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(71) Applicant: **Wuppermann Staal Nederland BV**
4782 PW Moerdijk (NL)

(72) Inventor: **Kwinten, Wilhelmus Johanes Petrus**
4891 SL Rijsbergen (NL)

(74) Representative: **Haan, Raimond et al**
Arnold & Siedsma
Bezuidenhoutseweg 57
2594 AC The Hague (NL)

(54) PASSIVATION SYSTEM COMPRISING AN EXPELLING DEVICE

(57) The present invention relates to passivation system (1), configured to passivate a steel plate (2), comprising:
- a compressor (3) with a lubricant (4) that is passivation inhibiting;
- a passivation unit (5);
- an expelling device (8), arranged between the compressor (3) and the passivation unit (5), and configured to remove the lubricant (4) from the steel plate (2);
- wherein the expelling device (8) comprises a blower (9) that is configured to blow the lubricant (4) away from the expelling device (8) and off of the steel plate (2).

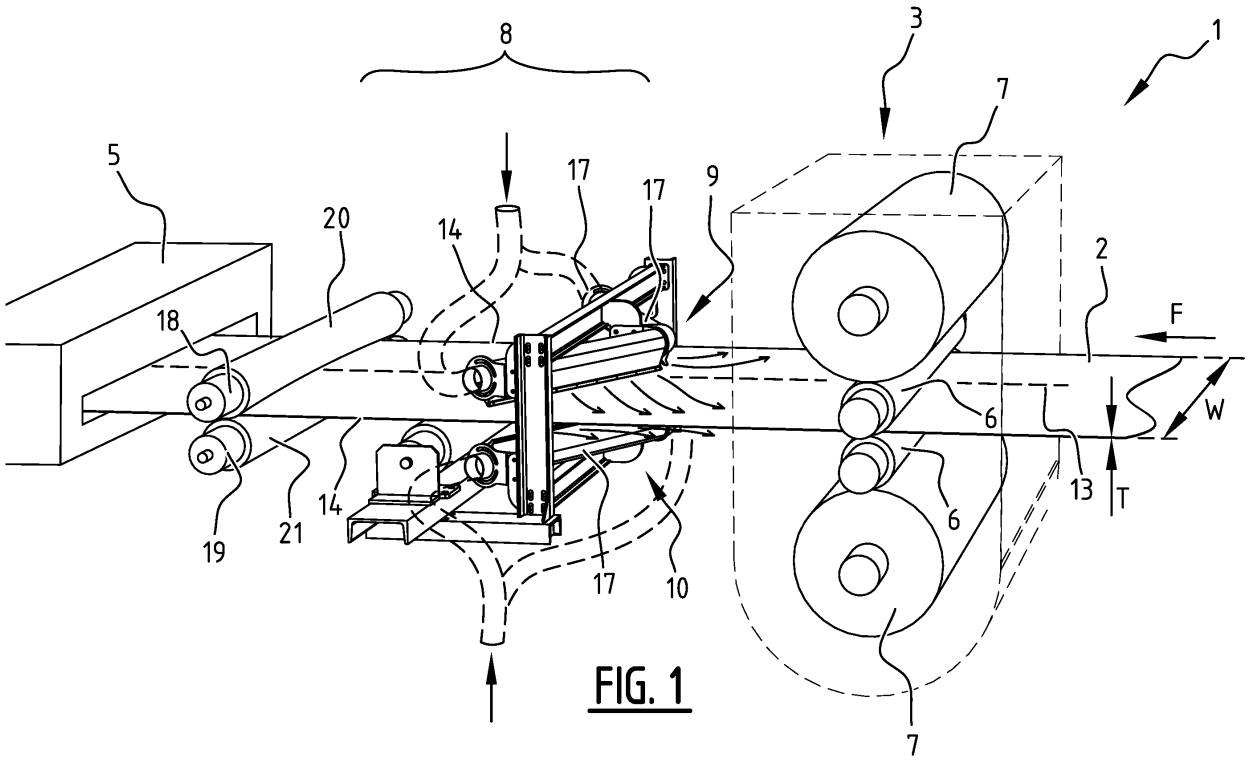

FIG. 1

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Description

[0001] The present invention relates to a passivation system, configured to passivate a steel plate, comprising a compressor with a lubricant and a passivation unit. In particular, the invention is related to a continuous passivation system, wherein steel strips may undergo a passivation treatment in a substantially continuous process.

[0002] During hot-dip passivation of hot-rolled steel strip, the strip is first introduced into a pickling station. In a subsequent step, the strip is introduced into a rinsing station, then into a drying station, and in a further step it is introduced into a heating furnace and subsequently passivated.

