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(54) Benævnelse: **FREMGANGSMÅDE TIL BELÆGNING AF EN STÅLPLADE MED ET METALLAG**

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Method for coating a steel sheet with a metal coating

The invention relates to a method for coating a steel sheet with a metal coating according to the preamble of claim 1 and to a device for implementing this method and to a steel sheet provided with a metal coating according to the preamble of the claim.

From the prior art in methods for galvanic coating of steel strips with a metal coating, it is known for the steel strip moving at a strip speed to be passed successively through a plurality of electrolyte baths which are arranged one behind another and in which a metal coating protecting against corrosion is deposited electrolytically on the steel strip. Thus, for example, when producing tinned sheet, it is known for a steel strip for electrolytic tinning to be passed through a plurality of tinning tanks which are arranged one behind another in the strip running direction and in which in each case there is a tin anode, in order to coat the steel strip connected as cathode electrolytically with a coating of tin. Here, typically, the steel strip runs sequentially through 5 to 10 such tinning tanks, wherein as a rule in each tinning tank a coating of tin of approx. 0.1 to 0.7 g/m^2 is deposited. At the highest possible strip speed of up to 700 m/min this makes it possible to set a current density of less than 25 A/dm^2 in the individual tinning baths. With higher current densities there is the danger of excessive development of heat which can lead to an impairment in the tinning quality if the heat produced in the tinning tanks cannot be dissipated.

After the deposition of the coating of tin in a thickness which is necessary to achieve an adequate corrosion resistance and which usually lies between 0.5 and 12 g/m^2, the galvanically deposited coating of tin is melted on by heating the coated steel strip in order firstly to produce a thin alloy layer at the junction between the surface of the steel strip and the coating of tin and secondly to produce a shiny tin surface. Here, the melting-on of the coating of tin is usually carried out conductively in an annealing furnace or inductively by means of electromagnetic induction in an induction furnace. It is also known from DE 10 2011 000 984 A1 for a coating of tin on a steel strip to be melted on by irradiation with an electromagnetic radiation of high power density in order to form a thin alloy layer at the boundary layer between the coating of tin and the steel strip.

US 4,726,208-A discloses a multi-stage method for tinning of steel sheet in which in a first stage a first thin coating of tin is applied in a coating thickness of 0.05 lb per base box on the surface of the steel sheet to form a flash coating of tin and then alloyed with the steel of the steel sheet. After this, in a second stage, on one side of the steel sheet a further coating of tin is applied to the alloy layer with a coating thickness of at least 0.20 lb per base box, melted on superficially by means of induction heating and finally quenched in a quenching bath. During the superficial melting-on of the coating of tin applied in the second stage, any as yet unalloyed components of the first coating of tin (flash coating) are alloyed with the steel of the steel sheet.

DE 1 496 835-A and US 3,285,838-A also disclose methods for multi-stage galvanic tinning of a steel sheet in an acid galvanising bath in which firstly a thin pre-plating coating (flash coating) of tin is applied to the steel sheet and this pre-plating coating of tin is then brought to liquefaction by heating the steel sheet. After the liquefaction of the pre-plating coating, a further tin plating operation is carried out in a further acid galvanising bath in order to deposit a further coating of tin on the pre-plating coating. The further coating of tin is again brought to liquefaction by heating the steel sheet. Here, the weight of the pre-tinning coating (pre-plating coating of tin) is at least 22.7 grams per standard area ("base box"), which corresponds to a coating thickness of at least 1.14 g/m^2 for the pre-tinning coating. To liquefy the pre-tinning coating, the steel sheet is heated to a temperature of between 288°C and 454°C.

US 3 062 726 discloses a further method for tinning of a steel sheet in which firstly a first thin coating of tin is deposited on the steel sheet and then melted on by heating the steel sheet to temperatures above the melting temperature of the tin. After this, the steel sheet coated with the first thin coating of tin is quenched and treated with a pickling bath, and finally a second coating of tin is applied to the first thin coating of tin. The thickness of the first thin coating of tin preferably corresponds to a coating thickness of 18 to 27 grams per standard area ("base box"), corresponding to a coating thickness of 0.9 g/m^2 to 1.35 g/m^2.

