



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
23.10.2019 Bulletin 2019/43

(51) Int Cl.:
B08B 7/00 (2006.01) B21B 28/04 (2006.01)

(21) Application number: **18167519.0**

(22) Date of filing: **16.04.2018**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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(54) **LEVELER CLEANING SHEETS AND RELATED METHODS**

(57) Method of cleaning the rolls of a leveler machine (6), such as the work rolls of a tension leveler, for example, the method comprising the steps of: contacting a leveler cleaning sheet (20) with at least a part of the curved surface of the one or more rolls to enable cleaning by rotation of the one or more rolls; the leveler cleaning sheet (20) comprising a substrate (21) and a first adhesive layer (22) provided over the substrate (21), and the

surface of first adhesive layer (22) contacting at least a part of the curved surface of the one or more rolls; wherein the first adhesive layer (22) exhibits an adhesion to ferrous or non-ferrous metals of higher than 10 cN/20mm. In addition, a method of manufacturing a leveler cleaning sheet (20) and to leveler cleaning sheets (20) produced by said method.

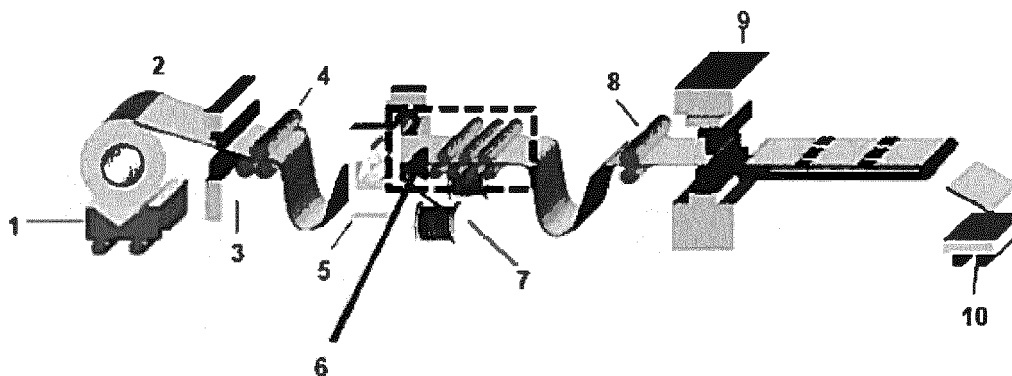


Fig. 1

Description

FIELD OF INVENTION

[0001] The present invention relates to a method of cleaning the rolls of a leveler machine, such as the work rolls of a tension leveler, for example.

[0002] In addition, the invention relates to a method of manufacturing a leveler cleaning sheet and to leveler cleaning sheets produced by said method.

BACKGROUND OF THE INVENTION

[0003] Leveler machines are widely applied for the processing of materials into flat shapes. For example, a leveler arrangement using multiple rolls may be used to process metal coils into flat sheets by application of high pressure (see Fig. 1).

[0004] A general problem observed in tension leveling processes is that contaminants (metal particles, paper powder, felt particles, abrasive metal oxides (Al_2O_3), and other foreign materials) may stick to the work and backup rolls during leveler operation and collect thereon until they generate marks and dents in the resulting leveled sheet, cause undesired vibration in the leveling machine and reduce the yield and/or quality of the leveled material. Figures 2A to 2D show a roll with typical contaminations, which generally appear as dark spots (Fig. 2A), which, when magnified, may be identified as metal (Fig. 2B), cloth and wood (Fig. 2C) and dust (Fig. 2D) contaminants.

[0005] In view of the above, a number of different methods have been proposed to minimize or eliminate the formation of marks and dents in the leveled strip by regular roll cleaning procedures, including off-line cleaning of the rolls after removal from the leveler. Another method includes cleaning of the work rolls in the deactivated leveler, for example by inserting a cleaning pad into the roll nip and manually rotating the roll to wipe foreign materials off of its surface, or by washing the rolls with a solvent spray.

[0006] Since these methods are time-consuming and often require highly qualified operating personnel to be conducted effectively, efforts have been made to develop in-line processes, wherein the cleaning operation is performed while running the leveler machine. For example, US 2007-180879 A1 discloses the implementation of a scraping device for continuous cleaning of work rolls. While this method reduces losses in production time, it is relatively expensive, particularly when cleaning of more than two rolls is desired, and requires additional maintenance. Other methods include passing a strip of fabric (e.g. felt) which is soaked in or sprayed with organic solvent, such as petroleum hydrocarbon or cellulose thinner, through the leveler machine, thereby wiping the surface of the back-up rolls and removing contaminating particles (see EP 0 715 551 B1, for example). However, felt cleaning requires at least about 30 minutes per cleaning step and the cleaning efficiency is difficult to judge. Last

but not least, the use of organic solvents raises concerns from an environmental point of view.

[0007] In addition, conventional methods using cleaning sheets often have the problem that the cleaning preparation and operation steps are difficult or even impossible to perform by a single operator.

[0008] Therefore, it remains desirable to provide an efficient in-line cleaning method, which is simultaneously inexpensive, environment-friendly, improves production efficiency, and which may be conducted by a leveler operator in a simple manner. In addition, it is desirable to provide a high quality leveler cleaning sheet which may be produced easily and used for the aforementioned method.

SUMMARY OF THE INVENTION

[0009] The present invention solves these objects with the subject matter of the claims as defined herein. The advantages of the present invention will be further explained in detail in the section below and further advantages will become apparent to the skilled artisan upon consideration of the invention disclosure.

[0010] The present inventors found that using a leveler cleaning sheet comprising specific configuration and adhesive properties enables inexpensive, efficient, and simple in-line cleaning of leveler machine rolls.

[0011] Generally speaking, the present invention therefore relates to a method of cleaning one or more rolls of a leveler machine, comprising contacting a leveler cleaning sheet with at least a part of the curved surface of the one or more rolls to enable cleaning by rotation of the one or more rolls; the leveler cleaning sheet comprising a substrate and a first adhesive layer provided over the substrate, and the surface of first adhesive layer contacting at least a part of the curved surface of the one or more rolls; wherein the first adhesive layer exhibits an adhesion to ferrous or non-ferrous metals of higher than 10 cN/20mm. Optionally, the leveler cleaning sheet comprises a second adhesive layer between the substrate and the first adhesive layer and in contact with the substrate, and a carrier layer between the first and the second adhesive layers; and wherein the adhesion to ferrous or non-ferrous metals of the second adhesive layer is higher than that of the first adhesive layer.

