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(71) Applicant: **DANIELI & C. OFFICINE MECCANICHE
S.p.A.
33042 Buttrio (UD) (IT)**

(72) Inventors:
• **Filippi, Pietro
20052 Monza (MI) (IT)**

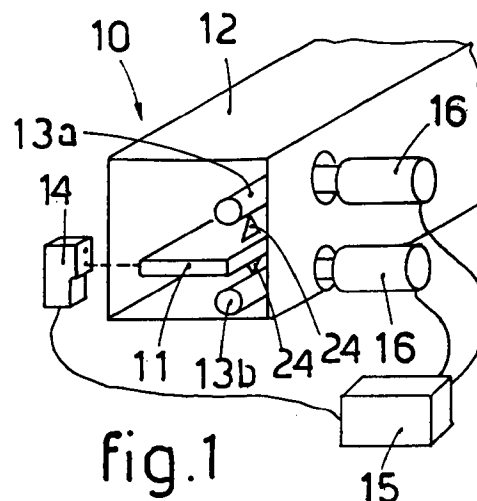
• **De Marco, Fausto
33047 Remanzacco (UD) (IT)**
• **Marconi, Gianfranco
34170 Gorizia (IT)**
• **Crespan, Luca
33052 Cervignano del Friuli (UD) (IT)**
• **Bordignon, Giuseppe
33050 Bicinico (UD) (IT)**

(74) Representative: **Petraz, Gilberto Luigi
GLP S.r.l.
Piazzale Cavedalis 6/2
33100 Udine (IT)**

(54) **Thermal method to control the deformations of hot-rolled sections and relative device**

(57) Thermal method to control the deformations of hot-rolled sections (11) upstream of a cooling plate (18), whereby the section (11) being fed undergoes longitudinally a cooling by means of jets of a cooling fluid applied by delivery means (13), the jets of fluid (24) being in the form of a wall or beam and having their axes parallel to the longitudinal axis of the section (11) and having a rate of flow of cooling fluid such as to lap at least one limited zone of the section (11), so as to obtain in the material and in said zone a higher yield point which will prevent possible subsequent plastic deformations generated by stresses of a thermal type, and will prevent micro-structural alterations which impair the quality of the product, the intense cooling zone being arranged along a line determined according to the type of section (11).

Device to control the deformations of hot-rolled sections (11), cooperating with the cooling plate (18) of the sections downstream of the rolling line (17), said device (10) comprising means (13) to deliver a cooling fluid under pressure in the form of a wall or beam, the jets of fluid (24) cooperating respectively with at least one surface of the section (11) so as to create a limited cooling zone extending longitudinally to the section, said cooling fluid under pressure being parallel to the longitudinal axis of the section (11) itself, and the said delivery means being able to move transversely to the section (11).



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Description

This invention concerns a thermal method to control the deformations of hot-rolled sections and the relative device, as set forth in the respective main claims.

The method to control the deformations of hot-rolled sections according to the invention is applied to the field of iron and steel processing and, to be more exact, to the step of cooling long sections leaving a hot-rolling line.

The state of the art covers the problem that long sections, whether they be flat or have a symmetrical or asymmetrical cross-section, such as a U-shaped, V-shaped, L-shaped cross-section or another cross-section, undergo in the step of cooling downstream of the last rolling pass deformations whereby the sections leaving the cooling zone are not straight but include a curvature or twisted shape.

This deformation creates considerable problems in subsequent treatments and in the end-use of the section.

The inclusion of sections more or less greatly deformed requires an operation downstream of the cooling plate to select the sections according to their deformation and also requires that the deformed sections should undergo a subsequent mechanical straightening step with a resulting increase in cost.

The higher the moment of inertia of the section of the rolled product is in relation to the axis perpendicular to the plane of deformation, the worse this problem becomes.