A multi-stage coating method for tinning a steel sheet is also known from GB 448,288.

The multi-stage coating methods known from the prior art in which firstly in a first stage a thin first coating of metal (flash coating) is applied to a steel sheet, the thin coating of metal is then melted on and thereafter at least one further thicker coating of metal is applied to the first coating of metal, are characterised by good corrosion resistance of the coated steel sheet. However, the method of production is costly and energy-intensive due to the step of melting on the first thin coating of metal, since to melt on the first thin coating of metal the entire steel sheet has to be heated to temperatures above the melting temperature of the coating material of the coating of metal. Furthermore, a comparatively high overall thickness is necessary for the coating of metal applied in order to obtain good corrosion resistance for the coated steel sheet.

Starting from here, the underlying object of the invention is to improve the corrosion resistance of a steel sheet coated with a coating of metal and to improve the energy and resource efficiency of the coating method. A further object is to provide a steel sheet coated with a coating of metal which offers high corrosion resistance and at the same time exhibits good weldability and good ironing characteristics and is suitable for the production of packaging containers, in particular cans.

These objects are achieved with the method with the features of claim 1 and the device with the features of claim 14 and with a steel sheet with the features of claim 15. Preferred forms of embodiment of the method according to the invention are disclosed in the dependent claims.

In the method according to the invention, firstly a first thin coating of metal is applied as pre-plating to the steel sheet, preferably by means of galvanic deposition of a thin coating of metal in an electrolysis bath. The thin coating of metal of the pre-plating is then melted on by heating the steel sheet provided with the pre-plating to temperatures above the melting temperature of the coating of metal. After this, at least one further coating of metal of the same material as the coating of metal used for the pre-plating is applied to the pre-plating. This is preferably carried out again by galvanic deposition of the further coating of metal on the coating of metal of the pre-plating. According to the invention, the thickness of the coating of metal of the pre-plating is at most 200 mg/m^2 and is thus much thinner than the thicknesses of the pre-plating coatings known from the publications of the prior art named initially. The further coating of metal which is applied to the melted-on coating of metal of the pre-plating in the method according to the invention is as a rulethicker than the thin coating of metal of the pre-plating, for example by a factor of from approx. 2 to 120 and preferably by a factor of from 4 to 60.

The melting-on of the thin coating of metal of the pre-plating is effected – other than in the case of the methods known from the prior art – by means of irradiation of the thin coating of metal with a radiation of high energy density, namely an electromagnetic radiation, in particular a laser radiation, or an electron beam. Here, the irradiation of the coating of metal is expediently effected by beaming an aimed bundle of rays on to the surface of the coating of metal, for which the bundle of rays can be either electromagnetic radiation and in particular laser radiation or an electron beam. Expediently, the melting-on of the thin coating of metal of the pre-plating is effected using a radiation source, for example a laser or an electron gun, with which energy is beamed into the thin coating of metal of the pre-plating at such a high level that the pre-plating is melted on completely over its entire thickness of at most 200 mg/m^2 down to the boundary layer with the steel sheet. As a result of this, the thin coating of metal of the pre-plating is converted at least essentially completely into an alloy layer which consists of atoms of iron of the steel sheet and atoms of the metal of the coating of metal.

The complete melting-on of the thin coating of metal of the pre-plating leads to the formation at the boundary layer between the thin coating of metal of the pre-plating and the steel sheet of an alloy layer which consists of atoms of the metal of the coating of metal and of atoms of iron of the steel sheet. The thin coating of metal of the pre-plating is at least largely completely converted into a thin alloy layer by the complete melting-on by means of irradiation with the electromagnetic radiation, i.e. after the thin coating of metal of the pre-plating has been melted on, this consists at least essentially of an alloy composed of atoms of the metal of the coating of metal and atoms of iron of the steel sheet.

