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(54) **Berendezés fémszalag folyamatos kezelésére**

METHOD AND DEVICE FOR CONTINUOUS TREATMENT OF A METAL STRIP

DESCRIPTION

The invention relates to a device for continuous processing of a metal strip, particularly a metal strip made of aluminium (or an aluminium alloy) or of non-ferrous metal (or a non-ferrous metal alloy), having at least one thermal treatment apparatus, which is in the form of a strip flotation furnace through which the metal strip is floated, and having a strip guidance apparatus, with which the position of the metal strip can be controlled or adjusted in the strip running plane and transversely to the direction of advance of the strip, wherein the strip flotation furnace has at least one heating line on the infeed side and one cooling line on the outfeed side. The metal strip preferably has a thickness of 0.1 mm to 6 mm.

The thermal treatment apparatus is a strip flotation furnace which is equipped with a heating line and a cooling line. The heating line usually consists of a number of heating zones (heating and/or temperature maintenance zones) and the cooling line usually consists of a number of cooling zones. In such a thermal treatment apparatus, the metal strip is heated up to a specified (setpoint) temperature, optionally kept at this temperature for a specified period, then cooled down again. It passes through the furnace without contact, which is achieved by keeping the strip suspended between nozzles (air nozzles) to which a corresponding air pressure is applied. The cooling in the cooling zones may be carried out using air, water or a combination of air and water. Such strip flotation furnaces with a heating line on one side and a cooling line on the other side are known (see for example DE 198 04 184 A1).

DE 103 26 071 discloses a device for the continuous treatment of a metal strip, having at least one thermal treatment apparatus through which the metal strip is guided in suspended manner, and having a strip position adjustment device, with which the position of the metal strip is controllable or adjustable in the strip running plane and transversely to the direction of advance of the strip, wherein the thermal treatment apparatus has at least one heating line on the infeed side, and one cooling line on the outfeed side.

Such a device for continuous treatment of a metal strip of the kind described in the introduction, having a thermal treatment apparatus, that is to say a strip flotation furnace, may be in the form of a tempering or annealing line, for example, in which the metal strip undergoes a thermal treatment process for metallurgical reasons, e.g., in order to obtain certain strength and deformation properties. Alternatively, the device may also be a strip coating system or strip coating line, in which the thermal treatment of the metal strip is not carried out for annealing purposes, but to dry a coating on the strip, so that the furnace is then designed as a continuous dryer.

The metal strip is preferably an aluminium or non-ferrous metal strip with a thickness in a range from 0.1 mm to 6 mm.

Since the metal strip is heated to temperatures close to its melting point in annealing lines, it is usually necessary to ensure that the tension on the strip is relatively low inside the thermal treatment apparatus, to prevent the strip from breaking. For this purpose, the strip tension is reduced on the infeed side in a tension roller set, for example, and then restored in another tension roller set on the outfeed side after cooling. In the thermal treatment apparatus (the strip flotation furnace), the specific strip tension is in the order of 0.5 to 1 MPa, for example. Since the strip is able to "wander", particularly under low tension inside the furnace, due to possible camber, for example, it is essential to position the strip appropriately, preferably to centre the strip, with the aid of a strip position adjustment device. The positioning consequently takes place transversely to the direction of advance of the strip, in the strip running plane. Such a strip position adjustment device typically comprises at least one control roller as well as suitable position measuring devices such as strip edge detection devices. In the systems known in actual operation, the strip position adjustment device is arranged after the thermal treatment apparatus, that is to say after the cooling line. In practice, the control roller is usually configured as a "PI strip centring control", i.e. with a proportional, P-component and an integral, I-component. The effect of the I-component operates upstream into the furnace section, and prevents the strip from deviating excessively from its course in the furnace. The control roller is usually mounted on a movable base frame. This frame revolves the roller about a notional centre of rotation or axis of rotation which is located in the furnace section and aligned perpendicularly to the strip running plane. The dimension of offset of the roller from the centre line of the furnace section is the proportional component, the dimension of tilt of the roller is the integral component of the strip centring control. If a roller is tilted, the strip shifts back towards the strip centre due to the "coil effect". Such systems, already known from operational use, have generally proven effective.