[0003] EP-B1-1 861 517 of Applicant describes a controlled thickness reduction in hot-dip coated (= hot-dip finished) hot-rolled steel strip, and an installation used therefor. It describes a method for the hot-dip coating of a hot-rolled steel strip, whereby the steel strip passes through a pickling station, a rinsing station, a drying station, a heating furnace and then a melting bath. The final thickness and the thickness tolerance of the hot-dip coated steel strip are achieved by a controlled thickness reduction in a rolling-mill stand in the processing line. At least one thickness gauge located in the exit of the rolling-mill stand checks whether the final thickness has been achieved and any deviations upwards or downwards are fed back as a control signal for the adjustment of the rolling-mill stand so that the thickness reduction can be correspondingly increased or decreased.

[0004] Steel strips often undergo a passivation process. Passivation, in physical chemistry and engineering, refers to a material becoming "passive," that is, less affected or corroded by the environment of future use. Passivation involves creation of an outer layer of shield material that is applied as a micro coating, created by chemical reaction with the base material, or allowed to build from spontaneous oxidation in the air. As a technique, passivation is the use of a light coat of a protective material, such as metal oxide, to create a shell against corrosion.

[0005] In the past, passivation of steel strips generally involved the application of hexavalent chromium based compounds. Hexavalent chromium (chromium(VI) or Cr(VI)) refers to chemical compounds that contain the element chromium in the +6 oxidation state (thus hexavalent). Cr(VI) passivation was considered to provide superior corrosion protection in comparison to alternative non-toxic trivalent chromium and chromium free applications. However, significant environmental and health concerns led to the ban on Cr(VI) passivation in almost all industries within the European Union market.

[0006] Chrome-free and trivalent chromium alternatives for hexavalent chromium based compounds are available, but have the disadvantage that they are incompatible with the emulsion used for rolling.

[0007] During rolling, chemical lubricants such as QWERL® that is commercially available via the Quaker Chemical Corporation®, are applied to increase roll life. For example, QWERL® may be applied in a solution of 2 Vol-% QWERL® and 98 Vol-% de-mineralized water. Also other chemicals, such as cleaning agents, are periodically applied to the rolls of a rolling mill stand.

[0008] Incompatibility of the chrome-free and trivalent chromium alternatives for hexavalent chromium based compounds with the emulsion used for rolling results in a - mainly optical - deterioration of the steel strips. The unwanted optical effects include stripes and stains that are not acceptable for this kind of products.

[0009] JP 2004 21805 is considered to form the closest prior art, relative to which at least the characterizing features are novel. It describes a passivation system according to the pre-amble of claim 1, and is directed to removing a processing liquid used during rolling of a steel plate before it is subjected to a chemical conversion treatment. It proposes a two step washing process, wherein the processing liquid is first washed in an alkaline solution, and successively washed with water.

[0010] The further Japanese documents JP S54 78348 and JP S56 134005, and the international patent application WO2006/109380, are acknowledged as further prior art.

[0011] An object of the present invention is to provide a passivation system that is improved relative to the prior art and wherein at least one of the above stated problems is obviated.

[0012] Said object is achieved with the passivation system, configured to passivate a steel plate, according to the present invention, comprising:

- a compressor with a lubricant that is passivation inhibiting;
- a passivation unit;
- an expelling device, arranged between the compressor and the passivation unit, and configured to remove the lubricant from the steel plate; and
- wherein the expelling device comprises a blower that is configured to blow the lubricant away from the expelling device and off of the steel plate.

[0013] According to the invention, the passivation inhibiting lubricant that is used in the compressor is driven away from the expelling device and off of the steel plate before the steel plate reaches the passivation unit. In this way, the passivation inhibiting lubricant is removed before it may inhibit or hinder a passivation step. In this way, the passivation system according to the invention, on the one hand allows the application of a lubricant to increase the life span of the compressor. On the other hand, it is prevented that this lubricant may negatively influence the passivation of the steel plate, e.g. causing unwanted optical side effects as mentioned above, in a later step of a process executed by said passivation system.

[0014] The expelling device of JP 2004 21805 is configured to remove the lubricant from the steel plate by a

two step washing process. During washing, the lubricant is removed from the steel plate and is mixed with the washing medium, i.e. either the alkaline or water. Consequently, the lubricant is not blown away from the expelling device, but is more or less absorbed by the (washing medium of the) expelling device. In the development of the proposed solution of JP 2004 21805 to remove the processing liquid using a two step washing process, a great amount of options were considered:

- firstly a method of rinsing water-soluble machining fluid for temper rolling with water;
- secondly high-pressure washing with water;
- next, washing with a light hydrocarbon oil such as an organic solvent was examined;
- fourth, washing with a chemical solution was examined;
- then, acid-based chemicals were tested; and
- successively, alkaline detergents were examined.

[0015] The closest prior art thus considered a great amount of options before finally proposing a two step washing process, wherein the processing liquid is first washed in an alkaline solution, and successively washed with water. However, none of all the carefully selected options considered examining the use of a blower. The thorough search for a solution to remove a passivation inhibiting processing liquid did not result in the idea to use a blower, nor did it stimulate the developers to consult a document such as JP S54 78348 that relates to a different technical field, but that does disclose a blower. JP S54 78348 discloses system, wherein a coolant is blown away from a workpiece using air jet nozzles on an exit side of a rolling device before the workpiece is delivered to an annealing or plating process.