The energy density introduced into the thin coating of metal of the pre-plating with the irradiation and the irradiation time are expediently selected so that the thin coating of metal of the pre-plating is melted on just completely over its entire thickness down to the boundary layer with the steel sheet without the radiation introducing a significant amount of energy into the underlying steel sheet. Thus, essentially, the introduction of the energy density is limited locally to the thickness of the thin coating of metal of the pre-plating. This allows considerable savings in energy because the steel sheet is not notably heated by the locally limited introduction of energy in the area close to the surface. Here, the irradiation time is dependent on the strip speed with which the steel strip is passed through the coating tanks in which the steel strip is coated with the coating of metal. Strip speeds in the region of a few hundred metres per minute produce short irradiation times in the µs range. It is also possible to use pulsed sources of radiation, such as for example pulsed lasers, to set an expedient irradiation time, the pulse duration preferably being less than 10 µs.

Because of the much thinner coating of metal of the pre-plating, the method according to the invention stands out compared with the methods according to the prior art in that a considerable amount of coating material can be saved. Surprisingly, it has been shown that in spite of the very tiny coating thickness of the coating of metal of the pre-plating of at most 200 mg/m^2, the locally limited melting-on of the thin coating of metal of the pre-plating through the radiation leads to the formation of a very thin and very dense alloy layer at the boundary layer between the thin coating of metal of the pre-plating and the steel sheet. In spite of its tiny thickness, this very thin and at the same time dense alloy layer leads to a considerable increase in the corrosion resistance of the steel coated according to the invention. Above all because of its high density, the very thin alloy layer with an alloy coating thickness of a maximum of 200 mg/m^2 guarantees outstanding protection against corrosion. It can be assumed that this high level of protection against corrosion can also be obtained with lower alloy coating thicknesses of for example only 20 to 100 mg/m^2. However, it is technologically difficult to adjust the coating thickness of the pre-plating to values below approx. 50 mg/m^2 since for example with galvanic deposition of the coating of metal of the pre-plating in the coating baths, a minimum current density must be set to keep the galvanic coating process stable.

For the radiation with which the temperature of the thin coating of metal is increased to values above the melting temperature, an energy density of from 0.03 to 3 J/cm^2 and preferably of from 0.1 to 2 J/cm^2 has proved to be suitable for melting on the thin coating of metal of the pre-plating.

If a coated steel sheet with a high surface shine is to be produced with the method according to the invention, in one expedient form of embodiment of the method according to the invention, after the deposition of the further coating of metal on the thin coating of metal of the pre-plating, a further melting-on of the entire metal coating can be effected by heating to a temperature above the melting temperature of the coating of metal. Preferably, this melting-on of the entire coating of metal is effected inductively in an induction furnace and leads to a shiny surface, as desired for example for use of metal-coated sheet steels as packaging steel. However, the melting-on of the surface of the (further or last) coating of metal can also be effected with high-energy beams, i.e. by irradiation with electromagnetic radiation or an electron beam – like the melting-on of the pre-plating.

With the method according to the invention a steel sheet provided with a metal coating can be produced in which a thin alloy layer is formed in the boundary layer between the surface of the steel sheet and the coating of metal, this alloy layer being composed of atoms of the iron of the steel sheet and of atoms of the metal of the coating material, the thickness of the alloy layer being at most 200 mg/m^2 and the proportion of the free non-alloyed metal in the coating of metal being at least 50% and preferably lying between 80% and 99%. Here, the thin layer of alloy is produced by the melting-on of the thin coating of metal of the pre-plating. The following deposition of a further (thicker) coating of metal on the thin coating of metal of the pre-plating produces a relatively high metallic (and thus non-alloyed) proportion in the coating. In particular if a subsequent melting-on of the further (thicker) coating of metal is omitted entirely or this is only carried out for a short time at a temperature which lies little above the melting temperature of the coating material, the entire quantity of the further coating of metal can be present in non-alloyed form (therefore as free tin in the case of tin coating for example). This is advantageous for example for the weldability of the coated steel sheet and responsible for good ironing characteristics due to the good lubricating effect of the metallic (non-alloyed) proportion of the coating.

This and further advantages of the method according to the invention will become apparent from the embodiment examples of the invention described in the following.

The embodiment example described in the following of the method according to the invention relates to the tinning of a steel strip for the production of a tinned sheet which can be used for example for the production of packaging containers, in particular cans for foodstuffs. However, the invention is not limited to the tinning of steel strips, and can also be applied accordingly for coating of steel sheets with other coatings of metal, for example of zinc or nickel. In the embodiment example described, the substrate (steel sheet) is present in the form of steel strip which is passed successively through a plurality of tinning tanks arranged one behind the other in the strip running direction. However, the invention is not limited to the coating of a steel strip in such a strip coating installation, but can also be applied in other coating installations in which for example steel sheets in panel form are successively provided with a coating of metal in coating tanks.

