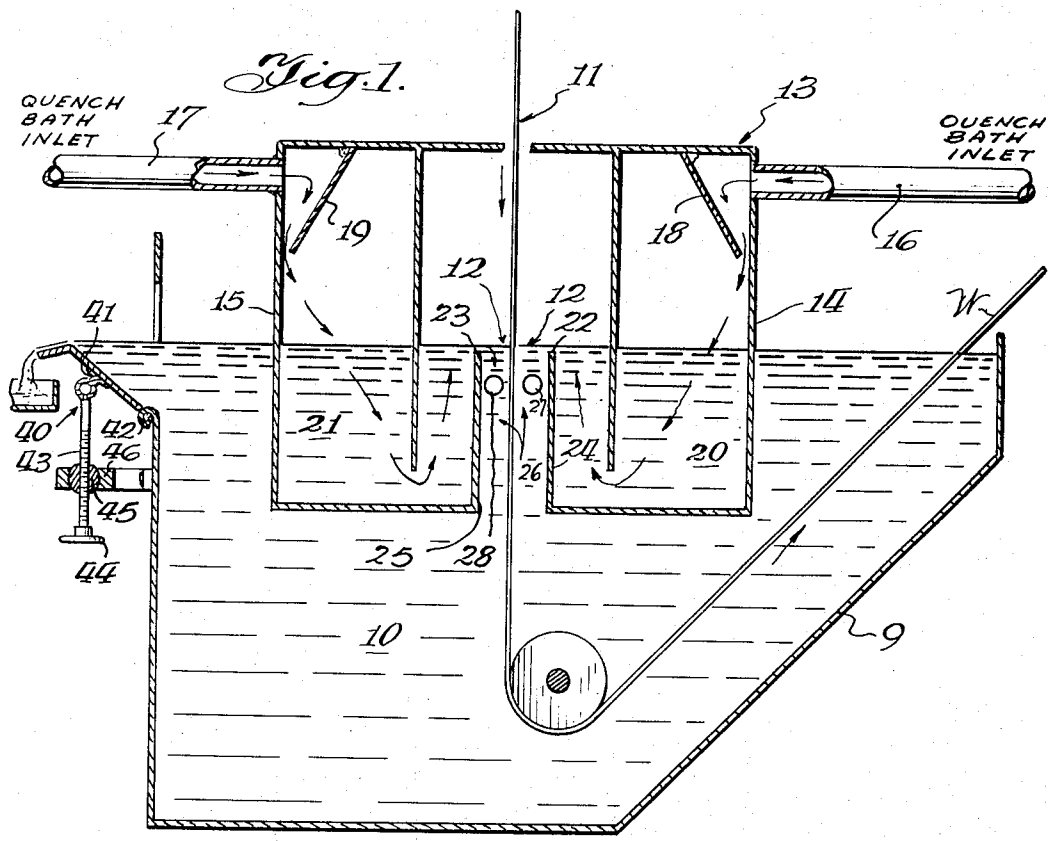
Dec. 19, 1967 H. L. TAYLOR 3,358,980

APPARATUS FOR QUENCHING WEB MATERIAL

Original Filed Nov. 21, 1961 2 Sheets-Sheet 1

Fig. 1.