So as to overcome this problem, proposals have been made to submit the sections leaving the rolling line and upstream of the cooling plate to a controlled cooling method which consists of submitting the advancing sections to jets of cooling fluid which have the task of achieving a more uniform distribution of the temperature in the cross-section of the section.

In such devices of the state of the art the aim is to achieve a homogeneous cooling of the section, this result being achieved by cooling the whole surface in a homogeneous manner or by cooling the surface more intensely at some tendentially hotter points.

Each of the means to deliver the fluid laps a broad zone of the section and this system has not been found satisfactory since it cannot control the behaviour of the section, with the outcome that the sections produced still include an uncontrolled and undesired deformation.

In any event, it is very difficult to obtain such a result in practice inasmuch as rather long cooling times and therefore considerable longitudinal extents of the cooling devices are required for a homogeneous cooling down to low enough temperatures.

So as to reduce these longitudinal extents it is necessary to employ high cooling speeds, but this involves the drawback that micro-structural changes are produced in the section and impair its quality.

Moreover, the application of these technologies requires a knowledge in real time of the thermal map in

the cross-section of the section downstream of the last rolling mill stand.

This distribution of temperature is not generally known inasmuch as the only temperature which can be measured in the line is the surface temperature.

There has also been a proposal to intervene on the section by means of jets of water, so as to modify the geometric form (JP-A-61-150710, Nippon Steel), immediately after the section has left the last stand.

This procedure however does not pursue the aims of the present invention, nor can it pursue them, due to the substantial difference of the two methods.

The present applicants have designed, tested and embodied this invention to overcome the shortcomings of the state of the art and to achieve further advantages.

This invention is set forth and characterised in the respective main claims, while the dependent claims describe variants of the idea of the main embodiment.

The purpose of this invention is to provide a thermal method to control the deformation of hot rolled sections, whether they be flat or U-shaped, V-shaped, L-shaped sections or sections having any other cross-section.

The thermal method according to the invention has the purpose of preventing the occurrence of deformations in the rolled sections during the cooling step downstream of the last rolling mill stand.

The method according to the invention has the purpose of cooling the section in a controlled manner along at least one thin strip located at a determined position so as to obtain at the end of the cooling step a substantially straight section devoid of deformations and free of micro-structural changes which reduce the quality of the product.

The method according to the invention includes a controlled cooling of the section on at least one side thereof and along at least one specific line, the position of which depends on the cross-section of the section, so as to create with different cooling speeds one or more limited strips with a higher yield point which prevents possible subsequent plastic deformations.

This limited strip or these limited strips with a higher yield point act as a reinforcement to prevent the occurrence of further deformations downstream of the cooling zone.

This controlled cooling laps at least one limited strip in such a way as to maintain any stresses generated by a non-homogeneous downstream cooling of the section below the limit of elasticity of the material

The method according to the invention arranges to check continuously and downstream the linear condition of the section being cooled and to control in feedback the characteristics of the cooling fluid delivery means such as the position of the delivery means and/or the pressure and/or the rate of flow of the cooling fluid.

In flat sections a line of controlled cooling is positioned parallel to the longitudinal edges of the section in a strip which extends from the longitudinal edge over about a third of the width of the section.

According to a variant, the flat section is cooled intensely along two parallel lines positioned symmetrically in relation to the plane of the longitudinal centreline of the section, each cooling line being comprised in a strip which extends from the longitudinal edge over about a third of the width of the section.

In the event of angular sections having a V-shape or L-shape or sections having a U-shape, the cooling lines may coincide with both the outer or inner corners, or with the longitudinal edges according to various combinations.

The zone of controlled cooling of the sections may be one single zone or more than one, depending on the type of section.

The device to perform the thermal method according to the invention includes means to deliver cooling fluid which deliver a jet of cooling fluid in the form of a wall or beam with its axis parallel to the longitudinal axis of the section so that the zone lapped is limited.

The delivery means are able to deliver a flow of cooling fluid which laps at least a limited zone of the section in such a way as to obtain, in the material and in said zone, a higher yield point which prevents possible subsequent plastic deformations generated by stresses of a thermal type, preventing micro-structural alterations which impair the quality of the product.