To produce a tinned steel sheet (tinned sheet), a steel sheet present in the form of a steel strip 1 is guided at a strip speed in the range of 100-700 m/min through a plurality of coating baths 2a, 2b, 2c, ... arranged one behind another in the strip running direction, as shown diagrammatically in figure 1. In the embodiment example, the coating tanks 2 are embodied in the form of tinning tanks in which in each case a tin anode 4 is arranged and which are filled with an electrolyte 5 (for example methane sulphonic acid). The steel sheet 1 moved through the tinning tanks is connected as cathode in order to deposit a thin coating of tin galvanically on both sides of the steel strip. The coating device illustrated diagrammatically in figure 1 is provided with a total of 10 tinning tanks (2a, 2b, ... 2j) arranged one behind another. However, more or fewer tinning tanks can also be employed depending on the desired total thickness of the coating of metal to be applied to the steel strip. In each of the tinning tanks, a thin coating of tin is deposited galvanically on the surfaces of the steel sheet, the coating thickness deposited in each tinning tank expediently lying in the range of from 50 to 500 mg/m^2. Preferably, the current density set in the galvanic tinning tanks lies between 10 and 25 A/dm^2 and the bath temperatures of the electrolyte as a rule lie between 30°C and 50°C.

In the front coating baths (tinning tanks) 2a, 2b, firstly a thin pre-plating coating (flash coating) of tin is deposited electrolytically (on both sides of the steel strip 1). The coating thickness of this pre-plating coating of tin expediently lies between 50 and at most 200 mg/m^2. Preferably, the coating thickness of the thin pre-plating coating lies between 80 and 150 mg/m^2 and particularly preferably is approx. 120 mg/m^2. After running through the first coating baths 2a, 2b, the thincoating of tin of the pre-plating deposited there on one side of the steel sheet is melted on. For this, on one side of the steel sheet 1 an electromagnetic radiation, which is produced for example with a laser 3, is beamed on to the surface of the thin coating of tin of the pre-plating. For this, a radiation source 3, for example a laser or an electron gun, is arranged between the second coating bath 2b and the third coating bath 2c. The energy density and the irradiation time of the bundle of rays emitted by the radiation source 3 is selected so that the thin coating of tin of the pre-plating (flash coating) which was applied in the front tinning tanks, is meltedon completely over its entire thickness down to the boundary layer with the steel strip. For this, energy densities of the radiation of between 0.03

and 3.0 J/cm^2 and preferably between 0.1 and 2.0 J/cm^2 have proved to be suitable. Expediently, the thin coating of tin of the pre-plating is heated by irradiation for just a short time to temperatures between the melting point of tin (250°C) and 500°C and preferably to temperatures in the range of from approx. 300°C to 400°C. After the thin coating of tin of the pre-plating (flash coating) has been melted on, this is cooled to temperatures below the melting temperature of the tin. The cooling is carried out expediently and in an energy-saving manner by self-cooling by conducting the heat through the steel strip 1 which is still cold.

After the melting-on of the thin coating of tin of the pre-plating and the cooling, the steel strip 1 is passed sequentially through the following rear tinning tanks 2c, 2d, ... 2j. There, further coatings of tin are deposited galvanically on both sides of the steel strip. Further coatings of tin are also deposited on the melted-on thin coating of tin of the pre-plating which was applied in the front tinning tanks 2a, 2b, until a thick coating of tin of the desired coating thickness is present on both sides of the steel strip 1. The coating thickness of the entire coating of tin composed of the thin coating of tin of the pre-plating and the further coatings of tin from the rear tinning tanks 2c, ... 2j, expediently lies between 0.5 g/m^2 and 12 g/m^2.