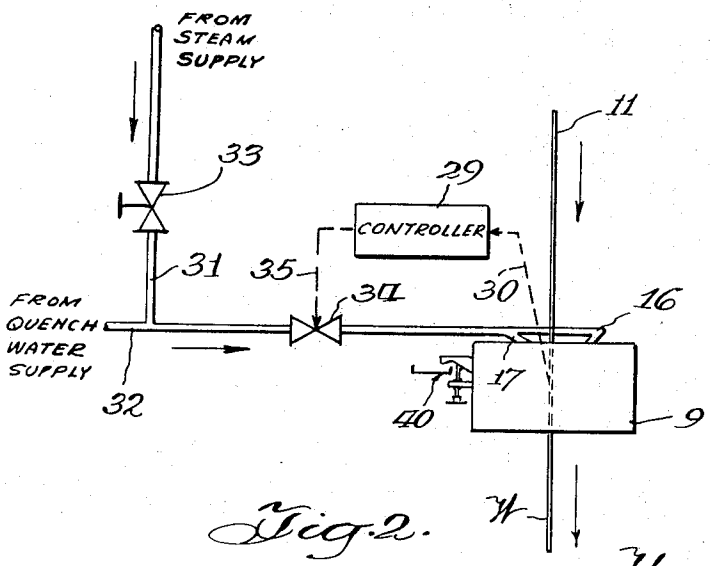


Fig. 2.

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APPARATUS FOR QUENCHING WEB MATERIAL

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Fig. 3.

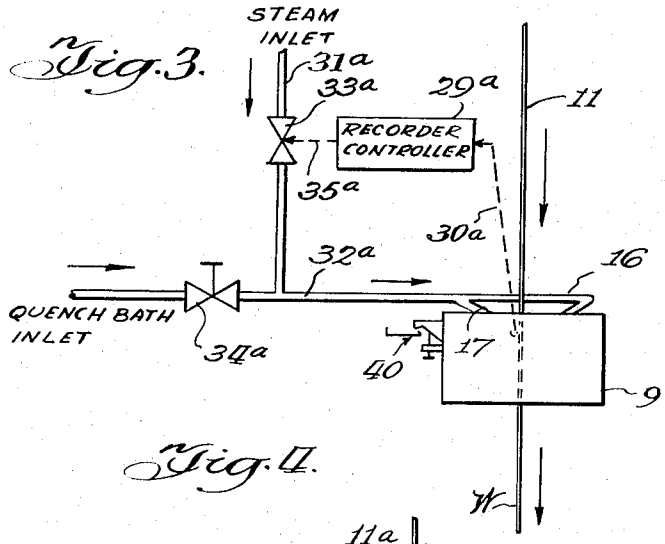
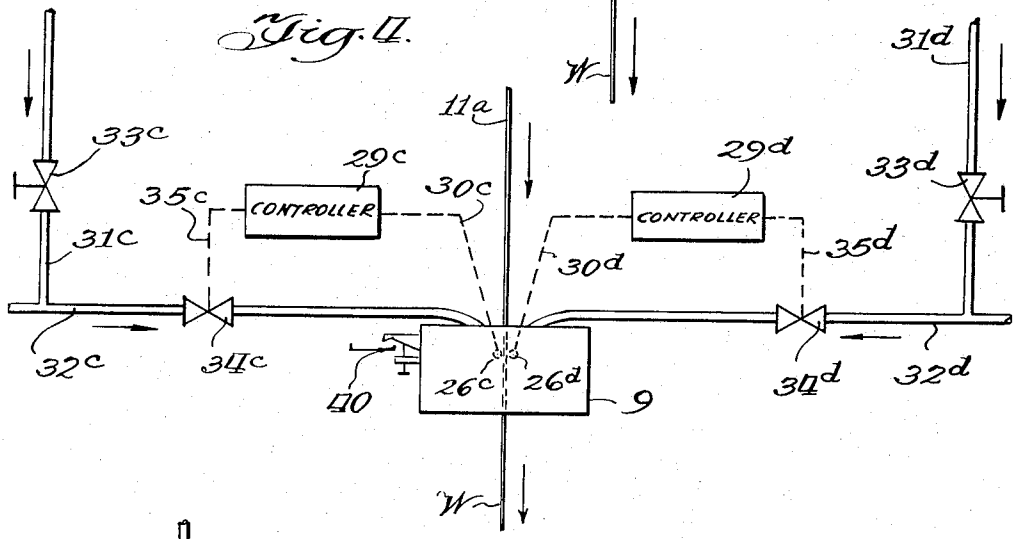


Fig. 4.