According to the invention, this zone of intense cooling is arranged along a longitudinal line determined according to the type of section.

These cooling fluid delivery means can be moved transversely to the direction of feed of the section.

The transverse position of the cooling fluid delivery means is associated with monitoring means such as photoelectric cells, for instance, which check the position and the linear condition of the section and which govern a control and actuation assembly associated with the device according to the invention.

The transverse position of the delivery means can be adjusted continuously and advantageously automatically.

The device according to the invention can be fitted upstream or downstream of the assembly which shears to size and which is positioned downstream of the rolling line.

These cooling fluid delivery means can be associated advantageously, but not necessarily, with a channel for the passage of the section.

The attached figures are given as a non-restrictive example and show some preferred embodiments of the invention as follows:-

- Fig.1 is a partial three-dimensional view of the device according to the invention;
 Fig.2 is a front view of a variant of the device of Fig.1;
 Figs.3a and 3b show front views of the device according to the invention in association with two different sections;

Fig.4 shows another form of embodiment of the device according to the invention.

Fig.5 shows a rolling plant employing the device according to the invention;

Figs.6, 7 and 8 show a cross-section of three sections undergoing the method according to the invention.

The reference number 10 in the figures denotes generally a device for the controlled cooling of hot-rolled long sections 11 according to the invention.

The device 10 according to the invention is used to prevent the deformations of long sections 11 of any cross-section, such as flat products, angular V-shaped, L-shaped, U-shaped sections, etc. leaving a rolling line 17 upstream of a cooling plate 18.

In this case the device 10 is positioned downstream of a shears 20 that shears to size.

According to a variant the device 10 is positioned upstream of the shears 20 that shears to size.

The device 10 according to the invention comprises in this case a channel 12 in which the section 11 is fed axially; this channel 12 includes at least two means 13 to deliver cooling fluid, respectively upper 13a and lower 13b, these means 13a, 13b being positioned respectively above and below the plane of feed of the sections 11.

The cooling fluid delivery means 13 deliver jets 24 of cooling fluid in the form of a wall or beam, the jets having their axes parallel to the longitudinal axis of the section 11, so that the zone of the section 11 thus lapped lies along a limited longitudinal strip of the section 11.

In the device 10 according to the invention the cooling fluid delivery means 13 can be moved advantageously transversely to the channel 12 in such a manner that the jets 24 of cooling fluid always cooperate with that determined zone of the section 11, independently of the relative temporal position of that specific part of the section with respect to the feed axis, such zone where the cooling jets operate depending on the type of the section 11.

In this case, the cooling fluid delivery means 13 can be moved transversely and are associated with respective independent actuators 16.

The device 10 according to the invention comprises monitoring means 14, which in this case are of a photoelectric cell type and are fitted respectively at the inlet and outlet of the channel 12 so as to monitor continuously the position and linear condition of the section 11 being fed.

These monitoring means 14 are associated with an actuation and control assembly 15, which actuates the actuators 16 for correct positioning of the cooling fluid delivery means 13 according to signals received from the monitoring means 14.

According to the signals received from the monitoring means 14 the actuation and control assembly 15

can also adjust the rate of flow and/or pressure of the water wall delivered by the cooling fluid delivery means 13.

According to a variant shown in Fig.2, the channel 12 includes cooling fluid delivery means 13 positioned both on the right and on the left so as to cool the flat section 11 along two parallel longitudinal lines positioned advantageously in the vicinity of the longitudinal edges of the section 11.

Each cooling line is advantageously included in a longitudinal strip associated with the respective longitudinal edge of the section 11 and extending transversely over about a third of the width of the section 11.

In the examples of Figs.3a and 3b the cooling fluid delivery means 13a and 13b are positioned so as to lap substantially the vertex 21 of the V-shaped section 11 (Fig.3b) or of the L-shaped section 11 (Fig.3a).