After the deposition of the further coating of tin, the steel sheet can be heated again for a short time to temperatures above the melting temperature of the tin in order to melt on at least the region of the surface of the coating of tin. This melting-on of the surface region of the coating of tin and a subsequent quenching in the water bath produce a surface shine on the coating of tin. However, other than in the case of the methods known from the prior art, the coating of tin no longer has to be melted on completely over its entire thickness in order to produce both a surface shine and a thin alloy layer at the boundary layer between the coating of tin and the steel sheet. Rather it is sufficient just to melt on the region of the coating of tin close to the surface in order to produce the surface shine, because the melting-on of the thin coating of tin of the pre-plating (flash coating) which was applied in the front tinning tanks 2a, 2b, has already produced a thin alloy layer which guarantees a high corrosion resistance for the tinned sheet. For the production of the surface shine on the surface of the coating of tin it is sufficient to heat the coated steel sheet only to temperatures in the region of 232°C (melting temperature of the tin) and approx. 300°C, and preferably to temperatures between 240°C and 260°C. This allows considerable energy savings to be made in comparison with the melting-on methods known from the prior art because with the known melting-on methods the coating of tin has to be heated to much higher temperatures in order to both produce the surface shine and form the thin alloy layer at the boundary layer with the steel sheet.

The tinned sheets produced in this way are characterised by a very high corrosion resistance which is produced by the thin and very dense alloy layer at the boundary layer between the thin coating of tin of the pre-plating and the steel strip. Tinned sheets produced according to the invention can have measured ATC values of less than 0.1 and even less than 0.05 $\mu A/cm^2$, which indicates a very good corrosion resistance.

The tinned sheets produced with the described embodiment example of the method according to the invention are particularly suitable for the production of packaging containers, in particular cans for foodstuffs. The side of the steel sheet on which the thin coating of tin of the pre-plating has been melted on is expediently used for the inside of the can because this side of the steel sheet exhibits a high corrosion resistance due to the formation of the alloy layer at the boundary layer between the thin coating of tin and the steel sheet. On the other side of the steel sheet the entirety of the tin deposited galvanically expediently remains as free tin. This leads to good ironing characteristics for the tinned steel sheet when ironing because there the free tin acts as a lubricant.

The invention is not limited to the described embodiment example. Thus, the thin coating of tin of the pre-plating need not be applied in the first two tinning tanks 2a, 2b, but it can also be deposited solely in the first tinning tank 2a or in the first three tinning tanks 2a to 2c. The radiation source 3 for meltingon the coating of tin of the pre-plating is then for example arranged between the first tinning tank 2a and the second tinning tank 2b or between the third tinning tank 2c and the fourth tinning tank 2d, and so on. The thickness of the coating of tin deposited in the front tinning tanks is adjusted by appropriate selection of the current density so that the overall thickness of the thin coating of tin of the pre-plating does not exceed the upper limit of 200 mg/m^2 according to the invention. It is also possible to melt on the thin layer of tin of the pre-plating not only on one side but on both sides of the steel strip before the further coatings of tin are deposited in the rear tinning tanks. The additional melting-on of the (thick) coating of tin deposited in the rear tinning tanks can be omitted if there is no need for the coating of tin to have a surface shine, for example for the production of cans using the ironing method (DWI).

If irradiation with an electron beam is used to melt on the thin coating of metal of the pre-plating, it is expedient to carry out at least the step of the method in which the pre-plating is melted on in a vacuum (expediently of at least 10^{-2} mbar). This makes it possible to avoid energy losses when irradiating with the electron beam.

The steel sheet produced according to the invention is characterised by very good corrosion stability which is produced by the corrosion resistant alloy layer between the surface of the steel sheet and the coating of metal. The thin alloy layer is created by the melting-on of the thin coating of metal of the pre-plating. The thickness of the alloy layer can be set by management of the method according to the invention by appropriate selection of the thickness of the pre-plating coating. The subsequent deposition of a thick coating of metal on the thin coating of metal of the pre-plating in the rear coating baths (if the coating thickness of the coating of metal is as specified) produces a relatively high metallic (and therefore non-alloyed) proportion in the coating. This is advantageous for example for the weldability of the coated steel sheet (for example for the production of three-part cans) and responsible for good ironing characteristics due to the good lubricating effect of the metallic (non-alloyed) proportion of the coating. Expediently, the metallic (non-alloyed) proportion in the coating is at least 50% and preferably at least 70% and particularly preferably between 80% and 99%.