[0012] A further aspect of the present invention relates to a method of manufacturing a leveler cleaning sheet, comprising the steps of: providing a double-sided adhesive tape comprising a first adhesive layer, a second adhesive layer, a carrier layer between the first and the second adhesive layers, and an optional release liner in contact with the first adhesive layer; adhering the surface of the second adhesive layer to a substrate to provide the leveler cleaning sheet, wherein the first adhesive layer exhibits an adhesion to ferrous or non-ferrous metals of higher than 10 cN/20mm, and wherein the adhesion to ferrous or non-ferrous metals of the second adhesive layer is higher than that of the first adhesive layer.

[0013] Another aspect of the present invention is a leveler cleaning sheet manufactured by the aforementioned method.

[0014] Preferred embodiments of the leveler cleaning sheets according to the present invention and the related methods of the present invention are described in the following description and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

FIG. 1 shows an exemplary leveling process using a metal coil.

FIG. 2A shows a contaminated roll surface.

FIG. 2B is a magnified view of a part of Fig. 2A, showing metal contaminations.

FIG. 2C is a magnified view of a part of Fig. 2A, showing cloth and wood contaminations.

FIG. 2D is a magnified view of a part of Fig. 2A, showing dust contaminations.

FIG. 3A illustrates the exemplary configuration of a leveler cleaning sheet as used in the present invention.

FIG. 3B illustrates the exemplary configuration of a leveler cleaning sheet comprising two adhesive layers as used in the present invention.

FIG. 3C illustrates the exemplary configuration of a leveler cleaning sheet according to the present invention.

FIG. 3D illustrates the exemplary configuration of a double-sided tape as used in the present invention.

FIGS. 4A to 4H illustrate an exemplary manual application of a cleaning sheet provided in roll form, according to an embodiment of the present invention.

FIG. 5 is a photograph of a cleaning sheet that has been passed through a leveler machine according to Example 1 of the present invention.

FIG. 6A is a photograph of the cleaning sheet according to Example 2 before insertion into leveler.

FIG. 6B is a photograph of the cleaning sheet according to Example 2 after cleaning operation.

FIG. 7 is a photograph of an opened leveler showing uncleaned and cleaned parts of a working roll.

DETAILED DESCRIPTION OF THE INVENTION

[0016] For a more complete understanding of the present invention, reference is now made to the following description of the illustrative embodiments thereof.

Leveler Roll Cleaning Method

[0017] In a first embodiment, the present invention relates to a method of cleaning one or more rolls of a leveler machine, comprising contacting a leveler cleaning sheet with at least a part of the curved surface of the one or

more rolls to enable cleaning by rotation of the one or more rolls; the leveler cleaning sheet comprising a substrate and a first adhesive layer provided over the substrate, and the surface of first adhesive layer contacting at least a part of the curved surface of the one or more rolls; wherein the first adhesive layer exhibits an adhesion to ferrous or non-ferrous metals of higher than 10 cN/20mm.

[0018] The leveler machine is generally not particularly limited as long as comprises work rolls supported by backup bearings, and may include flatteners, shape correction levelers and tension levelers, for example. Preferably, the leveler machine is a tension leveler, which is usually configured to pull a strip (made of metals or alloys, such as hot rolled steel, cold rolled steel, stainless steel, aluminum, or copper, or of non-metallic specialized materials) beyond its yield point (i.e. the point on stress-strain curve which indicates the limit of elastic behavior and the beginning of plastic behavior) both by elongating and bending the strip over a series of work rolls in order to permanently eliminate edge wave and center buckle and correct excessive crossbow and coil set.

[0019] An exemplary processing line for the leveling of a metal coil and for the production of flat metal sheets is illustrated in Fig. 1. Herein, a metal coil provided on a coil car (1) is fed through an uncoiler (2) and a triple roll-assembly (3), followed by a rewind shirr (4). After passing a trimmer (5), which cuts the metal foil to a predetermined width, the trimmed metal foil enters the leveling machine (6) comprising a multiplicity of rolls (see dashed line marking), while the scrap material exiting the trimmer (5) is wound on a scrap winder (7). Via a feeder (8), the leveled material is then conveyed to a shirr machine (9), wherein the metal foil is cut into flat sheets with predetermined length and collected as finished goods (10).

[0020] In order to perform the cleaning operation according to the present invention by contacting a leveler cleaning sheet with at least a part of the curved surface of the one or more rolls of the leveler, the leveler cleaning sheet is inserted into the leveler machine and passed through the running machine, preferably under normal leveling conditions. Accordingly, the rolls do not have to be removed or made accessible as in manual cleaning operations and necessary adjustments may be kept at a minimum.

[0021] During the cleaning operation, it is recommended to set the line speed of the leveler to 0.5 to 2 m/min, preferably to 0.7 to 1.3 m/min. However, other line speeds may also be selected by the skilled artisan depending on the desired cleaning performance and the available time for the cleaning operation. In view of the properties of the used cleaning sheet (which will be explained in further detail below), passing the sheet through the leveler once is sufficient for effective cleaning. Accordingly, the actual duration of the cleaning process is remarkably shortened and takes less than one minute for most tension levelers, typically around 20 seconds. In comparison to most conventional techniques, the production loss is therefore sig-

nificantly reduced.

[0022] The leveler roll gap may be suitably adjusted by the skilled artisan depending on the thickness of the roll cleaning sheet.

[0023] In general, the leveler cleaning sheet used in the method according to the first embodiment of the present invention may be configured according to cleaning sheet (20a) shown in Fig. 3A, comprising a substrate (21) and a first adhesive layer (22). However, it may be preferable that the used leveler cleaning sheet comprises one or more further layers between the substrate and the first adhesive layer, for instance a second adhesive layer (23) according to the cleaning sheet (20b) depicted in Fig. 3B

[0024] In a preferred embodiment, a leveler cleaning sheet according to Fig. 3C is used the sheet (20c) comprising a second adhesive layer (23) between the substrate (21) and the first adhesive layer (22) and in contact with the substrate (21), and a carrier layer (24) between the first and the second adhesive layers (22) and (23). Such a configuration may be easily achieved by adhering a double-sided pressure-sensitive adhesive tape comprising the first adhesive layer, the second adhesive layer, and the carrier layer between the first and the second adhesive layers, to the substrate in order to provide the leveler cleaning sheet. The step of adhering the surface of the second adhesive layer to a substrate may be performed manually or mechanically, e.g. by a lamination device.

[0025] In general, if a second adhesive layer is used in the abovementioned configurations, the adhesion to ferrous or non-ferrous metals of the second adhesive layer is higher than that of the first adhesive layer in order to prevent delamination of the double-sided adhesive tape from the substrate during contact of the first substrate with the one or more rolls to be cleaned.

[0026] The leveler roll gap may be suitably adjusted by the skilled artisan depending on the thickness and the rigidity of the roll cleaning sheet.