A system of the type described in the introduction is known for example from DE 103 37 502 B4. A furnace with heating zones and cooling zones is followed by a deflection roller that serves as the strip centring control.

A further system, in which a deflection device is arranged after the outfeed from a strip flotation furnace, and below which a collection basin is located to serve as a fluid trap, is also known from DE 103 26 071 A1. The deflection may also serve at the same time as the strip centring control, wherein the strip position is detected by sensors located above and below the strip, and the movement of the strip centring control to re-centre a strip that has shifted out of alignment is effected by means of a cylinder.

In practice, the need to build ever more powerful annealing lines is increasing to keep pace with the rapidly growing demand for aluminium bodywork strips. In order to achieve higher production capacities, the strip passes through the treatment section faster. However, since only a limited heat input can be introduced into the strip in each heating zone, it follows that the thermal treatment apparatus should be designed longer to allow greater production capacity. Since the strip runs more easily inside the furnace section due to the low strip tension, there is a risk in long furnace systems that the known strip position adjustment devices are no longer sufficient to keep the strip run stable inside the furnace, with the danger that the strip may deviate laterally and run against the furnace structure. This can lead to undesirable damage to the strip or cause it to tear, and systems with increased production capacity cannot be created simply by applying this principle. - This is the point at which the invention is introduced.

The object underlying the invention is to provide a device for continuous treatment of a metal strip of the type described in the introduction, which is characterized by improved strip position control, and which in particular guarantees flawless strip running over long furnace sections.

To solve this object, in a species-related apparatus for continuous treatment of a metal strip, the invention teaches that the strip position adjustment device is arranged in the cooling line. For this purpose, the cooling line is preferably divided into at least a first cooling line section and second cooling line section arranged at a distance thereafter, the strip position adjustment device being positioned between the first cooling line section and the second cooling line section. According to the invention, the strip position adjustment device is consequently no longer arranged on the output side after the thermal treatment apparatus, and also consequently no longer arranged after the last cooling zone, but rather integrated in the cooling line, as it were, by the preferred division of the cooling line into two cooling sections. In a first section, the strip is cooled down far enough for it to pass the strip position adjustment device without problems. Thus, the first cooling line section is followed by the strip position adjustment device. The strip then passes through the second cooling line section, and thus also the second part of the cooling zones, with the result that the strip is then cooled down to the desired final temperature. In this way, it is thus possible to work with a furnace section having a long total length and thus also with long heating and cooling lines, thereby increasing production capacity without significantly increasing the length of the free strip in the low tension area. In this way, the strip can be reliably prevented from deviating from its course inside the furnace.

The strip position adjustment device itself may be of conventional construction, so conventional solutions can be used. According to the invention, the important feature is the particular positioning of the strip position adjustment device inside the furnace section and in the cooling line.

Accordingly, the strip position adjustment device for the strip position control may comprise a conventional, adjustable deflection roller, e.g., a 90° deflection roller or it may be designed as such. However, it is advisable to provide the roller with a suitable (high-) temperature resistant coating, as the temperature of the strip between the first cooling section and the second cooling section is preferably between 100°C and 200°C, particularly preferably between 120°C and 150°C. Alternatively to a 90° control roller, the strip centre control may also be assured by other known means, for example with the aid of a multi-roll control device such as a three-roll control device or a control driver (e.g., as a roll pair). Suitable coatings are preferably provided in this case also. The strip position control or strip centring control is preferably designed in generally known manner as a PI controller. The control roller, or the multi-roller assembly, is thus mounted in generally known manner on a movable base frame. The frame rotates the roller or rollers about a notional pivot point, which is also located in the furnace section. The degree of shift of the roller from the centre line of the furnace section is the proportional component, the degree of tilt of the roller is the integral component of the strip centring control.

Alternatively, the strip position adjustment device may be designed as a non-contact strip position adjustment device. For this, strip centring control may be provided in contactless manner via linear motors, for example. In this case, in principle any known means for influencing the metal strip via linear motors may be used, such as are described in DE 197 19 994 A1, for example.