Surprisingly, it has been shown that the very thin coating of metal of the pre-plating after the melting-on by means of irradiation with an aimed bundle of rays of electromagnetic radiation or an electron beam exhibits a good surface structure and arrangement which allows the further deposition of a coating of metal on the melted-on and alloyed coating of metal of the pre-plating. In the region of the coating of metalof the pre-plating close to the surface, the melting-on produces columnar growth nuclei on which the metal atoms of the coating material can grow during the subsequent coating and so guarantee good adhesion of the further coating of metal to the (alloyed) coating of metal of the pre-plating.

PATENTKRAV

1. Fremgangsmåde til belægning af en stålplade med et metallag omfattende følgende fremgangsmådetrin:

påføring af et første tyndt metallag som forplettering, hvor forpletteringens påførte metallag højst udgør 200 mg/m^2,
påsmeltning af forpletteringens metallag ved hjælp af bestråling af metallaget med en elektromagnetisk stråling eller med en elektronstråle, hvorved forpletteringens metallag fuldstændigt påsmeltes i dettes samlede tykkelse og derved i det mindste hovedsageligt fuldstændigt forvandles til et legeringslag bestående af stålpladens jernatomer og af atomer af metal, der hører til metallaget,
påføring af i det mindste et yderligere metallag på det ved påsmeltningen frembragte legeringslag.

2. Fremgangsmåde ifølge krav 1, kendetegnet ved, at forpletteringens påsmeltede metallag efter påsmeltningen afkøles til en temperatur under metallagets smeltetemperatur.

3. Fremgangsmåde ifølge krav 1, kendetegnet ved, at bestrålingstiden, inden for hvilken forpletteringens metallag bestråles med elektromagnetisk stråling eller med elektronstrålen, højest andrager 10 µs og foretrukket andrager mellem 10 ns og 1µs.

4. Fremgangsmåde ifølge et af de forudgående krav, kendetegnet ved, at påføringen af forpletteringens metallag andrager mellem 50 mg/m^2 og 200 mg/m^2 og foretrukket andrager 100 mg/m^2.

5. Fremgangsmåde ifølge et af de forudgående krav, kendetegnet ved, at den elektromagnetiske strålings energimængde, der anvendes til bestråling til forpletteringens metallags påsmeltning, andrager mellem 0,03 J/cm^2 til 3 J/cm^2 og foretrukket mellem 0,1 og 2 J/cm^2.

6. Fremgangsmåde ifølge et af de forudgående krav, kendetegnet ved, at efter påføring af det yderligere metallag på forpletteringens metallag ophedes den belagte stålplade til påsmeltning af den

samlede metalbelægning induktivt til en temperatur beliggende over metallagets smeltetemperatur.

7. Fremgangsmåde ifølge krav 6, k e n d e t e g n e t v e d , at efter påføring af det yderligere metallag på forpletteringens metallag ophedes den belagte stålplade til en temperatur andragende mellem 232 ^{0}C og 300 ^{0}C og foretrukket mellem 240 ^{0}C og 260 ^{0}C.

8. Fremgangsmåde ifølge et af de forudgående krav, k e n d e t e g n e t v e d , at forpletteringens metallag påføres stålpladen på begge sider ved hjælp af galvanisk påføring af belægningsmetal og v e d a t påsmeltningen af forpletteringens metalbelægning kun er blevet foretaget på en side.

9. Fremgangsmåde ifølge et af de forudgående krav, k e n d e t e g n e t v e d , at forpletteringens påsmeltning tilvejebringes ved at rette et strålebundt på forpletteringens metallags overflade, og hvor strålebundtet rettes kontinuerligt forløbende eller også pulseret, fortrinsvis med en maksimal impulsvarighed, der andrager 1 μs.

10. Fremgangsmåde ifølge et af de forudgående krav, k e n d e t e g n e t v e d , at metallagets belægningsmateriale består af tin, zink eller nikkel, og idet metallaget hørende til forpletteringen samt det yderligere metallag er af samme belægningmateriale.