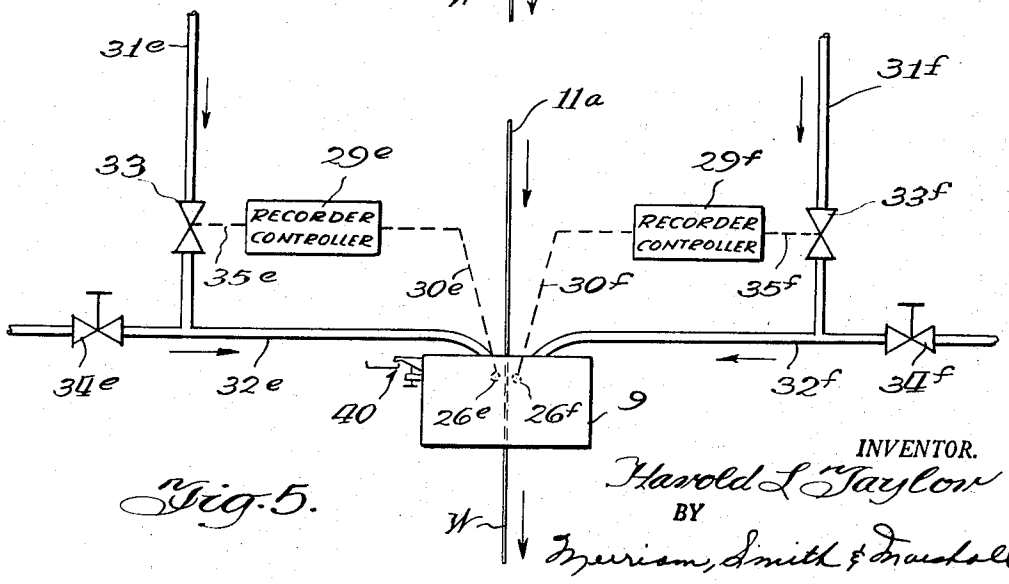


Fig. 5.

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3,358,980

APPARATUS FOR QUENCHING WEB MATERIAL

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Continuation of application Ser. No. 153,834, Nov. 21, 1961. This application Jan. 21, 1965, Ser. No. 426,988
30 Claims. (Cl. 266—3)

ABSTRACT OF THE DISCLOSURE

Quench a heated web of material (e.g., tin plate) in a liquid bath. Introduce additional liquid quenching medium to bath at location where web enters bath. Prevent surface turbulence in bath at region where web initially contacts quenching medium. Control temperature and flow rate of additional quenching medium, the same on both sides of web, or different on each side of web. Control level of bath. Gives product without quench patterns on surface.

This application is a continuation of application Serial No. 153,834, now abandoned, filed by the present inventor on Nov. 21, 1961, and bearing a title corresponding to that of this application.

This invention relates to a method and apparatus for quenching a web of material. In particular, it relates to a method and apparatus for progressively and continuously quenching a moving web of material, such as tin plate, at a selected temperature level.

The invention finds particular application in situations in which the temperature level of the quenching medium is important to the physical or chemical properties of the quenched material. In this aspect, the quenching of tin plate is one important form and, for illustrative purposes, the invention will be explained in this form.

In a conventional electroplating line for tin plate, the coating which results from electroplating has a dull, mat character. In order to brighten the coating of the electroplated material, it is conventional to heat the material until the coating is momentarily melted or in a molten or substantially plastic state, whereupon it is immediately directed into a cooling bath, thereby to be quenched and solidified. It has been found that two distinct types of quench patterns or surface imperfections may result for conditions where the quenching bath temperature is not at the correct level. One type of pattern appears as a light gray stain with very distinct border regions whenever the temperature of the quenching medium is too hot for the desired purpose. This same type of pattern can also occur when the liquid of the quenching bath is splashed or spattered upon the molten coating of the web prior to the full web immersion. The other type of pattern or stain is a dull, dark gray pattern with indistinct boundaries. This is produced whenever quenching occurs within a medium which is too cold for the intended purpose. Both types of patterns appear to the eye as a material deposit upon the electroplated surface. There is, however, not sufficient material present in these patterns to permit a reliable chemical analysis. Microscopic examination indicates that these patterns are actually a disturbance of the tin itself rather than a deposit of foreign substances.