[0016] In a preferred embodiment, the blower comprises an inclination relative to a width direction of the steel plate. This allows the blowing force to be controlled by selecting an appropriate height. Preferably, the blower has a smallest distance to the steel plate near a side edge of said steel plate. In this way, the blowing force increases towards the side edge of the steel plate, which allows the system effectively blow lubricant away from the blower and off of the steel plate. After all, considering a substantially evenly distributed film of lubricant on the steel plate, a blowing of said lubricant towards the side edges results in an accumulation of lubricant towards the side edges. If the distance between the blower and the steel plate decreases, the blower remains effective in blowing away this accumulated lubricant further towards the side edge, and finally off of the steel plate.

[0017] If the blower comprises one or more than one air knife according to an even further preferred embodiment, a substantially uniformly distributed flow pattern is obtained. Relative to discrete jet streams out of a plurality of nozzles, such a uniform distribution is optimal for effectively blowing away the lubricant off of the steel plate. Especially when the blower is an air knife, it is advantageous to increase the blowing force exerted by the air knife on the lubricant by providing said air knife with an inclination relative to a width direction of the steel plate, as described above.

[0018] According to an even further preferred embodiment, the blower is configured to direct an air stream at an angle γ relative to a feed direction of the steel pate, and the angle γ of the air stream is adjustable. In this way, the blowing force that is effective on the lubricant may be accurately adjusted.

[0019] Preferred embodiments are the subject of the dependent claims.

[0020] In the following description preferred embodiments of the present invention are further elucidated with reference to the drawing, in which:

Figure 1 is a perspective view of a passivation system according to the invention;
Figure 2 is a side view of a part of the passivation system of Figure 1;
Figure 3 is a top view of the passivation system of Figure 1;
Figure 4 is a frontal view of an expelling device of the passivation system of Figure 1; and
Figure 5 is a frontal view of rollers of the expelling device of the passivation system of Figure 1.

[0021] The passivation system 1 is configured to passivate a steel plate 2 and comprises a compressor 3 with a lubricant 4, and a passivation unit 5.

[0022] In the shown embodiment, the compressor 3 is a rolling mill, which is preferably a cold rolling mill or a skin pass mill. Compressor 3 compresses the steel plate 2 by rolling the plate 2 between rollers 6 which are compressed using further rollers 7, also known as back-up rolls. In order to increase roll life of the rollers 6 and 7, a lubricant, such as QWERL® temper mill fluid, is applied.

[0023] The steel plate 2 may be a strip, and is preferably a low alloyed steel strip. Typical dimensions of such a steel strip are a width W in the range 20 - 2000 mm, and a thickness T in the range of 0,9 - 7 mm.

[0024] The passivation system 1 may be configured to passivate a hot-dip coated steel plate 2, which typically has a coating, e.g. of zinc, in the range of 50 - 1200 g/m^2.

[0025] Chrome-free and trivalent chromium alternatives for hexavalent chromium based compounds currently used by the passivation unit 5, have the disadvantage that they are often incompatible with the emulsion used for rolling, i.e. lubricant 4. Thus, lubricant 4 is passivation inhibiting.

[0026] The passivation system 1 further comprises an expelling device 8, arranged between the compressor 3 and the passivation unit 5, and configured to drive the lubricant 4 away from the expelling device 8 and off of the steel plate 2.

[0027] In the shown embodiment, the expelling device 8 comprises a blower 9, and preferably also a further blower 10 that arranged on an opposite side relative to

the steel plate 2. In

[0028] Figure 1, blower 9 is arranged above the steel plate 2, while further blower 10 is arranged below the steel plate 2. Blowers 9, 10 are preferably similar in configuration.

[0029] The blower 9, 10 is configured to drive the lubricant 4 towards the compressor 3, i.e. opposite to the feed direction F of the steel plate 2. In this way the lubricant 4 is moved away from the passivation unit 5. Preferably, the lubricant 4 is driven back into the compressor 3, where it may be re-used as a lubricant 4. This is schematically indicated with receptor 11 in Figure 2.

[0030] As can be best seen in the top view of Figure 3, the blower 9, 10 comprises a V-shape and is arranged next to the steel plate 2, i.e. above or below the steel plate 2. A point 12 of the V-shape is arranged at or near a center line 13 of the steel plate 2. Legs 15 of the V-shape extend towards a side edge 14 of the steel plate 2. If the point of the V-shape is directed towards the compressor 3, the lubricant 4 is driven back towards the compressor 3 and toward the side edges 14 of the steel plate 2, where the lubricant is driven off of the steel plate 2. The lubricant 4 being driven away from the expelling device 8 and off of the steel plate 2 is also shown in the top view of Figure 3.