The strip treatment system preferably comprises a first tension roller set on the infeed side, which is arranged before the thermal treatment apparatus to lower the strip tension. It is also advantageous to provide another tension roller set on the outfeed side, and thus after the thermal treatment apparatus, by which the strip tension is increased again, so that further process steps may follow, such as tension levelling, cleaning, or edge trimming.

Optionally, it is within the scope of the invention that a (further) tension roller set is arranged after the strip position adjustment device, between the first cooling line section and the second cooling line section, in order to increase the strip tension at this earlier point. This has the advantage that the strip can pass through the second part of the cooling zones under slightly increased strip tension. In this case also, it is advisable to provide the rollers of such a roller set with corresponding heat-resistant coatings. According to the invention, it is important that a strip position adjustment take place between the first cooling line section and the second cooling line section. Optionally, it may be useful to provide a second strip position control after the second cooling line section. This can be particularly advantageous if no additional tension roller assembly is provided between the first cooling line section and the second cooling line section, so that treatment continues under reduced strip tension on the second cooling line section as well. If a tension roller set is provided between the two cooling sections, and the strip tension is already increased at this point, a second strip position control downstream of the second cooling line section may be omitted.

The effect of dividing the cooling line into two cooling line sections is that the two cooling line sections are (significantly) shorter than a corresponding undivided cooling line section. The entire thermal treatment apparatus, that is to say both the heating zone and the entire cooling line, may be made longer than conventional systems.

A further object of the invention is a method for continuous treatment of metal strip with a device of the kind described, wherein the metal strip is floated through the heating line and the cooling line to undergo the thermal treatment. This method is characterised in that the position of the metal strip (within the strip running plane and transversely to the strip running direction) is controlled or adjusted by means of a strip position adjustment device arranged in the cooling line.

As described earlier, such a strip position adjustment device is preferably provided with suitable measuring equipment and a feedback system so that real control of the strip position takes place. In general, however, the invention also extends to embodiments that operate with no measurement and/or no feedback system, so the strip position cannot be adjusted but merely guided.

The length of the first cooling line section is preferably dimensioned such that between the first cooling line section and the second cooling line section and thus in the area of the strip position control means the strip has a temperature of up to 200°C, e.g., 100°C to 200°C. Particularly preferably, its temperature reaches 150°C, e.g., 120°C to 150°C. The length of the second cooling line section may then be dimensioned such that, for example, the strip is fed out at a temperature of up to 70°C, preferably up to 60°C, e.g., 40°C to 60°C, so that subsequent process steps such as may follow.

The system according to the invention may be in the form of an annealing line, for example, or it may constitute part of an annealing line. The thermal treatment apparatus then has the form of an annealing furnace. Alternatively, the system can be configured as a strip coating line or part of a strip coating line. In this case, the thermal treatment apparatus is realised as a dryer or drying furnace. In both cases the furnaces/dryers are preferably constructed as strip flotation furnaces.

In the following, the invention is will be explained in greater detail with reference to figures representing only exemplary embodiments thereof. In the drawing:

Fig. 1 is a simplified, schematic illustration of a known strip treatment apparatus according to the prior art,

Fig. 2 is a simplified, schematic illustration of a strip treatment apparatus according to the invention, and

Fig. 3 is a modification of the embodiment of Fig. 2.