The method and apparatus of the invention are employed to obviate the aforesaid types of quench patterns and leave a bright, shiny surface. The web surface is cooled almost instantly and in the complete absence of any coolant splash on the web surface. In practicing the method and in employing the apparatus of the invention, a moving web of material, such as steel which has been electroplated with a suitable material, such as tin coating in a molten state, is progressively moved through a quenching bath. Since the thermal gradient between the

web of material (immediately before quenching) and the quenching liquid is the greatest in the region where the web of material first contacts the quenching medium, a quenching medium at a selected temperature level is there passed into contact with the web of material. This is in contradistinction to prior art installations wherein only the mean temperature level of the quenching bath was controlled.

The invention has its basis in the type of control which is achieved in a quenching bath through which the web of material is progressively moved. It has been found that, if the temperature level of the quenching medium is allowed to vary more than about ±10 degrees from a suitable optimum value, the above-mentioned quench patterns frequently result. The apparatus of the invention therefore includes means for varying the temperature level or heat removal properties of the quenching medium at the precise region where a moving web of material first contacts the bath of liquid quenching medium. The selected temperature level is dependent upon various conditions, such as the speed of the web of material, the general freedom from turbulence at the place where the web of material moves into contact with the liquid quenching medium, and the amount of heat energy contained by the moving web of material. Once the desired temperature level for the particular set of conditions is determined, the control system of the invention is automatically adjusted to supply a quenching medium at that temperature.

In a specific embodiment of the apparatus of the invention, the web of material with its molten coating on the surface is moved rapidly into and then through a quenching bath contained in a quenching tank. A temperature sensing device is located near the place where the web of material enters the quenching bath, thereby to be sensitive to the temperature level at that place. Usually, a moving web in tin-plate production moves at speeds up to about 1800 feet per minute, with speeds of 800 to 1000 feet per minute being most common. In response to a signal from the temperature sensing device, a controller controls the temperature level of the quenching medium which is passed into contact with the moving web of material at the place where the web of material passes into the quenching bath. When, for example, the temperature level of the quenching medium is too high at the point of entrance of the web, the controller is caused to operate to reduce the temperature level or to increase the rate at which the quenching medium flows into the quenching tank, or both controls may be used to restore the optimum temperature of operation, which is frequently known as the "set point temperature."

On the other hand, when the controller receives a signal which indicates that the temperature level of the quenching medium is too low, the controller is caused to operate to raise the temperature level or to decrease the rate at which the quenching medium flows into the quenching tank, or, again, both types of control may be used concurrently if appropriately controlled.

At the quenching tank, the quenching medium is passed into contact with the web of material in such a manner that there is a minimum of turbulence or splashing at the surface of the quenching medium through which the web of material moves. In one form, a quenching hood through which the quenching medium passes has a pair of spaced plates between which the web of material (with the coating thereon in a molten state) moves, although it is emphasized that the various details of construction of the quenching hood are not necessary in order to accomplish the purposes of the invention. After the quenching medium has passed over the upper edges of the spaced plates and then between them, it flows downwardly due to gravity and the surface tension of the moving web of material.

The cooling or quenching liquid medium which flows into the quenching hood compartments passes over baffles and partition elements and finally overflows the upper edges or lips of the spaced plates, thereafter to flow between a pair of closely spaced plates into an enlarged quench tank. The exit flow of the liquid from the large quench tank is finally drawn off at a selected level by permitting it to overflow an adjustable gate.