[0027] Accordingly, an efficient in-line cleaning method is provided, which is simultaneously inexpensive and environment-friendly, especially when compared to solvent-based cleaning methods. Last but not least, the method enables efficient cleaning of the rolls with a single pass of the cleaning sheet through the leveler, which remarkably accelerates the cleaning process and thus dramatically improves production efficiency.

[0028] The properties and compositions of the leveler cleaning sheet including the first adhesive layer and the substrate, as well as the optional carrier layer and the optional second adhesive layer will be further described in conjunction with the second embodiment below, including preferred embodiments thereof. Overall, it will be appreciated that the preferred features of the first and second embodiments specified above may be combined in any combination, except for combinations where at least some of the features are mutually exclusive.

Manufacturing Methods for Leveler Cleaning Sheets

[0029] In a second embodiment, the present invention relates to a method of manufacturing a leveler cleaning sheet, comprising the steps of: providing a double-sided adhesive tape comprising a first adhesive layer, a second adhesive layer, a carrier layer between the first and the second adhesive layers, and an optional release liner in contact with the first adhesive layer; adhering the surface of the second adhesive layer to a substrate to provide the leveler cleaning sheet, wherein the first adhesive layer exhibits an adhesion to ferrous or non-ferrous metals of higher than 10 cN/20mm, and wherein the adhesion to ferrous or non-ferrous metals of the second adhesive layer is higher than that of the first adhesive layer.

[0030] The initial step of method of manufacturing a leveler cleaning sheet according to the present invention lies in the provision of a double-sided adhesive tape in accordance to Fig. 3D, comprising a first adhesive layer (22), a second adhesive layer (23), a carrier layer (24) between the first adhesive layer (22) and the second adhesive layer (23), and an optional release liner (25) in contact with the first adhesive layer (22). Such double-sided adhesive tapes (20d) may be manufactured from scratch or may be suitably selected from commercially available products.

[0031] It is to be noted that the "adhesion to ferrous or non-ferrous metals", as used herein, denotes the peel adhesion property on a clean and dry surface made of a ferrous or non-ferrous metal, which may include surfaces of metals and metal alloys, such as steel, for example. While not being limited thereto, in a preferred embodiment of the present invention, the wording "adhesion to ferrous or non-ferrous metals", as used herein, denotes the peel adhesion on BA steel determined according to EN 1939.

[0032] In preferred embodiments from the viewpoint of balancing roll cleaning efficiency and applicability, the first adhesive layer exhibits an adhesion to ferrous or non-ferrous metals in the range of from 10 to 600 cN/20mm, further preferably in the range of from 50 to 500 cN/20mm, especially preferably in the range of from 100 to 450 cN/20mm, and most preferably in the range of from 150 to 400 cN/20mm, at which particularly advantageous roll cleaning efficiencies are achieved.

[0033] Suitable formulations for manufacturing the first and second adhesive layers with the above-cited adhesion properties will be known to the skilled artisan and are not particularly limited.

[0034] For instance, exemplary adhesive formulations for the first adhesive layer may include acrylate-based, rubber-based, urethane-based, silicone-based adhesive formulations and combinations of two or more thereof, preferably at contents of 50 wt.-% to 100 wt.-%, more preferably at contents of 60 wt.-% to 98 wt.-% by weight, such as from 70 wt.-% to 95 wt.-%, or from 80 wt.-% to 93 wt.-%, for example, each based on the total weight of the first adhesive layer.

[0035] In a preferred embodiment, the first adhesive layer comprises an acrylic pressure-sensitive adhesive. The acrylic pressure-sensitive adhesive preferably comprises a (meth)acrylic polymer as the main component (e.g. at a content of 50% by weight or more of the acrylic pressure-sensitive adhesive). The (meth)acrylic polymer may be selected from a block copolymer, an alternating copolymer, and a graft copolymer, for example.

[0036] While not being limited thereto, the (meth)acrylic polymer may be prepared by polymerization of one or more C₁-C₁₈-alkyl (meth)acrylate monomers. As examples thereof, methyl (meth)acrylate, ethyl (meth)acrylate, n-butyl (meth)acrylate, s-butyl (meth)acrylate, t-butyl (meth)acrylate, isobutyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, n-octyl (meth)acrylate, isooctyl (meth)acrylate, isodecyl (meth)acrylate, n-tridecyl (meth)acrylate, and n-tetradecyl (meth)acrylate may be mentioned. The (meth)acrylic polymer may also include other monomers copolymerizable with alkyl (meth)acrylate, e.g. for introducing a crosslinking site into the acrylic polymer or enhancing an aggregating ability of the acrylic polymer. The copolymerizable monomer component may be used solely or in combination of two or more thereof. In this regard, the ratio of the alkyl(meth)acrylate to the total amount of the monomer components constituting the acrylic polymer is desirably 50% by weight or more.

[0037] Exemplary urethane-based adhesive formulations include, but are not limited to polyisocyanate compounds (e.g. diphenylmethane diisocyanate, tolylene diisocyanate, hexamethylene diisocyanate) reacted with polyols (e.g. polyether polyols, polyester polyols, polycarbonate polyols, polycaprolactone polyols, etc.).

[0038] Exemplary rubber-based adhesive formulations include, but are not limited to natural rubbers or synthetic rubber-based adhesives (such as adhesives based on SBS, SBR, SEPS, SIS, SEBS, polyisobutylene, and/or butyl rubber, for example).

[0039] Methods for the preparation of polymer-based adhesives, including polymerization types (anionic, cationic or radical polymerization; solution, emulsification, mass, and suspension polymerization) and reaction conditions, are well-known in the art and may be appropriately selected by the skilled artisan depending on the used starting materials (i.e. monomers).

[0040] The first adhesive layer may comprise further additives, which may be appropriately selected by the skilled artisan from known materials, including but not limited to tackifiers (e.g. tackifying resins including one or more of rosin-based tackifying resins, terpene-based tackifying resins, hydrocarbon-based tackifying resins, epoxy-based tackifying resins, polyamide-based tackifying resins, elastomer-based tackifying resins, phenol-based tackifying resins, and/or ketone-based tackifying resins, for example), crosslinking agents (e.g. isocyanate-based crosslinking agents, epoxy-based crosslinking agents, oxazolidine-based crosslinking agents, aziridine-based crosslinking agents, melamine-

based crosslinking agents, peroxide-based crosslinking agents, urea-based crosslinking agents, metal alkoxide-based crosslinking agents, metal chelate-based crosslinking agents, metal salt-based crosslinking agents, carbodiimide-based crosslinking agents, and/or amine-based crosslinking agents; preferably used at (total) contents of 0.1 to 20 wt.-% based on total weight of the adhesive layer), plasticizers, polymerization inhibitors, emulsifiers, pH buffering agents, foam inhibitors, stabilizers, anti-aging agents, UV-absorbers, antioxidants, anticorrosion-agents, light stabilizers, peeling regulators, softening agents, fillers, colorants (pigment, dye, etc.), surfactants, antistatic agents, and the like.