[0031] The legs 15 of the V-shape enclose an angle α in the range of 115° - 145°, preferably in the range of 120° - 140°, and most preferably in the range of 125° - 135°. In the shown embodiment, the angle α is about 130°.

[0032] As can be best seen in the frontal view of the expelling device 8 in Figure 4, the blower 9, 10 comprises an inclination relative to the width direction W of the steel plate 2. The blower 9, 10 approaches the steel plate 2 from the point 12 of the V-shape towards an end 16 of the leg 15 of the V-shape that is arranged near the side edge 14 of the steel plate 2. Thus the distance perpendicular to the steel plate 2 between the steel plate 2 and the blower 9, 10 is larger near a center line of the steel plate 2 than near the side edges 14 of the steel plate 2.

[0033] The inclination encloses an angle β relative to the steel plate in the range of 1° - 10°, preferably in the range of 1° - 8°, and most preferably in the range of 1° - 6°.

[0034] The blower 9, 10 is configured to direct an air stream A at an angle γ relative to a feed direction F of the steel pate 2, wherein this angle γ is in the range of 10° - 60°, preferably in the range of 20° - 50°, and most preferably in the range of 30° - 40°. The feed direction F coincides with a longitudinal direction of the steel plate 2.

[0035] The angle γ of the air stream A may be adjustable, so that the passivation system 1 may be optimized for a variety of feed velocities. It is also conceivable that the angle γ may differ between blower 9 arranged above the steel plate 2 and blower 10 arranged below the steel plate 2. Thus γ_1 may be different from γ_2 to compensate for e.g. gravity effects.

[0036] The blower 9, 10 preferably comprises one or more than one air knife 17. As shown, preferably each leg 15 of the V-shape comprises an air knife 17. Using air knives 17, a uniform and laminar flow having a high velocity may be directed to the steel plate 2 to drive the lubricant 4 off said steel plate 2. The blower is preferably configured to provide a flow rate of at least 400 m^3/hour at a pressure of less than 1 bar. A practical set up may comprise two blowers that each have a flow rate of approximately 1200 m^3/hour at a pressure of around 70 mbar.

[0037] The expelling device 8 further comprises a roller 18, arranged between the blower 9 and the passivation unit 5, and configured to remove a lubricant 4 residue from the steel plate 2. If some lubricant 4 residue may be left on the steel plate 2 after passing the blower 9 in the feed direction F, it is effectively removed from the steel plate 2 before the steel plate 2 reaches passivation unit 5.

[0038] The expelling device 8 preferably further comprises an additional roller 19, wherein the roller 18 and the additional roller 19 are arranged on opposite sides relative to the steel plate 2 and are configured to guide the steel plate 2 there between.

[0039] The rollers 18, 19 may each be an absorbing roller or a squeeze roller.

[0040] The rollers 18, 19 comprise a compressive layer 20, 21 respectively to allow compensation for any thickness variation of the steel plate 2, which may typically be thicker near the center line 13 and thinner towards the side edges 14 thereof (Figure 5).

[0041] If desired, one or more than one further sets of (not shown) rollers may be arranged between the blower 9, 10 and the passivation unit 5.

[0042] The above described embodiment is intended only to illustrate the invention and not to limit in any way the scope of the invention. Accordingly, it should be understood that where features mentioned in the appended claims are followed by reference signs, such signs are included solely for the purpose of enhancing the intelligibility of the claims and are in no way limiting on the scope of the claims. The scope of the invention is defined solely by the following claims.

Claims

1. Passivation system (1), configured to passivate a steel plate (2), comprising:

   - a compressor (3) with a lubricant (4) that is passivation inhibiting;
   - a passivation unit (5);
   - an expelling device (8), arranged between the compressor (3) and the passivation unit (5), and configured to remove the lubricant (4) from the steel plate (2),

   characterized in that:

- the expelling device (8) comprises a blower (9) that is configured to blow the lubricant (4) away from the expelling device (8) and off of the steel plate (2).

2. System according to claim 1, wherein the blower (9) comprises an inclination relative to a width direction of the steel plate (2).

3. System according to claim 2, wherein the blower has a smallest distance to the steel plate near a side edge (14) of said steel plate (2).

4. System according to any of the foregoing claims, wherein the blower (9) comprises one or more than one air knife.

5. System according to any of the foregoing claims, wherein:

- the blower (9) is configured to direct an air stream at an angle γ relative to a feed direction (F) of the steel pate (2); and
- the angle γ of the air stream is adjustable.

6. System according to claim 5, wherein this angle γ is in the range of 10° - 60°, preferably in the range of 20° - 50°, and most preferably in the range of 30° - 40°.

7. System according to any of the foregoing claims, wherein the expelling device (8) comprises a further blower (10), arranged on an opposite side relative to the steel plate (2).

