined by the width of the flatness control units (12).
3. Method according to the claims 1 or 2, **characterized** in that the group of feeding devices (5,6,9) for the cooling medium are individually adjusted in amounts of cooling medium using the predetermined and respectively determined data.
4. Method according to the claims 1, 2 or 3, **characterized** in that the cooling medium is wedge-shaped blasted through the nozzles (5,6,9) onto the strip.

5. Method according to the claim 4, **characterized** in that the peak angle for the wedge-shaped blasting for the groups of nozzles (5,6,9) is between 20 and 30 degrees.
- 5 6. Equipment for controlling flatness of a stainless steel strip in connection with cooling after annealing in a finishing line, **characterized** in that by means of the flatness control units (12) of the flatness control device (11) the width of the strip (1) is defined in longitudinal zones (3) in utilization for determining the temperature (8) of the strip and in utilization for locating the feeding devices
10 (5,6,9) for the cooling media in the cooling areas before and after the temperature determination (8).
7. Equipment according to the claim 6, **characterized** in that the feeding devices (5,6,9) for the cooling media are located in the whole width of the strip
15 (1) transversally to the direction of the strip movement (2).
8. Equipment according to the claim 6 or 7, **characterized** in that at least one group of feeding devices (9) is located after the temperature determination.
- 20 9. Equipment according to the claim 6, 7 or 8, **characterized** in that at least the feeding devices (6,9) for using as cooling medium water are located beneath the strip (1).
10. Equipment according to any of the claims 6 - 9, **characterized** in that the
25 thermoscanner (8) is utilized for the temperature determination.
11. Equipment according to any of the claims 6 - 10, **characterized** in that the feeding devices for cooling media (5,6,9), the device (8) for the temperature determination and the flatness control units (12) are electrically connected
30 (10,14,15,16) with a central processing unit (7).

PATENTTIVAATIMUKSET

1. Menetelmä ruostumattoman teräsnauhan tasaisuuden kontrolloimiseksi hehkutuksen jälkeisen jäähtymisen yhteydessä viimeistelylinjalla, **tunnettu**
5 siitä, että nauhaa (1) jäähdytetään ensin nauhan kulkusuunnassa (2) syöttämällä ainakin yhtä jäähtytysväliainetta ainakin yhden poikittaisesti nauhan kulkusuuntaan nähden sijoitetun syöttölaiteryhmän (5,6) kautta nauhan (1) koko leveydelle, jäähtytysväliainemäärän ollessa säädetty käyttäen tallennettua ja ennalta määritettyä tietoa (7) nauhan halutusta lämpötilasta
10 tasaisuudelle, sitten nauhan lämpötila määritetään (8) ja lämpötilamäärityksen jälkeen lisävaihe jäähtytystä suoritetaan syöttämällä ainakin yhtä jäähtytysväliainetta ainakin yhden nauhan kulkusuuntaan (2) nähden poikittain sijoitetun syöttölaiteryhmän (9) kautta, kun lämpötilan määritetty arvo on erilainen kuin lämpötilan ennalta määritetty arvo, ennen kuin tasaisuutta
15 kontrolloidaan käyttäen kontrollilaitetta (11), joka sisältää useita tasaisuuskontrolliyksiköitä (12) ja on sijoitettu poikittain nauhan kulkusuuntaan (2) nähden.

2. Patenttivaatimuksen 1 mukainen menetelmä, **tunnettu** siitä, että lämpötila
20 määritetään termoskannerilla (8), joka on liikuteltavissa poikittain nauhan kulkusuuntaan (2) nähden, ja termoskanneria (8) käyttäen lämpötila määritetään nauhan pitkittäisillä vyöhykkeillä (3) ja jotka vyöhykkeet (3) on määritetty tasaisuuskontrolliyksiköiden (12) leveyden avulla.

25 3. Patenttivaatimuksen 1 tai 2 mukainen menetelmä, **tunnettu** siitä, että jäähtytysvälineen syöttölaiteryhmät (5,6,9) säädetään yksitellen jäähtytysväliainemääriin käyttäen ennalta määritettyä ja vastaavasti määritettyä tietoa.