[0041] The adhesion of the second adhesive layer to ferrous or non-ferrous metals is not particularly limited as long as it is higher than that of the first adhesive layer. However, in order to more effectively prevent delamination of the double-sided adhesive during the cleaning operation, the adhesion to ferrous or non-ferrous metals of the first adhesive layer is preferably less than 30%, more preferably less than 25% of that of the second adhesive layer. As a lower limit, it may be preferred that the adhesion to ferrous or non-ferrous metals of the first adhesive layer is higher than 4%, more preferably higher than 6% of that of the second adhesive layer.

[0042] In preferred embodiments, the adhesion to ferrous or non-ferrous metals of the second adhesive layer is in the range of from 800 to 2100 cN/20mm, further preferably 1000 to 2000 cN/20mm, more preferably 1200 to 1800 cN/20 mm, most preferably 1400 to 1650 cN/20mm. Working within these ranges effectively prevents delamination, while still allowing the double-sided tape to be easily removed after the cleaning process, thereby enabling the substrate to be reused for multiple roll cleaning operations.

[0043] As with the first adhesive layer, the material constituting the second adhesive layer is not particularly limited and may be suitably selected depending on its adhesion properties on ferrous or non-ferrous metals.

[0044] In a preferred embodiment, the second adhesive layer comprises an acrylic pressure-sensitive adhesive. Further preferably, the second adhesive layer comprises a (meth)acrylic polymer as the main component (e.g. at a content of 50% by weight or more of the acrylic pressure-sensitive adhesive) according to the above description of the first adhesive layer. Especially preferably, the acrylic pressure-sensitive adhesive used in the second adhesive layer is prepared by polymerizing a monomer composition comprising primarily an alkyl (meth)acrylate (e.g. a C₁-C₁₈-alkyl (meth)acrylate) and one or more modifying monomer(s) copolymerizable with the alkyl (meth)acrylate. As examples of such modifying monomers, hydroxyl group-containing monomers (including hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 6-hydroxyhexyl (meth)acrylate, 8-hydroxyoctyl (meth)acrylate, 12-hydroxylauryl (meth)acrylate, N-methylol(meth)acrylamide, vinyl alcohol, allyl alcohol, 2-hydrox-

yethyl vinyl ether, 4-hydroxybutyl vinyl ether, diethyleneglycol monovinyl ether, for example), carboxyl group-containing monomers ((meth)acrylic acid, carboxyl ethyl (meth)acrylate, itaconic acid, maleic acid, fumaric acid, etc.), styrene-based monomers (such as styrene or styrene derivatives comprising alkyl, halogen, or haloalkyl groups, for example), cyano group-containing monomers (e. g. acrylonitrile), epoxy group-containing monomers (e.g. glycidyl (meth)acrylate), amide group-containing monomers (e.g. (meth)acrylamide), imide group-containing monomers (e.g. N-cyclohexyl maleimide), vinyl ethers and vinyl esters (e.g. vinyl propionate) may be mentioned.

[0045] The carrier layer (24) is composed of materials that may be suitably selected by the skilled artisan, including polymers, metals, nonwoven fabrics, paper and combinations thereof, for example. Preferably, the carrier layer comprises a polymer, such as a polyester (e.g. polyethylene terephthalate (PET), polybutylene terephthalate, polyethylene naphthalate etc.), polyamide (aliphatic or aromatic polyamides, for example) and/or polyolefin (polyethylene, polypropylene, polybutylene, etc.). In terms of processability, a carrier layer comprising a polyester-based material is particularly preferred, as it allows easy lamination and use of rolls of double-sided adhesive tapes, as opposed to being limited to the application of sheets.

[0046] The carrier layer may further contain additives, such as antioxidants, UV-absorbing agents, antistatic agents, light stabilizers, fillers, colorants etc.. Also, the carrier layer may be composed of a single layer or of multiple layers having different compositions.

[0047] The thickness of the carrier layer may be suitably selected by the skilled artisan. Preferable thicknesses range from 1 μm to 1000 μm . Particularly preferred is a carrier layer thickness of from 50 μm to 250 μm , which enables easy die-cutting of the resulting cleaning sheet and renders it stable towards film burrs.

[0048] The optional release liner may be suitably selected from materials known in the art. Examples thereof include, but are not limited to siliconized paper, PE-coated paper, siliconized PE-coated paper, PET, PP, etc. As is understood, the double-adhesive tape used in the present invention may be provided with a release liner on both the first and the second adhesive layers. In case two release liners are used, they may be identical or different.

[0049] In general, the leveler cleaning sheet may be prepared on-site, by adhering the double-sided adhesive tape on the chosen substrate (in which case a release liner has preferably been also provided on the first adhesive layer, which may facilitate the handling for the operation personnel) or before delivery to the customer for easier application.

[0050] In an especially preferred embodiment, the method of the second embodiment further comprises the step of winding the cleaning sheet into a roll form, wherein the substrate contacts the first adhesive layer, and the

substrate is preferably on the outside surface of the roll. Such a configuration significantly facilitates the handling and the cleaning operation for the operating personnel, and further enables the insertion using a coil car, similarly to the process shown in Fig. 1. Also, no release liner on the first adhesive layer is necessary, so that the manufacturing costs may be further reduced. In further preferred embodiments, the roll is provided with perforations in parallel to the roll axis and/or a release liner having larger dimensions than the double-sided adhesive tape.

[0051] An exemplary manual application of such a cleaning sheet roll is illustrated in Figures 4A to 4H, including the steps of unrolling (an optionally pre-perforated) roll (Figs. 4A and 4B), tearing off (if perforated) or cutting the roll (Figs. 4C and 4D), manually applying the thus obtained sheet onto the roll material surface (Fig. 4E), optionally with a scraping tool (Fig. 4F), and removing the top release liner from the sheet (Figs. 4G and 4H), which may be further facilitated by providing the cleaning sheet with dry-edges at the side of the sheet (e.g. by dimensioning the top release liner larger than the double-sided adhesive tape).

[0052] The total thickness of the double-sided adhesive tape without the optional release liner(s) is preferably in a range of from 1 μm to 5 mm, further preferably in a range of from 5 μm to 500 μm , as may be determined according to EN 1942, for example.

[0053] In preferred embodiments, the double-sided pressure-sensitive adhesive tape exhibits a static shear of 10 mm/3h or less, more preferably of 5 mm/3h or less, further preferably of 2 mm/3h or less, which may be determined according to EN 1943.