8. System according to any of the foregoing claims, wherein the blower (9) is configured to drive the lubricant towards the compressor (3).

9. System according to any of the foregoing claims, wherein:

- the blower (9) comprises a V-shape and is arranged next to the steel plate, with a point (12) of the V-shape arranged at or near a center line (13) of the steel plate (2) and legs (15) of the V-shape extending towards a side edge (14) of the steel plate (2); and
- the point (12) of the V-shape is directed towards the compressor (3).

10. System according to claim 9, wherein the blower (9) approaches the steel plate (2) from the point (12) of the V-shape towards an end on the leg (15) of the V-shape that is arranged near the side edge (14) of the steel plate (2).

11. System according to any of the claims 2-10, wherein the inclination encloses an angle β relative to the steel plate in the range of 1° - 10°, preferably in the range of 1° - 8°, and most preferably in the range of 1° - 6°.

12. System according to at least claims 4 and 9, wherein each leg (15) of the V-shape comprises an air knife.

13. System according to at least one of the foregoing claims, wherein the blower (9) is configured to provide a flow rate of at least 400 m^3/hour at a pressure of less than 1 bar.

14. System according to at least one of the foregoing claims, the expelling device (8) further comprising:

- a roller (18), arranged between the blower (9) and the passivation unit (5), and configured to remove a lubricant residue from the steel plate (2);
- preferably comprising an additional roller (19), wherein the roller (18) and the additional roller (19) are arranged on opposite sides relative to the steel plate (2) and are configured to guide the steel plate (2) there between; and
- wherein more preferably one of the roller (18) or the additional roller (19) is an absorbing roller or a squeeze roller.

15. System according to at least one of the foregoing claims, wherein at least one of:

- the compressor (3) is a rolling mill, and preferably a cold rolling mill or a skin pass mill;
- the passivation unit (5) is configured to hot-dip coat the steel plate (2); and
- the steel plate (2) is a strip, preferably a low alloyed steel strip.