In order to illustrate the concept of the invention, it will be useful to begin by considering the prior art again, as shown in Fig. 1. Fig. 1 shows a known device for the continuous treatment of a metal strip, namely thermal treatment. This device comprises a thermal treatment apparatus 2, which is in the form of a strip flotation furnace. Metal strip 1 passes through said strip flotation furnace 2 in contactless manner, due to the fact that it is suspended without touching between upper and lower nozzles to which a corresponding air pressure is applied. Details are not shown. The strip flotation furnace 2, comprises a heating line 3 at the infeed and a cooling line 4 at the outfeed thereof. The heating line is typically composed of a plurality of heating zones 3', while the cooling line section is typically composed of a plurality of cooling zones 4', the individual zones being individually or separately controllable. In the heating zones, the metal strip is typically heated by means of the air takes place, so that the nozzles, for example the lower nozzles, can also assume the thermal treatment function as well as the support function. In the cooling zones, cooling is typically also carried out using air, or with a combination of air and water. In the case of an annealing line for aluminium strip for automobile bodies, the setpoint temperature in the heating zone is for example approximately 550°C to 570°C. Consequently, the heating zones constitute heating and temperature maintenance zones. It is also shown that the system has an upstream tension roller assembly 5, by which the strip tension is reduced, e.g., to a specific strip tension of 0.5 to 1 MPa, for example. After the strip flotation furnace 2, that is to say after final cooling zone, metal strip 1 is centre adjusted with the aid of a strip position adjustment device 7, which is to say that the position of the metal strip is adjusted in the strip plane and transversely to the strip running direction. Then, the strip tension is increased again to the usual level for the line, specifically 10 to 20 MPa, by means of a tension roller assembly 6 on the outfeed side. The low specific strip tension inside the strip flotation furnace means that it is necessary to centre the metal strip 1 again with the aid of strip position adjustment device 7.

If it is desired to increase the production capacity of a system such as is shown in Fig. 1, in principle the strip flotation furnace must be made longer. However, with the system according to the prior art shown in Fig. 1, when the strip flotation furnace is longer than a certain length there is a risk that the strip position adjustment device 7, e.g., control roller 8, is no longer sufficient, with the result that the strip run inside the furnace may become unstable, the strip may deviate laterally and run up against the furnace structure. This might lead to undesirable damage to the strip or cause it to tear, so that it is not advisable simply to lengthen the strip flotation furnace without additional measures.

According to the invention, therefore, strip position adjustment device 7 is no longer disposed after the thermal treatment apparatus 2 and consequently no longer after cooling line 4, but in the cooling line 4 itself. This is explained with reference to Figs 2 and 3, which show embodiments of the invention. Figs 2 and 3 also show a strip treatment device having a thermal treatment apparatus 2, which has a heating line 3 at the infeed and a cooling line 4 at the outfeed. Again, a tension roller assembly 5 is provided on the infeed side, and another tension roller assembly 6 may be provided on the outfeed side, which is only shown in Fig. 3, not in Fig. 2. Heating line 3 also consists of several heating zones 3', while cooling line 4 consists of several cooling zones 4'. According to the invention, cooling line 4 is divided into two cooling sections, a first cooling line section 4a, which is followed by a second cooling line section 4b. According to the invention strip position adjustment device 7 is now arranged between first cooling line section 4a and second cooling line section 4b. The metal strip is heated in generally known manner in heating line 3 to the desired temperature and the temperature can be maintained for a desired period with heating and temperature maintenance zones 3'. Accordingly, - apart from lengthening - heating zone 3 does not have to be modified from the prior art. Heating line 3 is then followed by first cooling section 4a, in which the metal strip is cooled down in a first stage, preferably to a temperature of 100°C to 200°C, e.g., 120°C to 150°C. After leaving the first cooling line section 4a, the strip centre adjustment is carried out via strip centring control 7. In the embodiment of Fig. 2 this comprises a 90° control roller 8. As shown in the embodiment of Fig. 2, this is followed by another tension roller assembly 9 in order to increase the strip tension. Then, the strip passes through the second cooling line section 4b, so that it is cooled down to the desired final temperature of e.g., 40°C to 60°C. In this way production capacity can be increased without increasing the free strip length appreciably, thereby preventing the strip from deviating from its path inside the furnace. A further strip position adjustment device and/or another tension roller assembly may follow the second cooling line section 4b. This is not shown in Fig. 2.

Fig. 3 shows a modified embodiment of the invention, wherein strip position adjustment device 7 is configured as a three-roll strip centre control with three rollers 10. Further, in Fig. 3 it is indicated that a further strip centre control device 11 as well as a further tension roller assembly 6 may be arranged after second cooling line section 4b. The additional strip centre control device 11 after second cooling line section 4b is advantageous because in this embodiment there is no tension roller assembly arranged between cooling lines 4a, 4b, and therefore the process continues under lower strip tension in second cooling line section 4b as well.