[0054] It will be understood that the double-sided adhesive tape may comprise further layers between the first and second adhesive layers beside of the carrier layer. For example, the double-sided adhesive tape may comprise one or more adhesive layers and/or carrier-type layers between the carrier layer and one of the first and second adhesive layers. However, a three layer-configuration consisting of a first adhesive layer, a second adhesive layer and a carrier layer between and in contact with the first and the second adhesive layers (as well as one or two optional release liner(s) on the surface(s) of the adhesive layer(s)) is preferable.

[0055] The substrate comprised in any of the above-described cleaning sheets may be suitably selected by the skilled artisan depending on the desired properties of the cleaning sheets and may be composed of a single layer or multiple layers with different compositions. It is important to note that the material constituting the substrate of the leveler cleaning sheet is not particularly limited as long as it is able to withstand the mechanical forces exerted by the leveler. For instance, the substrate may differ from the strip material for which the leveling process has been set up. As exemplary materials, metals (e.g. iron, copper, aluminum, zinc), alloys (e.g. hot rolled steel, cold rolled steel, stainless steel), polymers and combinations thereof may be suitably selected by the skilled

artisan depending on the desired properties of the cleaning sheets and may be composed of a single layer or multiple layers with different compositions. In preferred embodiments, the substrate may comprise a metal, an alloy, or a polymer. In a further preferred embodiment, the substrate material is selected from a material having a density of less than 3 kg/dm³, such as aluminum or polymer-based materials, for example, since such lightweight materials may be easily handled by a single operator as opposed to steel sheets, for example. Polymer-based materials, including, but not limited to polyamide or PTFE and derivatives thereof, are particularly preferred.

[0056] Accordingly, the method of the second embodiment enables facilitated and inexpensive production of a leveler cleaning sheet with excellent roll cleaning performance.

Leveler Cleaning Sheet

[0057] In a third embodiment, the present invention relates to a leveler cleaning sheet obtained by the method according to the second embodiment of the present invention described above. Specifically, the leveler cleaning sheet comprises: a first adhesive layer, a second adhesive layer, a carrier layer between the first and the second adhesive layers, and a substrate in contact with the second adhesive layer to a substrate to provide the leveler cleaning sheet, wherein the first adhesive layer exhibits an adhesion to ferrous or non-ferrous metals of higher than 10 cN/20mm, and wherein the adhesion to ferrous or non-ferrous metals of the second adhesive layer is higher than that of the first adhesive layer. An exemplary configuration is shown in Fig. 3C.

[0058] In a specifically preferred embodiment, the cleaning sheet is wound into a roll and further preferably comprises perforations in parallel to the roll axis and/or a release liner having larger dimensions than the double-sided adhesive tape, which significantly facilitates the handling of the cleaning sheet and the roll cleaning procedure so as to be executable by a single person (see Figs. 4A to 4H), and also allows for installation in a coil car in the feed section of leveler machines. Such a configuration represents a major improvement over conventional adhesive-based cleaning sheets which typically employ stiff materials not suitable for roll winding.

[0059] Other preferred properties and compositions of the layers constituting the leveler cleaning sheet according to the third embodiment of the present invention are further described in conjunction with the second embodiment above. Overall, it will be appreciated that the preferred features of the second embodiment specified above may be combined in any combination with the leveler cleaning sheet according to the third embodiment.

[0060] Overall, it will be appreciated that the preferred features of the first and second embodiments specified above may be combined in any combination, except for combinations where at least some of the features are

mutually exclusive.

EXAMPLES

Example 1

[0061] In an initial test, a leveler cleaning sheet with a configuration according to Fig. 3C was prepared by manually laminating multiple double-sided adhesive tapes (Nitto Double Coated Tape 61390; tape thickness without liner: 0.090 mm; adhesion to non-ferrous and ferrous metal surfaces: 1500 cN/20mm (open side), 350 cN/20mm (closed side); carrier: 0.012 mm transparent polyester) at the open sides onto a cleaned metallic substrate sheet (width: 1524 mm).

[0062] The thus obtained leveler cleaning sheet was passed through a tension leveler machine having a working roll (width: 1600 mm) contaminated with metal, dust and other dirt particles due to the metal sheet leveling under typical conditions, at a line speed of approximately 1 m/min.

[0063] Upon exiting the leveler, the cleaning sheet was visually inspected (see Fig. 3). The photograph in Fig. 5 shows that nearly all dirt particles on the working roll effectively adhered to the layer of the leveler cleaning sheet corresponding to the first adhesive layer within one or a few revolution(s) of the working roll. As is indicated by the dashed line, the cleaning efficiency may be easily judged based on the visual appearance of the cleaning sheet.

Example 2

[0064] The cleaning test according to Example 1 was repeated, with the exception that A3-shaped Nitto Double Coated Tape 61390 was manually applied onto the substrate in the arrangement shown in Fig. 6A. The visual appearance of the cleaning sheet exiting the leveler machine is depicted in Fig. 6B. As is shown in Fig. 6B, major dirt particles effectively adhered to the layer of the leveler cleaning sheet corresponding to the first adhesive layer. In addition, the leveler was opened and the cleaning performance was evaluated based on the appearance of the working roll. Fig. 7 is a photograph of the opened leveler, which shows that the part of the working roll that contacted the cleaning sheet (right hand side) has been effectively cleaned when compared to the uncleaned area of the working roll (left hand side).

[0065] Accordingly, it is demonstrated that the method according to the present invention effectively and quickly cleans the contaminated rolls of a leveler machine, enables simple and cost-effective cleaning operation, and allows the leveler operator to easily assess the degree of contamination of the working rolls.

[0066] Once given the above disclosure, many other features, modifications, and improvements will become apparent to the skilled artisan.

REFERENCE NUMERALS

[0067]

1	coil car
2	uncoiler
3	triple roll assembly
4	rewind shirr
5	trimmer
6	leveler
7	scrap winder
8	feeder
9	shirr machine
10	finished goods
20a / 20b / 20c	cleaning sheet
20d	double-sided adhesive tape
21	substrate
22	first adhesive layer
23	second adhesive layer
24	carrier layer
25	release liner

Claims

1. Method of cleaning one or more rolls of a leveler machine, comprising contacting a leveler cleaning sheet with at least a part of the curved surface of the one or more rolls to enable cleaning by rotation of the one or more rolls;

the leveler cleaning sheet comprising a substrate and a first adhesive layer provided over the substrate, and the surface of first adhesive layer contacting at least a part of the curved surface of the one or more rolls;
wherein the first adhesive layer exhibits an adhesion to ferrous or non-ferrous metals of higher than 10 cN/20mm.

2. Method of cleaning one or more rolls of a leveler machine according to claim 1, wherein the leveler cleaning sheet comprises a second adhesive layer between the substrate and the first adhesive layer and in contact with the substrate, and a carrier layer between the first and the second adhesive layers; and wherein the adhesion to ferrous or non-ferrous metals of the second adhesive layer is higher than that of the first adhesive layer.