30 4. Patenttivaatimuksen 1, 2 tai 3 mukainen menetelmä, **tunnettu** siitä, että jäähtytysväliaine puhalletaan kiilanmuotoisesti suuttimien (5,6,9) kautta nauhalle.

5. Patenttivaatimuksen 4 mukainen menetelmä, **tunnettu** siitä, että kiilanmuotoisen puhalluksen huippukulma suutinryhmille (5,6,9) on välillä 20 ja 30 astetta.

5

6. Laitteisto ruostumattoman teräsnauhan tasaisuuden kontrolloimiseksi hehkutuksen jälkeisessä jäähdytyksessä viimeistelylinjalla, **tunnettu** siitä, että tasaisuuskontrollilaitteen (11) tasaisuuskontrolliyksiköiden (12) avulla nauhan (1) leveys on määritetty pitkittäisillä vyöhykkeillä (3) käyttäen nauhan
10 lämpötilamäärittystä (8) ja käyttäen jäähdytysväliaineiden syöttölaitteiden (5,6,9) sijaintia jäähdytysalueilla ennen ja jälkeen lämpötilamäärittymisen (8).

7. Patenttivaatimuksen 6 mukainen laitteisto, **tunnettu** siitä, että jäähdytysväliaineiden syöttölaitteet (5,6,9) on sijoitettu nauhan (1) koko
15 leveydelle poikittain nauhan kulkusuuntaan (2) nähden.

8. Patenttivaatimuksen 6 tai 7 mukainen laitteisto, **tunnettu** siitä, että ainakin yksi syöttölaiteryhmä (9) on sijoitettu lämpötilamäärittymisen jälkeen.

20 9. Patenttivaatimuksen 6, 7 tai 8 mukainen laitteisto, **tunnettu** siitä, että ainakin jäähdytysväliaineena vettä käyttävät syöttölaiteryhmät on sijoitettu nauhan (1) alapuolelle.

10. Jonkin edellä olevan patenttivaatimuksen 6 - 9 mukainen laitteisto, **tunnettu**
25 siitä, että termoskanneria (8) käytetään lämpötilamäärittymiseen.

11. Jonkin edellä olevan patenttivaatimuksen 6 - 10 mukainen laitteisto, **tunnettu** siitä, että jäähdytysväliaineiden syöttölaitteet (5,6,9), laite (8) lämpötilan määrittymiseen ja tasaisuuskontrolliyksiköt (12) on sähköisesti
30 yhdistetty (10,14,15,16) keskusprosessiyksikköön (7).