If Figs 1 and 2 are compared, it is evident that the furnace zones 3', 4' in the embodiment of the present invention have an overall length that is greater than the length of the known embodiment according to Fig. 1. However, the free strip length is not greater, because strip centre control 7 is positioned after first cooling line section 4a. Thus, both heating line 3 and cooling line 4 may be significantly longer than in the prior art. However, dividing cooling line 4 creates cooling line sections 4a, 4b, each of which is (significantly) shorter than heating line 3.

BERENDEZÉS FÉMSZALAG FOLYAMATOS KEZELÉSÉRE

SZABADALMI IGÉNYPONTOK

1. Berendezés fémszalag (1), különösen alumíniumból vagy alumínium ötvözetből vagy színesfémből vagy színesfém ötvözetből lévő szalag folyamatos kezelésére,

   legalább egy temperáló berendezéssel, ami olyan szalagkemenceként (2) van kialakítva, amiben a szalag lebegtetve van átvezetve, és

   egy olyan szalaghelyzet szabályzó berendezéssel (7), amivel a fémszalag (1) helyzete a szalag futási síkjában és a szalag haladási irányára merőlegesen szabályozható vagy vezérelhető,

   ahol a szalagkemence (2) legalább egy bevezető oldali hevítő szakasszal (3) és egy kivezető oldali hűtő szakasszal (4) van ellátva,

   azzal jellemezve, hogy

   a szalaghelyzet szabályzó berendezés (7) a hűtő szakaszon (4) van elrendezve.

2. Az 1. igénypont szerinti berendezés, **azzal jellemezve, hogy** a hűtő szakasz (4) legalább egy első hűtő szakasz részre (4a) és egy második hűtő szakasz részre (4b) van felosztva, ahol a szalaghelyzet szabályzó berendezés (7) az első hűtő szakasz rész (4a) és a második hűtő szakasz rész (4b) között van elrendezve.

3. Az 1. vagy 2. igénypont szerinti berendezés, **azzal jellemezve, hogy** a második hűtő szakasz rész mögött egy további szalaghelyzet szabályzó berendezés (11) van elrendezve.

4. Az 1 – 3. igénypontok bármelyike szerinti berendezés, **azzal jellemezve, hogy** a szalaghelyzet szabályzó berendezés (7, 11) a szalag helyzetének szabályozásához egy állítható fordító hengerrel (8), például egy 90 fokos fordító hengerrel van ellátva, illetve ilyenként van kialakítva.
5. Az 1 – 3. igénypontok bármelyike szerinti berendezés, **azzal jellemezve, hogy** a szalaghelyzet szabályzó berendezés (7, 11) többhengeres, például három hengeres szabályzó berendezésként van kialakítva.
6. Az 1 – 5. igénypontok bármelyike szerinti berendezés, **azzal jellemezve, hogy** a szalaghelyzet szabályzó berendezés (7, 11) érintés nélkül müködő berendezésként van kialakítva, például lineáris motorokkal.
7. Az 1 – 6. igénypontok bármelyike szerinti berendezés, **azzal jellemezve, hogy** az első hűtő szakasz rész (4a) és a második hűtő szakasz rész (4b) között, a szalaghelyzet szabályzó berendezés (7)mögött egy feszítőhenger egység (11) van elrendezve.
8. Az 1 – 7. igénypontok bármelyike szerinti berendezés, **azzal jellemezve, hogy** a szalaghelyzet szabályzó berendezés (7) és/vagy a feszítőhenger egység (11) hengerei (8, 9) hőálló bevonattal vannak ellátva.
9. Eljárás fémszalag folyamatos kezelésére az 1 – 8. igénypontok bármelyike szerinti berendezéssel, ahol a fémszalagot hőkezelés céljából lebegtetve átvezetjük a hevitő szakaszon és a hütő szakaszon, **azzal jellemezve, hogy** a fémszalag helyzetét egy, a hütő szakaszon elrendezett szalaghelyzet szabályzó berendezéssel szabályozzuk vagy vezéreljük.
10. A 9. igénypont szerinti eljárás, **azzal jellemezve, hogy** a szalaghelyzet szabályzó berendezés egy első hütő szakasz rész és egy második hűtő szakasz rész között van elrendezve.
11. A 9. vagy 10. igénypont szerinti eljárás, **azzal jellemezve, hogy** a szalag helyzetének szabályozását egy proporcionális P-résszel és egy integrált I-résszel ellátott PI-vezérléssel végezzük.
12. A 9 - 11. igénypontok bármelyike szerinti eljárás, **azzal jellemezve, hogy** a szalaghelyzet szabályzó berendezés a hütő szakasz rész egy szakaszán, például az első hűtő szakasz rész és a második hűtő szakasz rész között van elrendezve, ahol a fémszalag hőmérséklete 200°C – ig, például 100°C és 200°C közé, előnyösen 150°C – ig, például 120°C és 150°C közé emelkedik.