3. Method of cleaning one or more rolls of a leveler machine according to claim 2, further comprising the steps of:
adhering a double-sided pressure-sensitive adhesive tape comprising a first adhesive layer, a second adhesive layer, a carrier layer between the first and the second adhesive layers, to a substrate in order to provide the leveler cleaning sheet.

4. Method of cleaning one or more rolls of a leveler machine according to any of claims 2 or 3, wherein the adhesion to ferrous or non-ferrous metals of the first adhesive layer is less than 25% of that of the second adhesive layer.

5. Method of cleaning one or more rolls of a leveler machine according to any of claims 2 to 4, wherein the first adhesive layer comprises an acrylic pressure-sensitive adhesive.

6. Method of cleaning one or more rolls of a leveler machine according to any of claims 1 to 4, wherein the first adhesive layer exhibits an adhesion to ferrous or non-ferrous metals in the range of from 100 to 450 cN/20mm, and the second adhesive layer, if present, exhibits an adhesion to ferrous or non-ferrous metals in the range of from 1000 to 2000 cN/20mm.

7. Method of cleaning one or more rolls of a leveler machine according to any of claims 1 to 6, wherein the substrate comprises a metal, an alloy, or a polymer.

8. Method of manufacturing a leveler cleaning sheet, comprising the steps of:

providing a double-sided adhesive tape comprising a first adhesive layer, a second adhesive layer, a carrier layer between the first and the second adhesive layers, and an optional release liner in contact with the first adhesive layer; and adhering the surface of the second adhesive layer to a substrate to provide the leveler cleaning sheet;
wherein the first adhesive layer exhibits an adhesion to ferrous or non-ferrous metals of higher than 10 cN/20mm, and
wherein the adhesion to ferrous or non-ferrous metals of the second adhesive layer is higher than that of the first adhesive layer.

9. Method of manufacturing a leveler cleaning sheet according to claim 8, wherein the first adhesive layer exhibits an adhesion to ferrous or non-ferrous metals in the range of from 100 to 450 cN/20mm, and the second adhesive layer exhibits an adhesion to ferrous or non-ferrous metals in the range of from 1000 to 2000 cN/20mm.

10. Method of manufacturing a leveler cleaning sheet according to any of claims 8 or 9, wherein the first adhesive layer comprises an acrylic pressure-sensitive adhesive.

11. Method of manufacturing a leveler cleaning sheet according to any of claims 8 to 10, wherein the sub-

strate comprises a metal, an alloy, or a polymer.

12. Method of manufacturing a leveler cleaning sheet according to any of claims 8 to 11, wherein the substrate comprises a polymer. 5
13. Method of manufacturing a leveler cleaning sheet according to any of claims 8 to 12, further comprising the step of winding the cleaning sheet into a roll, wherein the substrate is in contact with the first adhesive layer. 10
14. Leveler cleaning sheet manufactured by the methods according to any of claims 8 to 13. 15
15. Leveler cleaning sheet according to claim 14, wherein the cleaning sheet is wound into a roll and optionally comprises perforations in parallel to the roll axis and/or a release liner having larger dimensions than the double-sided adhesive tape. 20

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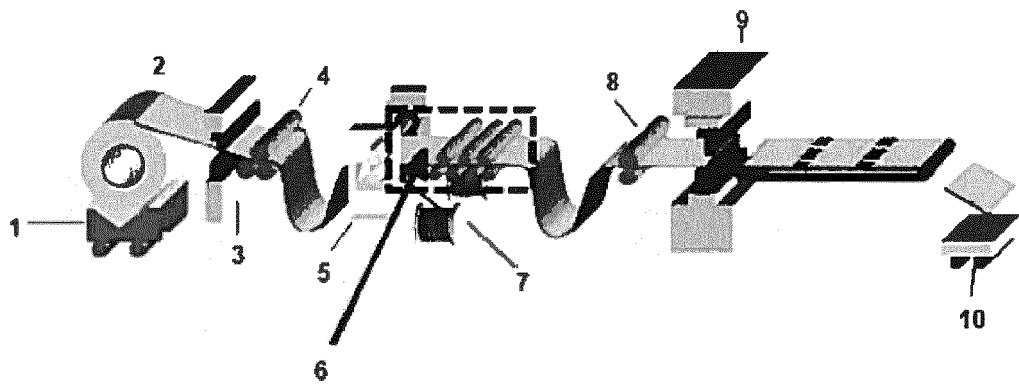