Fig.7 shows a V-shaped section 11 in which the jets 24 of cooling fluid formed as a wall or beam and produced by the delivery means 13 and referenced with the arrows 24 lap both the vertex 21 and the longitudinal edges 22 of the section 11.

Fig.8 shows an L-shaped section 11 with a plurality of jets 24 of cooling fluid lapping the central part and the corners 23 and the lateral edges 22 of the section 11.

However, other combinations of the jets 24 of cooling fluid are possible.

Fig.4 shows a device 10 according to the invention in cooperation with a U-shaped section 11, in which the cooling fluid delivery means 13 are positioned so as to lap with their jets 24 of cooling fluid formed as a wall or beam the corners 23 of the "U" so as to prevent the raising of the leading and/or trailing ends of the section 11.

Fig.6 shows a U-shaped section 11 in which the jets 24 of cooling fluid formed as a wall applied by the delivery means 13 lap both the corners 23 and the longitudinal edges 22 of the section 11.

According to a variant of the method according to the invention, the sections 11 undergoing the thermal straightening cooperate then with a descaling means 19 located upstream of the cooling plate 18 and downstream of the device 10.

According to another variant, the descaling means 19 may be located upstream of the device 10.

According to another variant, there is a descaling means 19 both upstream and downstream of device 10.

Claims

1. Thermal method to control the deformations of hot-rolled sections (11) upstream of a cooling plate (18), whereby the section (11) being fed undergoes longitudinally a cooling by means of jets of a cooling fluid applied by delivery means (13), **the method being characterised by the fact that** the jets of fluid (24) are in the form of a wall or beam and have their axes parallel to the longitudinal axis of the section (11) and have a rate of flow of cooling fluid such as to lap at least one zone of the section (11), so as

to obtain a higher yield point in the material and in the said zone which will prevent possible subsequent plastic deformations generated by stresses of a thermal type, and will prevent micro-structural alterations which impair the quality of the product, the intense cooling zone being arranged along a line determined according to the type of section (11).

2. Method as in Claim 1, **characterised by the fact that** the transverse position of the delivery means (13) with respect to the section (11) can be adjusted according to the position of the specific portion of the section (11) with respect to the feed axis, as it is downstream of the delivery means (13), the adjustment arranging that the limited zone is comprised in a strip located between the vicinity of the longitudinal edge and a third of the width of the flat section (11).
3. Method as in Claim 1 or 2, **characterised by the fact that** the transverse position of the means (13) delivering the fluid jets (24) in the form of a wall or beam is adjusted continuously and automatically.
4. Method as in any of Claims 1 to 3 inclusive, **characterised by the fact that** in the case of angular V-shaped sections (11) the limited cooling zone at least coincides with the vertex (21) of the section.
5. Method as in any of Claims 1 to 3 inclusive, **characterised by the fact that** in the case of U-shaped sections (11) the limited cooling zones are at least two in number and are positioned so as to coincide with the two corners (23) of the "U".
6. Method as in any claim hereinbefore, **characterised by the fact that** in cooperation with the thermal straightening stage, the section (11) undergoes descaling.
7. Device to control the deformations of hot-rolled sections (11), cooperating with the cooling plate (18) of the sections downstream of the rolling line (17), **characterised by the fact that** said device (10) comprises means (13) to deliver a cooling fluid under pressure in the form of a wall or beam (24), the delivery means cooperating respectively with at least one surface of the section (11) so as to create a limited cooling zone extending longitudinally to the section, said cooling fluid under pressure being parallel to the longitudinal axis of the section (11) itself, and said delivery means (13) being able to move transversely to the section (11).
8. Device as in Claim 7, **characterised by the fact that** in the case of flat sections (11) the axis of the limited cooling zone lies at a distance from the longitudinal edge comprised between the vicinity of the

edge and a third of the width of the section (11).