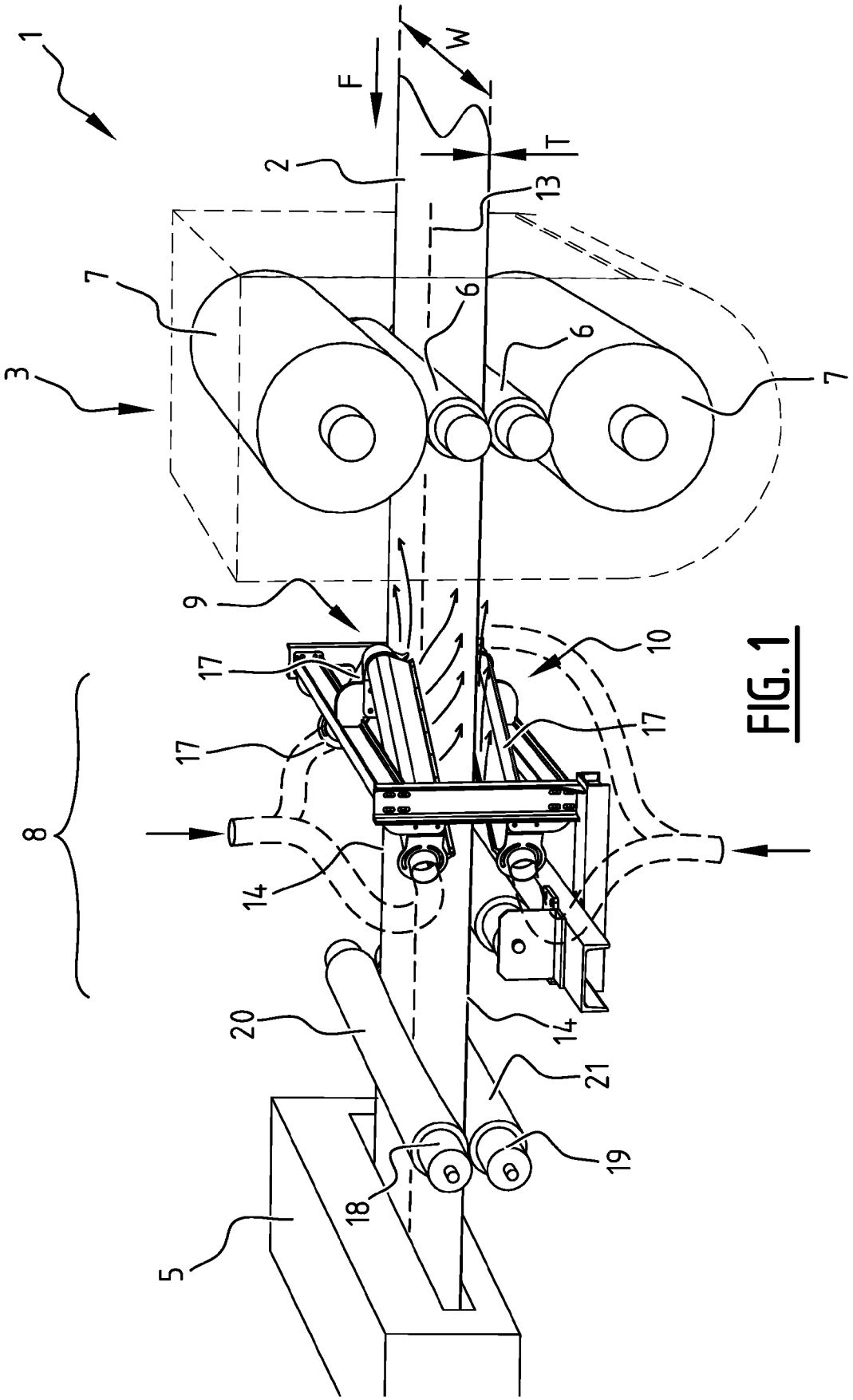

FIG. 1

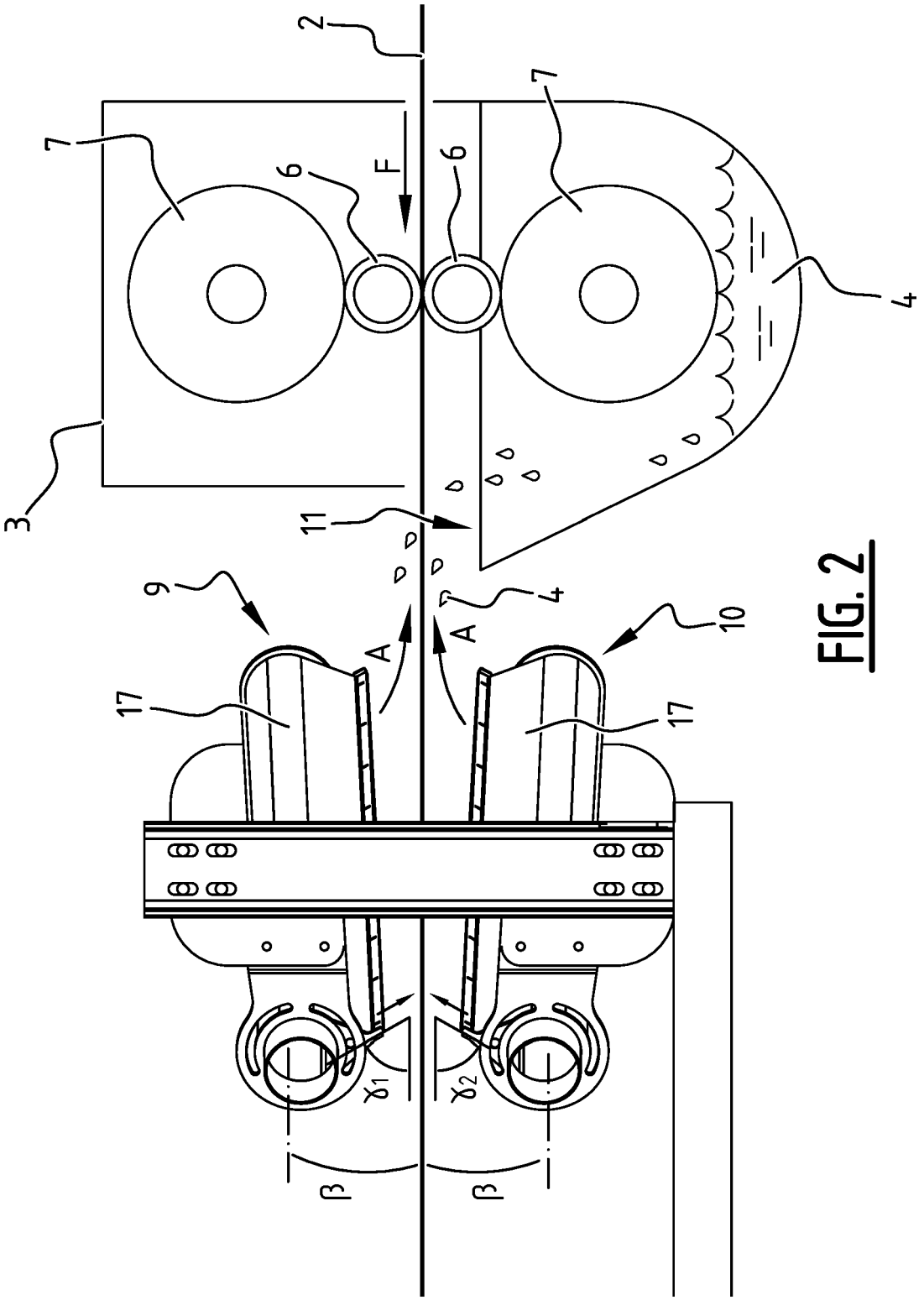

FIG. 2

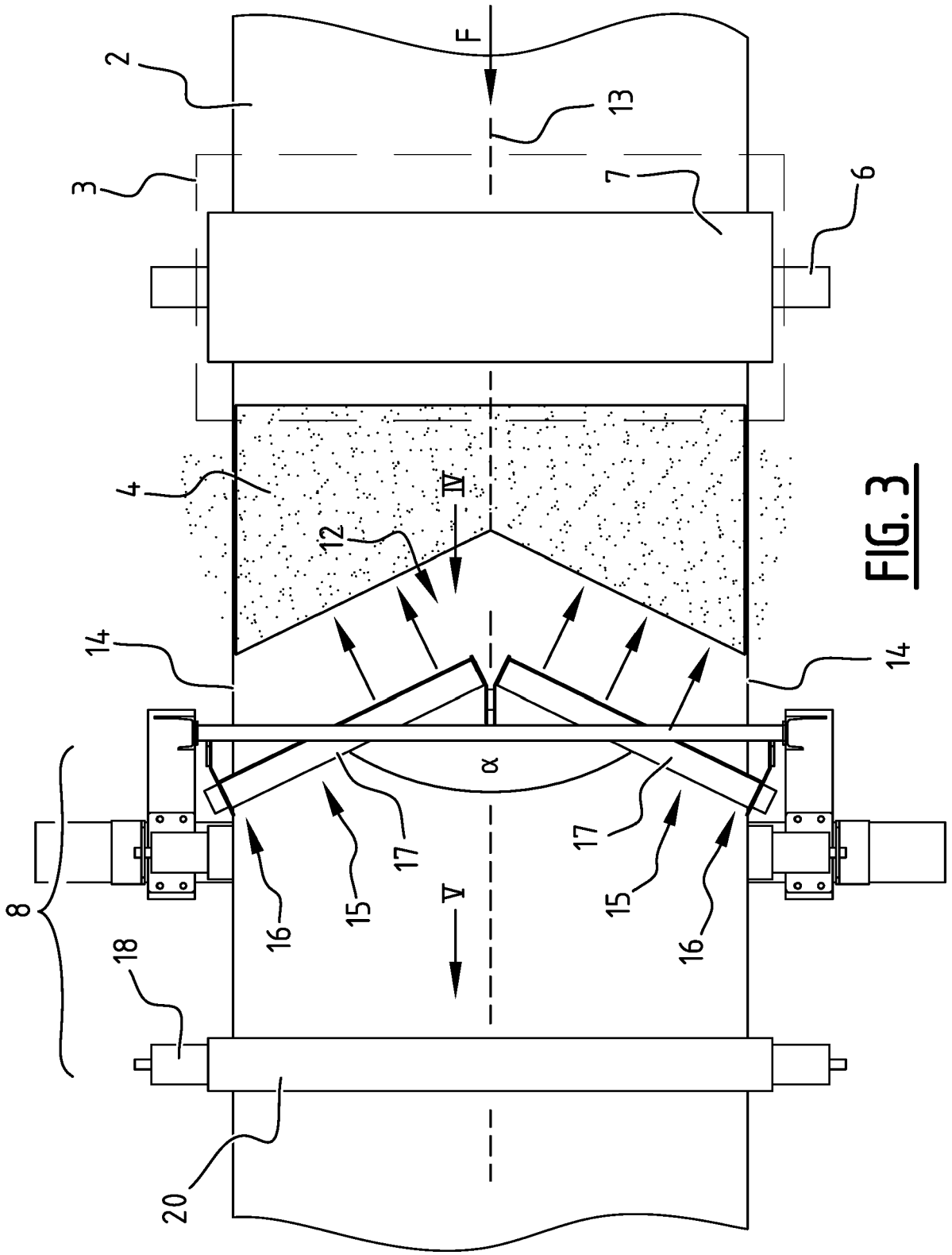

FIG. 3

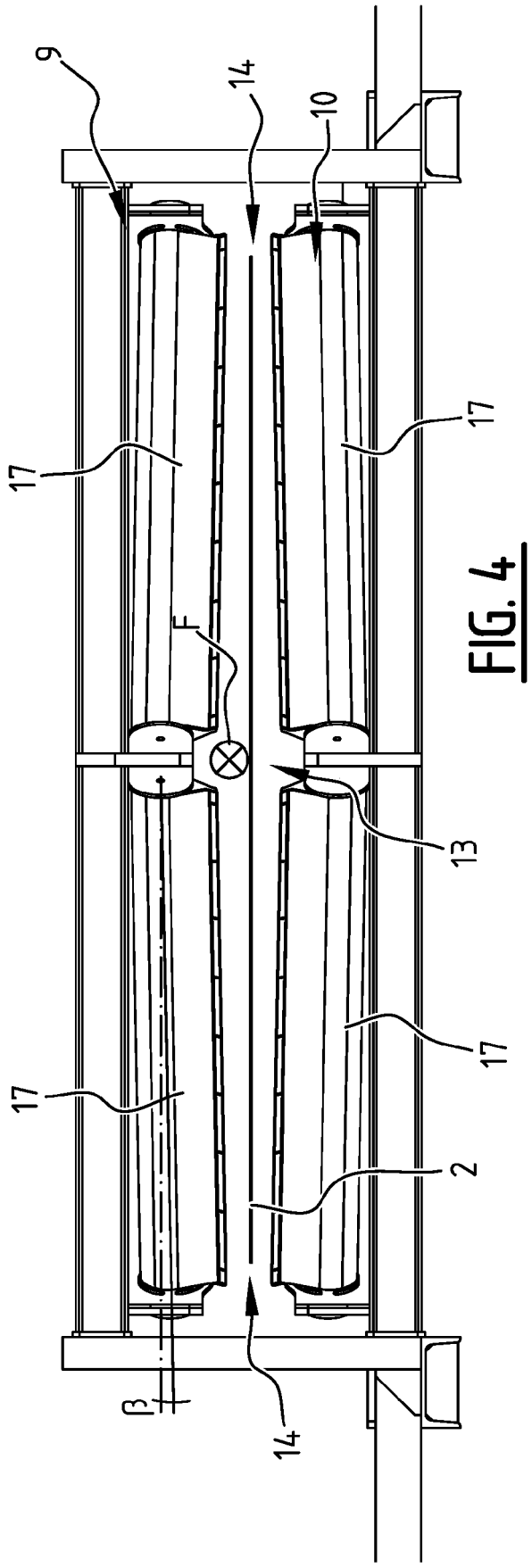

FIG. 4

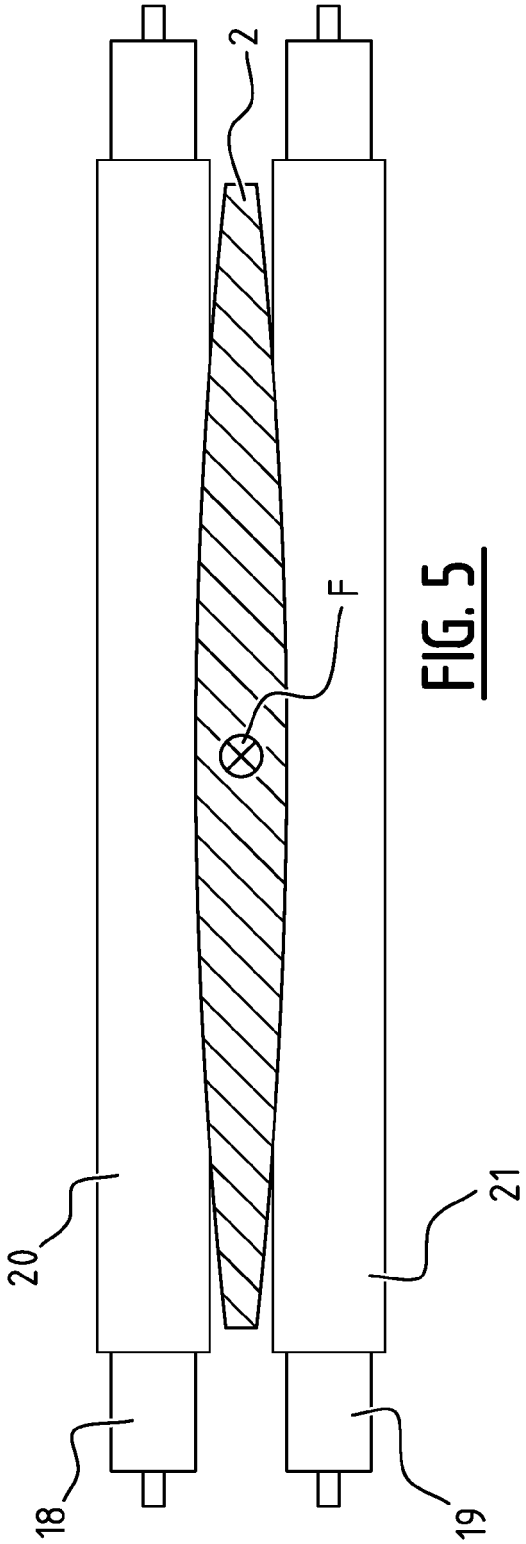

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 18 19 5118

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	JP S56 134005 A (SUMITOMO METAL IND) 20 October 1981 (1981-10-20) * abstract *	1-15	
Y	WO 2006/109380 A1 (MITSUBISHI HITACHI METALS [JP]; SAITO TAKEHIKO [JP]; FUKUYAMA GORO [JP]) 19 October 2006 (2006-10-19) * abstract *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

C23C
B21B
C23G
B08B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	19 December 2018	Mauger, Jeremy

CATEGORY OF CITED DOCUMENTS

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