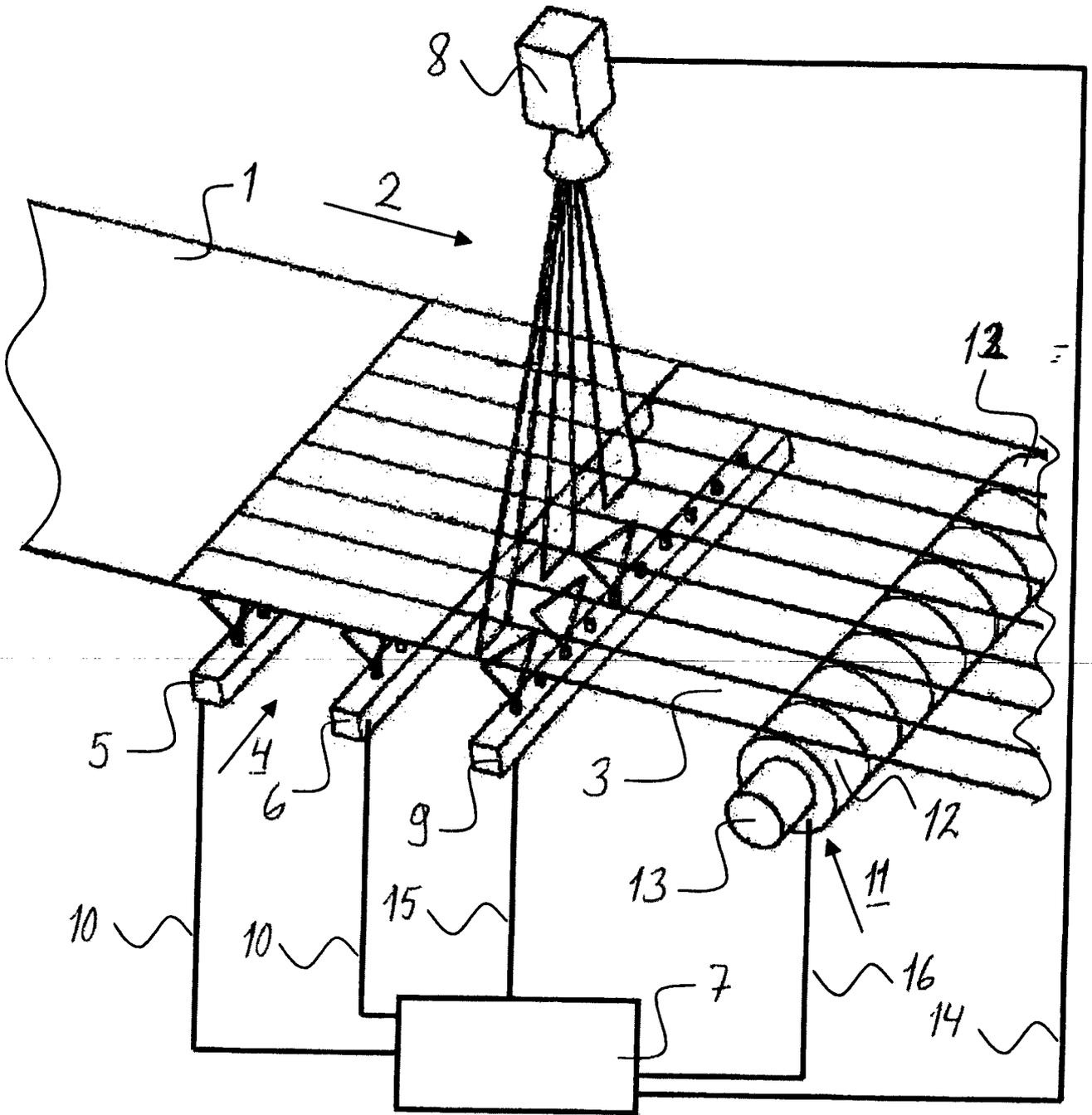


FIG. 1

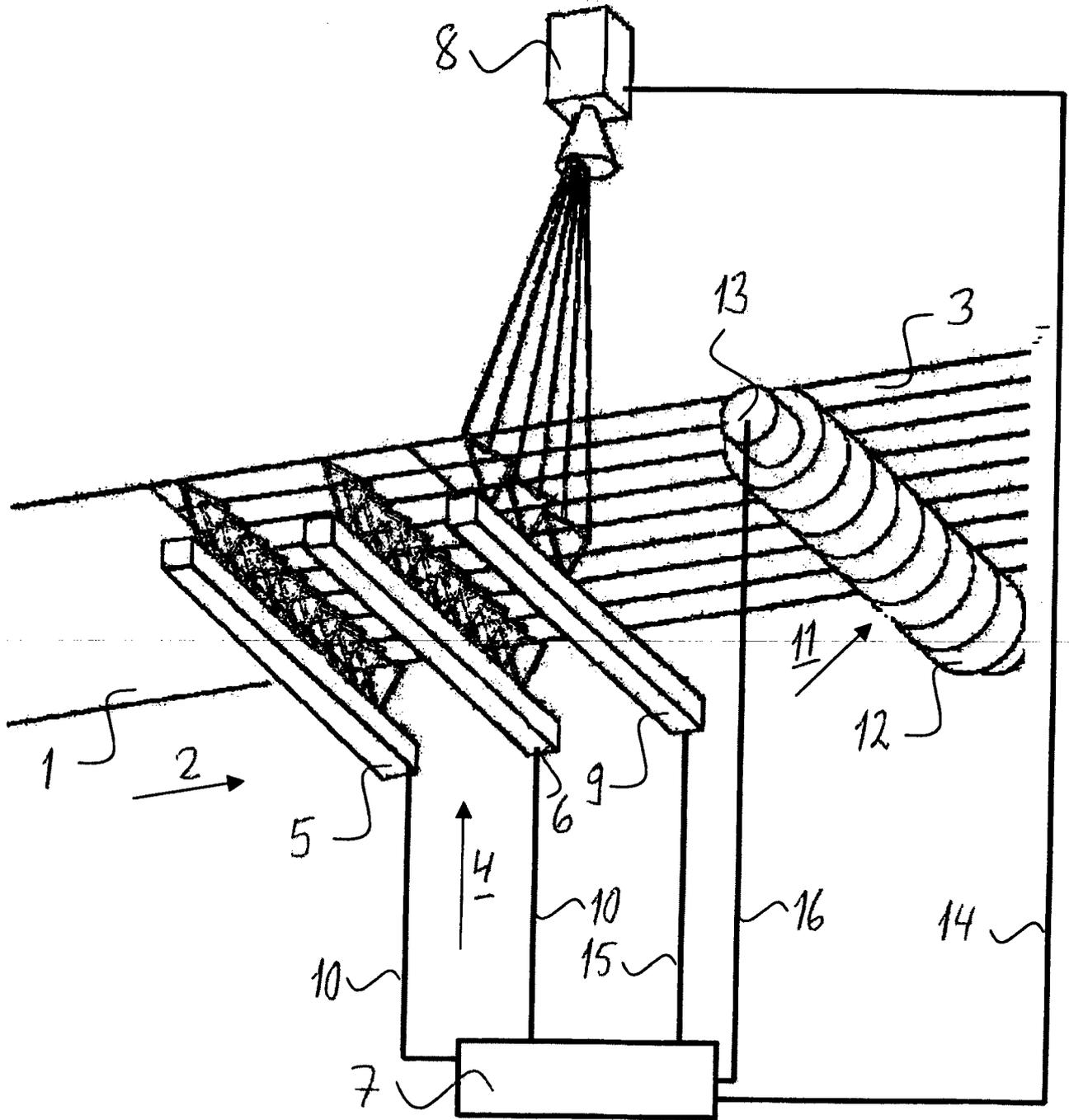


Fig. 2

PATENTTI- JA REKISTERIHALLITUS

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TUTKIMUSRAPORTTI

PATENTTIHAKEMUS NRO	LUOKITUS	
20070622	Int.Cl. B21B 45/02 (2006.01) B21B 37/28 (2006.01) B21B 37/74 (2006.01)	ECLA B21B 45/02 B21B 37/28 B21B 37/74
TUTKITUT PATENTTILUOKAT (luokitusjärjestelmät ja luokkatiedot)		
IPC 8: B21B		
TUTKIMUKSESSA KÄYTETYT TIETOKANNAT		
EPO-INTERNAL, WPI		

VIITEJULKAISUT

Kategoria*)	Julkaisun tunnistetiedot ja tiedot sen olennaisista kohdista	Koskee vaatimuksia
X	JP 2003293030 A (NIPPON STEEL CORP) 15. lokakuuta 2003 (15.10.2003), ks. kuvat 1-4 ja tiivistelmä tietokannassa Patent Abstracts of Japan sekä konekäännös englannin kielelle kappaleet 1, 3-5, 7, 9-11, 13-15, 19, 31, 33, 38, 45, 48, 49, 52 ja 64, vaatimukset 1, 2	1-11
A	US 4596615 A (MATSUZAKI KATSUSHIGE et al.) 24. kesäkuuta 1986 (24.06.1986)	1-11
A, D	EP 1153673 A1 (NIPPON STEEL CORP et al.) 14. marraskuuta 2001 (14.11.2001)	1-11
A	JP 2001137943 A (NIPPON STEEL CORP et al.) 22. toukokuuta 2001 (22.05.2001), ja tiivistelmä tietokannassa Patent Abstracts of Japan	1-11
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Jatkuu seuraavalla sivulla

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Lisätietoja liitteessä

Päiväys
 16.06.2008

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TUTKIMUSRAPORTTI**PATENTTIHAKEMUS NRO**

20070622

VIITEJULKAISUT, JATKOA

Kategoria*)	Julkaisun tunnistetiedot ja tiedot sen olennaisista kohdista	Koskee vaatimuksia
A, D	JP 2002045908 A (NITTETSU PLANT DESIGNING CORP et al.) 12. helmikuuta 2002 (12.02.2002), ja tiivistelmä tietokannassa Patent Abstracts of Japan	1-11