The inflowing quenching or cooling medium first reaches the web after it overflows the outer edges of the spaced plates of the quenching hood. As the cooling liquid then flows into the quench tank proper, it flows in a path which is between the web and the overflowed plate and substantially parallel to the direction in which the fast-moving web is traveling. Under the circumstances, the surface of the coolant or quenching medium in the region between the spaced plates is substantially free of turbulence at the region of first contact with the web. This is due to the fact that all movement of the coolant is always in the direction inwardly toward the main quench bath away from the surface thereof.

Such freedom from turbulence is sufficient to preclude splash or splatter which could otherwise occur as the web enters the bath. The end result is substantially to preclude all possibility that splash marks will appear on the web as a whole. Any splashing of the cooling medium upon the tin plate in its molten or plastic state is sufficient to produce such spotting as substantially to detract from the sales value of the end product.

Even though the surface of the cooling medium is calm and substantially free from turbulence, the movement of the web beneath the surface of the cooling medium induces considerable turbulence beneath the surface of the quenching bath. This results because of the relatively narrow spacing of the plates and the relatively great speed of the web of material with respect to the quenching medium.

In addition, some turbulence results beneath the surface of the coolant because of the substantial temperature difference between the coolant and the web proper. The web, with its coating of tin in a molten or plastic state, enters the cooling bath at a surface temperature in a range of about 440° F. to about 470° F. The coolant should be maintained somewhere in the range of about 80° F. to about 190° F. Usually at a relatively fast line speed, the bath temperature is lower than when the line speed is relatively slow. The temperature best suited is also determined by the coating thickness and the sheet thickness. Because of the temperature variance between the web and the coolant, the coolant adjacent to the web, at the time when there is the greatest temperature difference between them, may boil and this produces undersurface turbulence which brings fresh coolant in contact with and against the web surface. The result is that, as the web moves through the liquid cooling medium, the liquid is drawn downwardly in the direction of web movement because of surface tension between the liquid and the web, and the liquid coolant circulates relative to the web because of the temperature difference between the coolant and the web. This places a maximum amount of cooling liquid into contact with the web and, as can be appreciated, the turbulence beneath the surface of the quenching bath is highly desirable since the uniformity and completeness of quenching in minimum time is thereby augmented. The liquid level of the quenching bath with respect to the upper portion of the plate is also controllable, so that for a given web speed, given spacing of the plates, given density of the liquid quenching medium, and so forth, the liquid level of the quenching bath can be adjusted to obtain an optimum condition of minimum turbulence at the surface of the quenching bath.

When it is desired to coat a differentially coated web of material, that is, a web which is coated on one side with a certain thickness of material and on the other side with a greater thickness of material, a separate control system is employed for each side of the web of material. A liquid quenching medium at a selected temperature level is passed into contact with each of the sides of the moving web of material. The liquid quenching medium is maintained at one selected temperature level when passed into contact with the one coated side of the web of material, while the quenching medium is at a lower temperature level when passed into contact with the other more thickly coated side of the web of material. Hence it is apparent that a great degree of temperature control is achieved. Here also, the temperature is determined by the web speed, its thickness and the thickness of the tinplate coating applied.

In practicing the method of the invention the liquid quenching medium is caused to flow in the channel formed between the spaced plate and the web and to flow in the direction of web movement. The cooling medium is passed at the selected temperature level into contact with the moving web of material at the place where the web enters the quenching bath and in such a way that turbulence is there avoided.

When a differentially coated web of material is to be quenched, for optimum results a liquid quenching medium at a different temperature level is passed into contact with each side of the web of material.

Having generally described the invention, reference is now made to the accompanying drawings in which:

FIGURE 1 is a diagrammatic view mainly in cross-section showing in particular the apparatus employed in passing the quenching medium into contact with the moving web of material;

FIGURE 2 is a diagrammatic view showing one system by which the temperature level of the liquid quenching medium is controlled;

FIGURE 3 is a diagrammatic view showing another system by which the temperature level of the liquid quenching medium is controlled;

FIGURE 4 is a diagrammatic view showing a system particularly adapted for the quenching of a differentially coated web of material employing essentially a duplication of the system shown in FIGURE 2 of the drawings to control the liquid quenching medium which is passed into contact with each side of the web of material; and

FIGURE 5 is a diagrammatic view showing a system particularly adapted for the quenching of a differentially coated web material employing essentially a duplication of the system shown in FIGURE 3 of the drawings to control the liquid quenching medium which is passed into contact with each side of the web of material.