Fig. 1

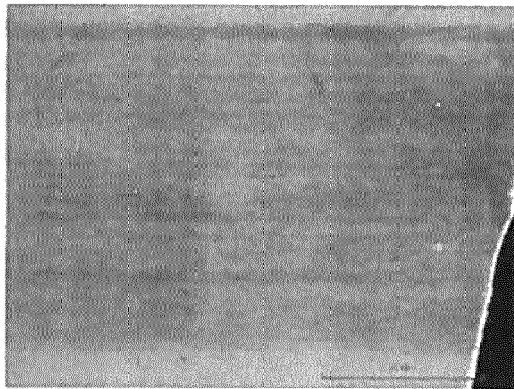


Fig. 2A

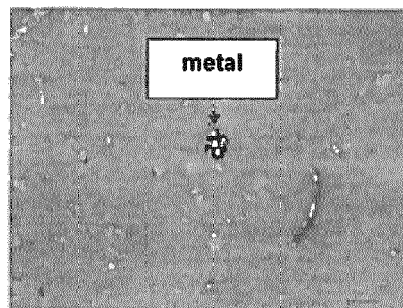


Fig. 2B

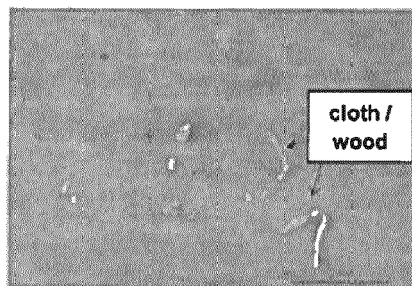


Fig. 2C

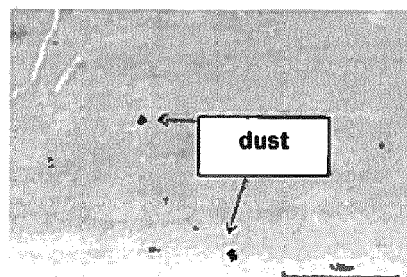


Fig. 2D

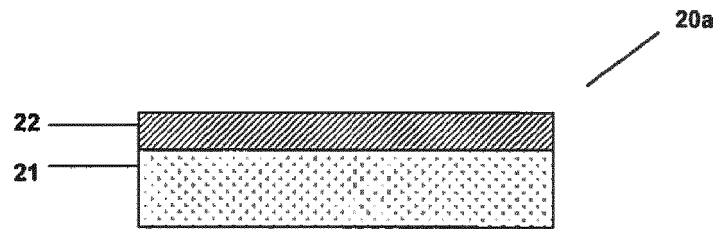


Fig. 3A

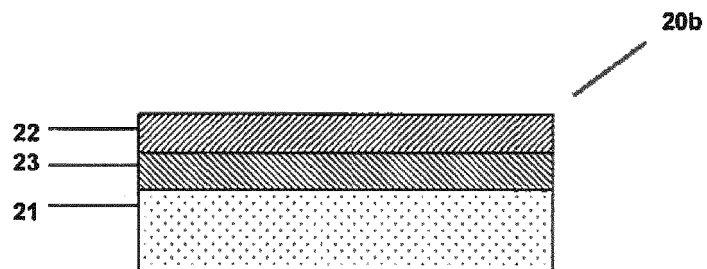


Fig. 3B

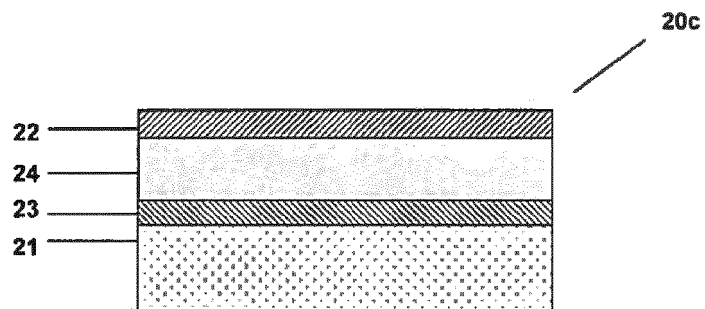


Fig. 3C

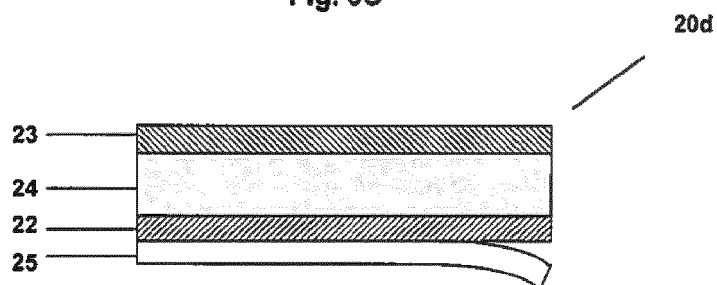


Fig. 3D

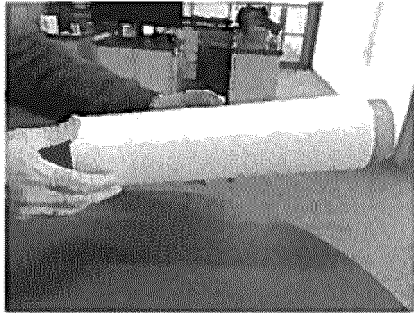


FIG. 4A

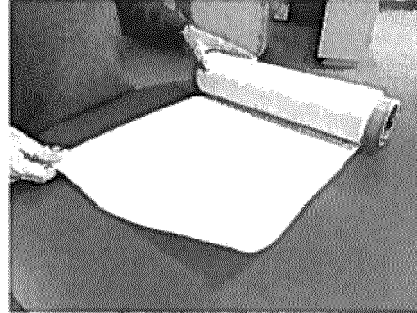


FIG. 4B

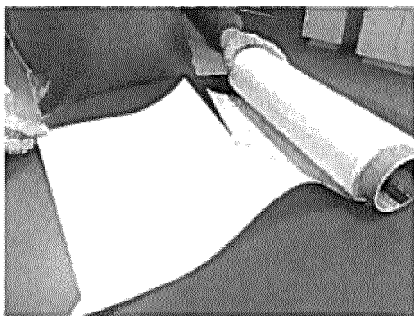


FIG. 4C