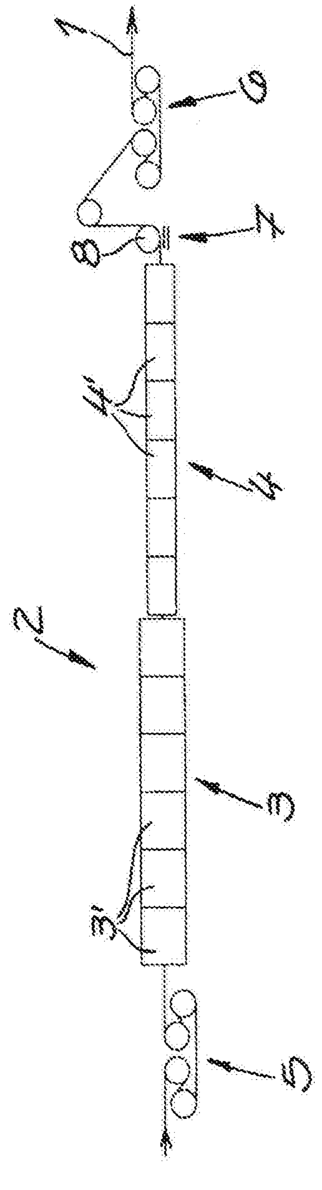

Fig.1

Prior art

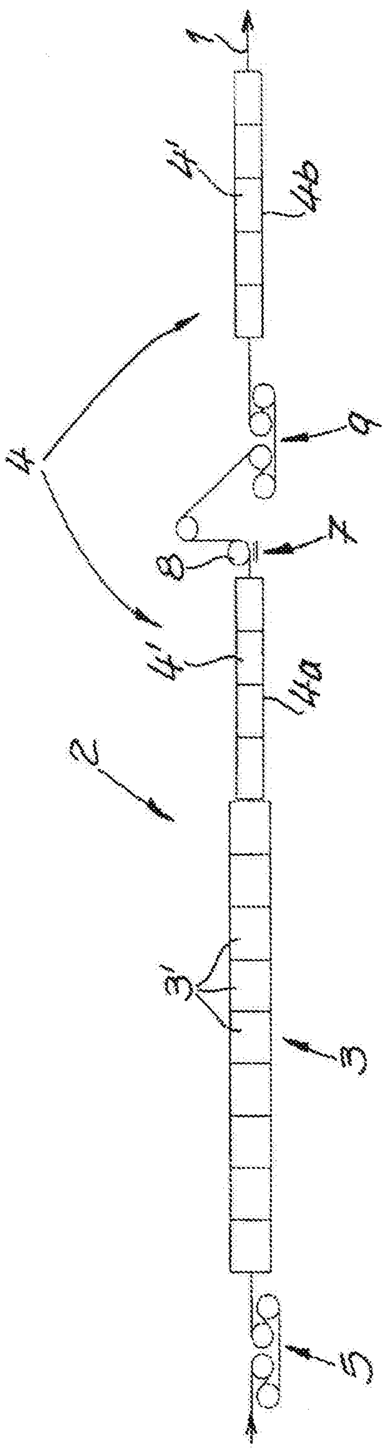

Fig.2

Fig.3