Referring now to FIGURE 1 of the diagrammatic drawings, there is shown a quenching tank **9** which contains a quenching bath **10** through which a web of material **11** moves in the direction shown by the arrows. The term "quenching bath" is intended to include the quenching medium which has been introduced at the place generally indicated at **12** where the moving web of material contacts the newly introduced liquid quenching medium, which is usually water at controlled temperature. A quenching hood, generally indicated at **13**, is employed for passing the liquid quenching medium into contact with the web of material **11**. The quenching hood **13** is shown to be divided generally into two compartments **14** and **15**, each of which introduces the quenching medium into contact with one side of the web of material. The compartments **14** and **15** have conduits **16** and **17** which lead therein to supply a quenching bath which flows in toward baffle plates **18** and **19** respectively, whch assure thorough mixing of the liquid quenching medium. The compartments **14** and **15** contain sumps **20** and **21** which assure that there is not a great deal of turbulence in the liquid quenching medium when it passes over a pair or lips **22** and **23** of a pair of spaced plates **24** and **25** between which the web with its molten tin coating is passed. The liquid quenching medium which passes over the lips **22** and **23** reaches the region where the flow into the tank **9**

is along a path substantially parallel to web travel and the liquid quenching medium is most effective in quenching of the incoming web at the region indicated at **12**.

A temperature sensing device, indicated generally at **26**, comprises a pair of temperature sensing elements **27** and **28** to determine the temperature level of the liquid quenching medium at about the region where the web and strip are first in contact. This element is any well known type of unit for temperature sensing and from which it is customary to develop an electrical signal to actuate or control a controller **29** over a line **30** (see FIG. 2, for instance). The controller **29** is preferably a recorder controller, that is, one which not only has a function of controlling some other component but also of recording the temperature level sensed by the temperature sensing device **26**.

While various forms of temperature sensing and control elements may be used, the operation has been carried out with a pressure regulator and filter of the Brown Instrument Corp. type, such as the #358249–1, and an air-operated indicating and recording electronic potentiometer of the same company, Model #152P13, PSH1–96–K1–11–A1A4, operated in conjunction with a Minneapolis-Honeywell thermocouple having a pressure tight protecting well with a sensitive tip for securing purposes, such as its Sensitive Tip Model M.S. 9M9A–2, an element Model 9J30ADY2–2A and a general purpose head Model 9M1B.

As shown in the control system of FIGURE 2 of the drawings, a conduit **31** leads from a source of steam supply into a conduit **32** which leads from a source of liquid quenching medium supply. The conduit **31** contains a manually operable valve **33** of any suitable form which is employed for varying the flow rate of the inlet steam. The conduit **32** has disposed therealong a modulating or flow-control valve **34** which is operated from a signal over a line **35** which leads from the controller **29**. When the temperature sensing device **26** sends a signal to the controller **29**, for example, to indicate that the temperature level of the liquid quenching medium is too low, the controller **29** operates to modulate the valve **34** to permit less liquid quenching medium to flow through the conduit **32**. When, on the other hand, the temperature sensing device **26** indicates to the controller **29** that the temperature level of the liquid quenching medium is too high, the controller modulates the valve **34** to permit a greater quantity of liquid quenching medium to pass through the conduit **32**, into conduits **16**, **17**.

The diaphragm control valve **34** may be a Minneapolis-Honeywell unit control valve with a Moore positioner Series 800–11 usually operating in air-to-close fashion.