9. Device as in any of Claims 7 to 8 inclusive, **characterised by the fact that** the delivery means (13) are associated with monitoring means (14) for continuous monitoring of the exact position and of the linear condition of the section (11) being fed, the monitoring means (14) being associated with an actuation and control assembly (15) which adjusts the transverse position of the cooling fluid delivery means (13).
10. Device as in any of Claims 7 to 9 inclusive, **characterised by the fact that** upstream of said device (10) there is at least a descaling means (19).
11. Device as in any of Claims 7 to 10 inclusive, **characterised by the fact that** downstream of said device (10) there is at least a descaling means (19).

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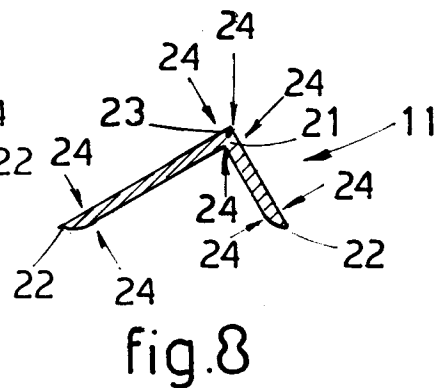
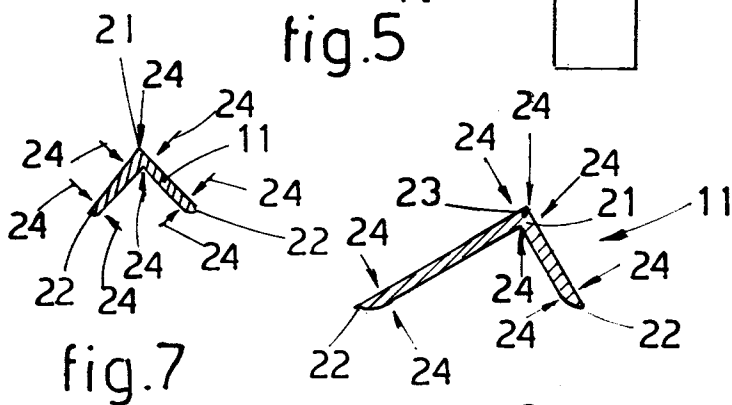
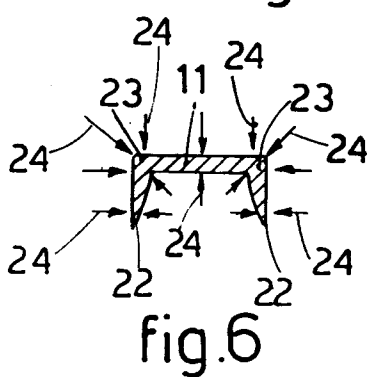
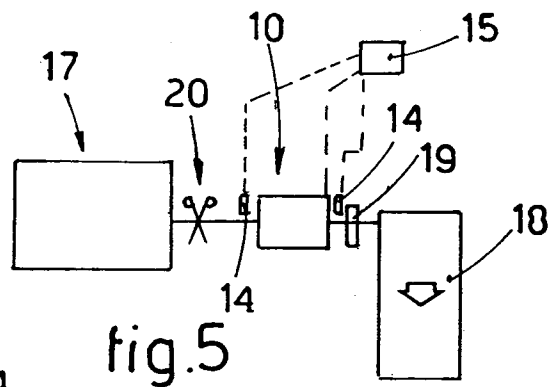
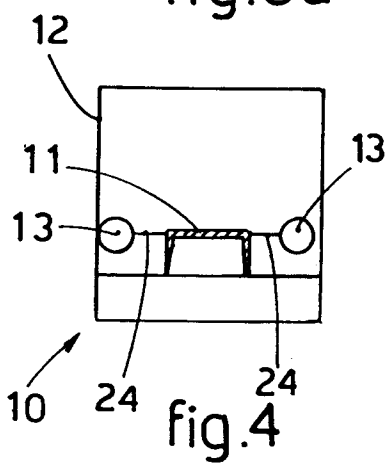
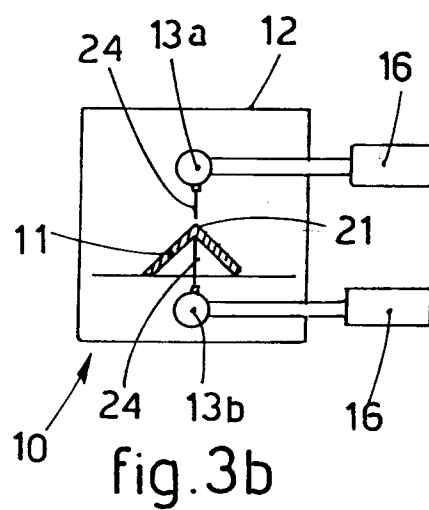
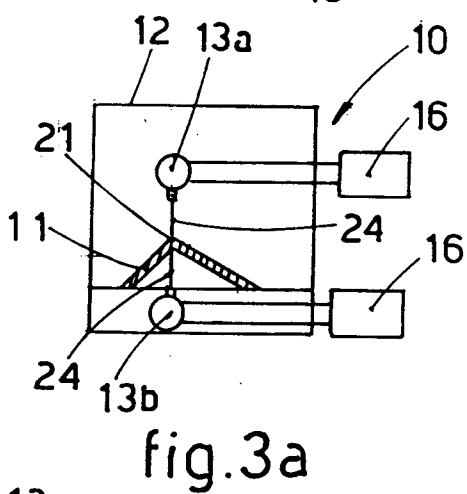
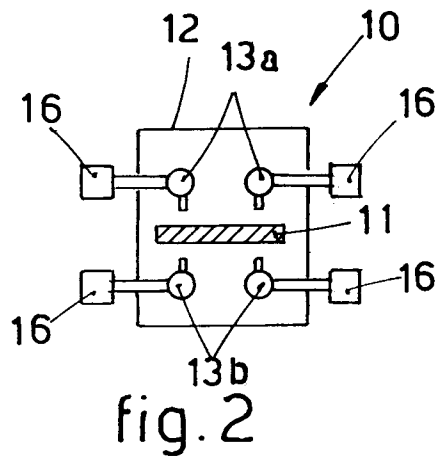
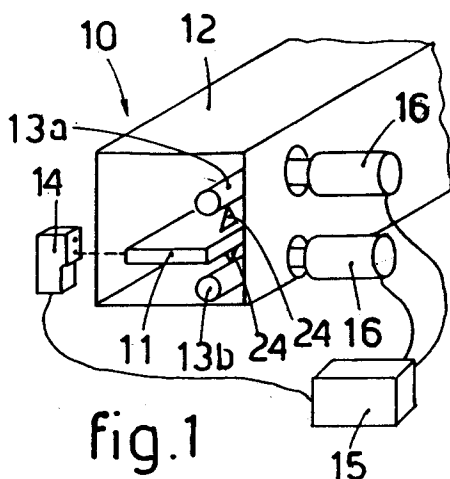
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EUROPEAN SEARCH REPORT

Application Number
EP 96 11 0287

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
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A	--- STEEL TIMES INCORPORATING IRON & STEEL, vol. 221, no. 3, REDHILL,GB, pages 125-126, XP000358897 J. DE LA HAMETTE ET AL: "A new generation of rolled structural sections" * page 125, right-hand column, line 14 - page 126, left-hand column, line 6; figure 3 *	1,3,7,9	
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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 17 October 1996	Examiner Plastiras, D
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EUROPEAN SEARCH REPORT

Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT			
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A	PATENT ABSTRACTS OF JAPAN vol. 18, no. 498 (M-1675), 19 September 1994 & JP-A-06 170431 (NKK CORP.), 21 June 1994, * abstract * -----	1	
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The present search report has been drawn up for all claims			
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THE HAGUE		17 October 1996	Plastiras, D
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