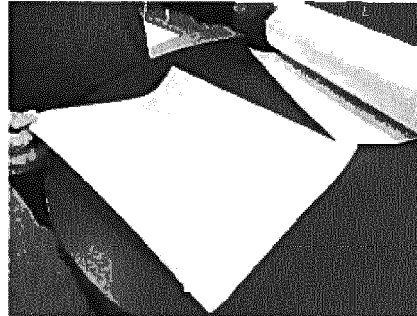


FIG. 4D

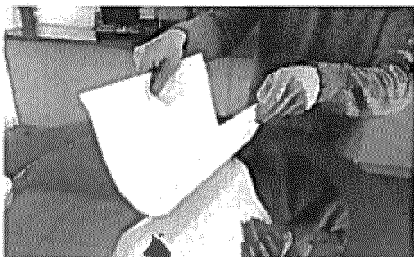


FIG. 4E

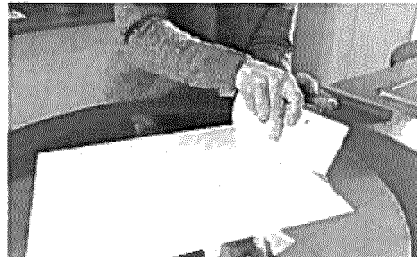


FIG. 4F



FIG. 4G



FIG. 4H

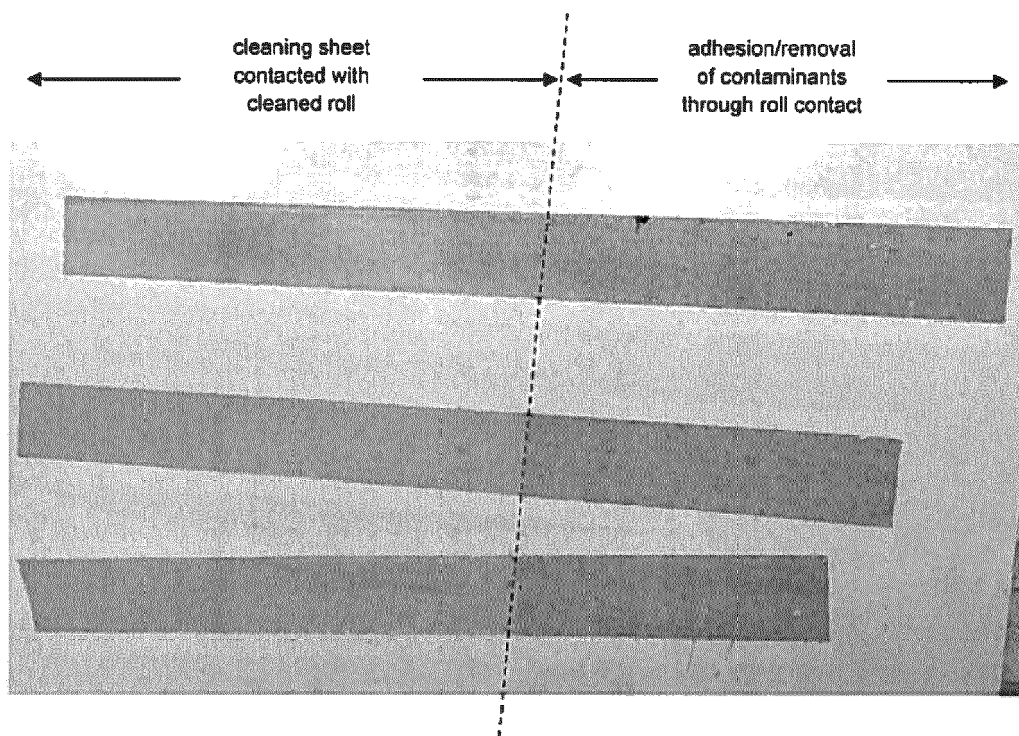


Fig. 5

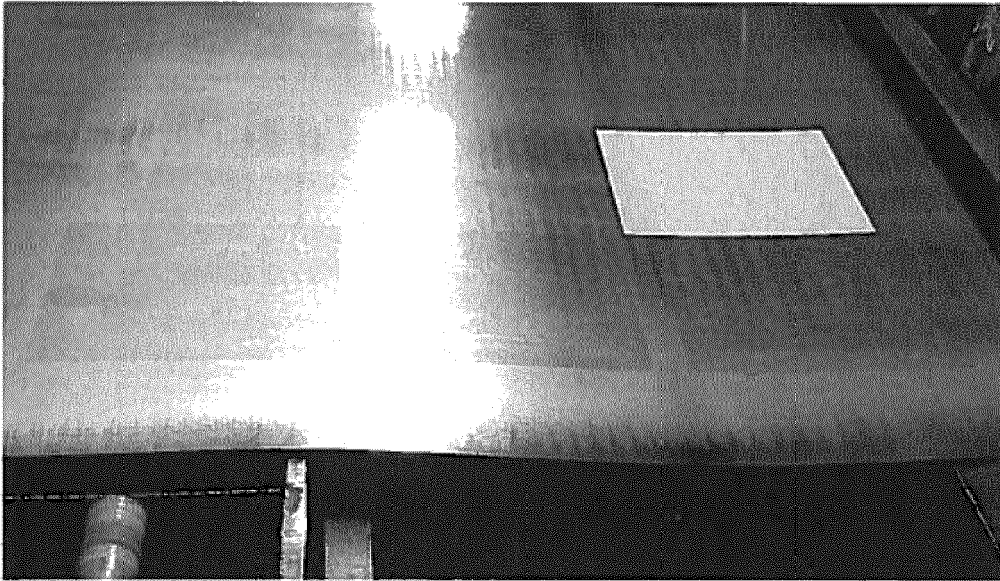


Fig. 6A

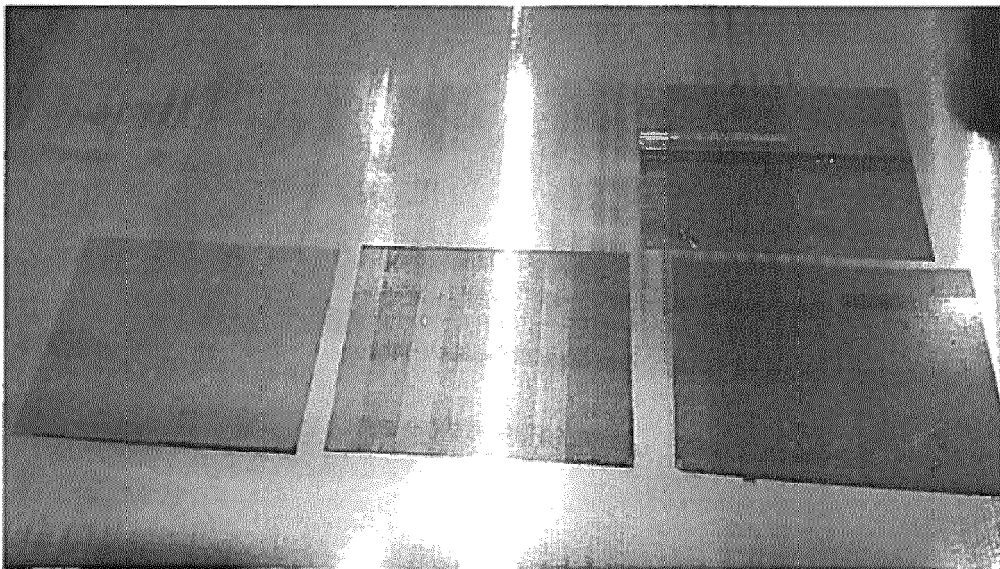


Fig. 6B

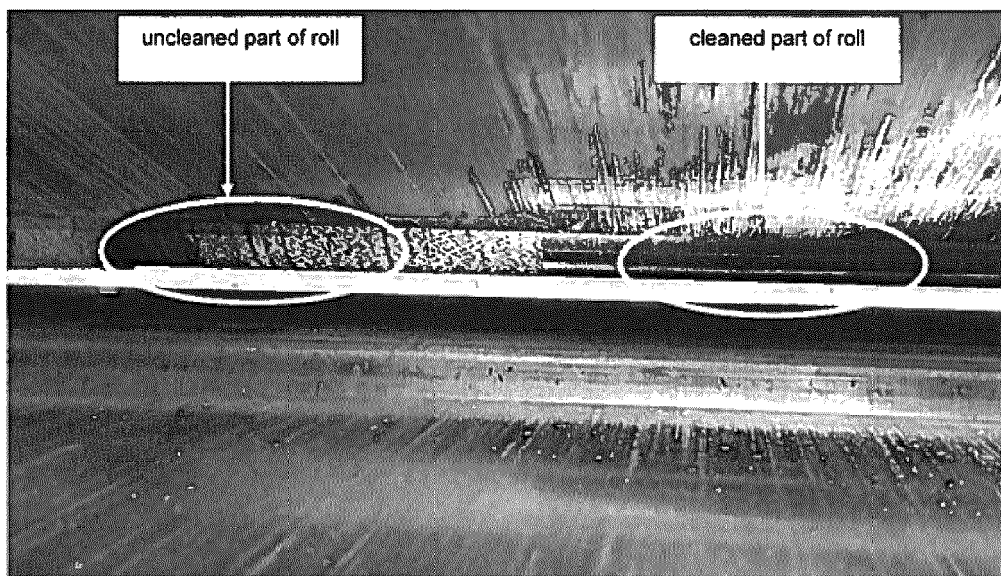


Fig. 7



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Place of search The Hague		Date of completion of the search 17 October 2018	Examiner van der Zee, Willem
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