An overflow device generally indicated at **40** is employed as an outlet for the quenching bath which is constantly being increased by the supply of liquid quenching medium. The device **40** is preferably made adjustable in character so that the liquid level above the lips **22** and **23** of the plates **24** and **25** can be varied so that the minimum of turbulence is experienced where the moving web contacts the place of contact **12** of the liquid quenching bath. The device **40** includes an adjustable gate **41** which is pivoted about a hinge **42**. An adjusting screw **43** is adapted to be turned by a handwheel **44** to pivot the gate **41** about the hinge **42**. The adjusting screw **43** passes through an internally threaded ball **45** which is supported in a socket **46** which is attached, for example, to the tank **9**.

Referring now to FIGURE 3 of the diagrammatic drawings, a modified arrangement is shown for controlling the temperature level of the liquid quenching medium. A conduit **31***a* leads from a suitable source of steam supply into a conduit **32***a* which leads from a suitable source of liquid quenching medium supply. The conduit **31***a* has disposed therealong a valve **33***a* which is operated under the influence of the recorder controller, while the conduit **32***a* has disposed therealong a manually operable valve **34***a*. In the control system shown in FIGURE 3, the recorder controller **29***a* controls the steam inlet through the valve **33***a* by a signal through a line **35***a*. The flow through the valve **34***a* to provide quenching liquid is manually operated. The main difference between the system shown in FIGURE 2 and FIGURE 3 is that in FIGURE 2 the controller **29** controls the quantity of liquid quenching medium which is supplied to the conduits **16** and **17**, while in the system of FIGURE 3 the quantity of liquid quenching medium which is supplied to the conduits **16** and **17** is relatively constant, but the temperature level of the liquid quenching medium is varied in response to a signal from the controller **29***a*.

In the embodiment of FIGURE 4 of the diagrammatic drawings, a duplication of the system shown in FIGURE 2 of the drawings is employed so that when required a liquid quenching medium at a selected temperature level can be passed into contact with each of the sides of a differentially coated moving web of material. One temperature sensing device **26***c* sends a signal to the recorder controller **29***c* over a line **30***c*. The signal from the recorder controller **29***c* is passed to a modulating valve **34***c* over a line **35***c* to modulate the valve opening thereof. A conduit **31***c* leads from a source of steam supply into a conduit **32***c* which leads from a source of liquid quenching medium supply. The conduit **31***c* contains a manually operable valve **33***c*. Similarly, a temperature sensing device **26***d* senses a signal from the other side of the web of material to a recorder controller **29***d* over a line **30***d*. The recorder controller **29***d* operates a modulating valve **34***d* with a signal which passes through line **35***d*. A conduit **31***d* leads from a source of steam supply into a conduit **32***d* which leads from a source of liquid quenching medium supply. The conduit **31***d* contains a manually operated valve **33***d*. Instead of the conduit **32** leading into branch conduits **16** and **17** as shown in FIGURES 2 and 3 of the drawings, the conduits **32***c* and **32***d* lead directly into the respective compartments **15** and **14** of the quenching hood **13**.

In the embodiment of FIGURE 5 of the drawings, a temperature sensing device **26***e* disposed on one side of the web of differentially coated material **11***a* passes a signal over a line **30***e* to a recorder controller **29***e*. A conduit **31***e* leads from a source of steam supply into a conduit **32***e* which leads from a source of liquid quenching medium supply. A conduit **32***e* has a manually operated valve **34***e* disposed therealong, while the conduit **31***e* has a modulating valve **33***e* disposed therealong. The recorder controller **29***e* controls the opening of the valve **33***e* through a signal which passes through line **35***e*. A temperature sensing device **26***f* disposed on the other side of the web of material **11***a* sends a signal through a line **30***f* to a recorder controller **29***f*. A conduit **31***f* which leads from a source of steam supply leads into a conduit **32***f* which leads from a source of liquid quenching medium supply. A manually operated valve **34***f* is disposed along the conduit **32***f* while a modulating valve **33***f* is disposed along the conduit **31***f*. The valve **33***f* is controlled by a signal from the recorder controller **29***f* which passes through a line **35***f*.