11. Fremgangsmåde ifølge et af de forudgående krav, k e n d e t e g n e t v e d , at den (de) yderligere metalbelægnings (metalbelægningers) belægningsmængde andrager mellem 0,5 g/m^2 og 12 g/m^2.

12. Fremgangsmåde ifølge et af de forudgående krav, k e n d e t e g n e t v e d , at det ved forpletteringens metallag og det yderligere metallag respektivt drejer sig om et tinlag, og v e d a t forpletteringens tinlag til påsmeltningen ophedes til en temperatur andragende mellem 250 ^{0}C og 500 ^{0}C og fortrinsvis mellem 300 ^{0}C og 400 ^{0}C, før forpletteringens påsmeltede tinlag belægges med i det mindste et yderligere tinlag.

13. Apparatur til galvanisk belægning af en stålstrimmel (1) med en belægning af metal med et flertal af belægningsbade (2), som befinder anordnet efter hinan-

den, og gennem hvilket stålstrimmelen (1) er ledt i en strimmelbevægelsesretning (v) med henblik på at påføre belægning af metal ved hjælp af galvanisk aflejring, hvor der i det forreste belægningsbad eller belægningsbade (2a, 2b) betragtet i strimmelforløbsretning først bliver påført en første tynd belægning af metal som forbelægning, og på den påføres yderligere metallag i de efterfølgende belægningsbade (2c, 2d, 2e, . . .), k e n d e t e g n e t v e d , at der i det i strimmelforløbsretning forreste belægningsbad eller belægningsbade (2a, 2b) først påføres et første tyndt metallag som forbelægning med en pålagt lagtykkelse andragende højst 200 mg/m^2, og der betragtet i strimmelforløbsretning efter det forreste belægningsbad eller efter de forreste belægningsbade (2a eller 2b) er anordnet en strålekilde (3) til en elektromagnetisk bestråling eller en elektronstråle med henblik på påsmeltning af forpletteringens metallag ved hjælp af bestråling med en elektromagnetisk stråling, navnlig med en laser-stråle eller en elektronstråle.

14. Med en metalbelægning forsynet og ifølge en fremgangsmåde ifølge et af kravene 1 til 12 fremstillet stålplade, hvor der i grænselaget mellem stålpladens overflade og metalbelægningen er udformet et tyndt legeringslag, som er sammensat af stålpladens jernatomer og af belægningens metalatomer, k e n d e t e g n e t v e d , at legeringslagets belægningstykkelse højest andrager 200 mg/m^2, og at andelen af fri, ikke-legeret metal i metalbelægningen i det mindste andrager 50 % og foretrukket mellem 80 % og 99 %.

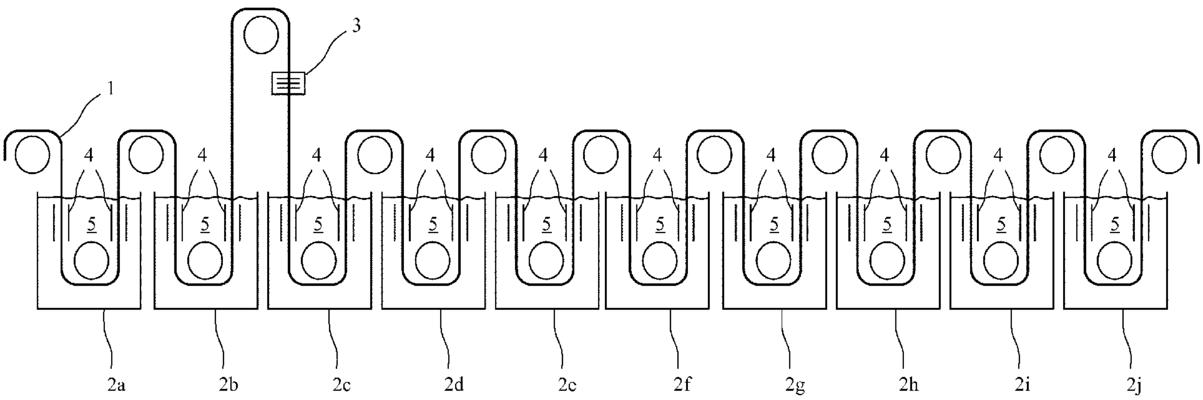

Fig. 1