The above-described embodiments and method being exemplary only, it will be understood that the present invention comprehends organizations and methods differing in form or detail from those presently described. Accordingly, the invention is not to be considered as limited, save as is consonant with the scope of the following claims.

What is claimed is:

1. In an apparatus for continuously quenching a substantially continuously moving web of material fed into and withdrawn from a tank containing a bath of liquid quenching medium: means for initially contacting said moving web with additional liquid quenching medium at the place where the web enters said bath; means for preventing surface turbulence in the liquid quenching me-

dium in the region of initial contact between the medium and the web; and means for controlling the temperature of said additional liquid quenching medium.

2. In the apparatus of claim 1: means for varying the liquid level of said bath.

3. In an apparatus for continuously quenching a substantially continuously moving web of material fed into and withdrawn from a tank containing a bath of liquid quenching medium: means for initially contacting said moving web with additional liquid quenching medium at the place where the web enters said bath; means for preventing surface turbulence in the liquid quenching medium in the region of initial contact between said medium and the web; means, disposed substantially adjacent the place of initial contact between the web and the qunching medium, for sensing the temperature of the liquid quenching medium; and means, responsive to said sensing means, for controlling the temperature of said additional liquid quenching medium.

4. In an apparatus for continuously quenching a substantially continuously moving web of material fed into and withdrawn from a tank containing a bath of liquid quenching medium; means for initially contacting said moving web with additional liquid quenching medium at substantially the place where the web enters said bath; means for maintaining said liquid quenching medium substantially free from surface turbulence in the region of initial contact with said web; means, disposed substantially at said place of contact, for sensing the instantaneous temperature of the liquid quenching medium; and means, responsive to said sensing means, for controlling the flow rate of additional liquid quenching medium which passes into quenching contact with said web.

5. In an apparatus for continuously quenching a web of material continuously fed into and withdrawn form a tank containing a bath of liquid quenching medium: means for initially contacting said web with additional liquid quenching medium at the place where the web enters said bath; means for maintaining the liquid quenching medium substantially free of surface turbulence at the region of initial contact with the web; means for introducing steam into said additional liquid quenching medium before the latter is passed into contact with said web; means, disposed substantially at the place of initial contact between the web and the liquid quenching medium, for sensing the temperature of the liquid quenching medium at the region of initial contact with ahe web; and means, responsive to a sigal received from said sensing means, for controlling the amount of steam introduced into said additional liquid quenching medium, to control the temperature thereof.

6. In an apparatus for continuously quenching a differentially coated web of material substantially continuously entering and leaving a cooling tank containing a bath of liquid medium: means for initially contacting the relatively thinly coated side of said web with a first additional liquid quenching medium, in a substantially turbulent-free state, at the place where the web enters said bath; first sensing means for coninuously sensing the temperature of the first additional liquid quenching medium at substantially the region of initial contact thereof with the web; means, activated by said first sensing means, for controlling the temperature of the first additional liquid quenching medium; means for independently initially contacting the other, more thickly coated side of said web with a second additional liquid quenching medium, in a substantially turbulent-free state, at the place where the web enters said bath; second sensing means for continuously sensing the temperature of the second additional liquid quenching medium at substantially the region of initial contact thereof with the web; and means activated by said second sensing means for controlling the temperature of the second additional liquid quenching medium.

7. A method for continuously quenching a web of material having thereon a coating of a second material of lower melting point, said second material being in a substantially molten state and at a selected temperature, said method comprising the steps of: moving the web along a selected path for immersion in a bath of liquid quenching medium, thereby to harden and solidify said coating; introducing additional liquid quenching medium into said bath; initially contacting said web with said additional liquid quenching medium at substantially the location where the web enters the bath; directing said additional liquid quenching medium, from the time it enters the region of initial contact with the web, in a confined flow inwardly into said bath, away from the surface thereof, along a path extending alongside said web and in the same direction as that in which the web moves, so that the surface of the liquid quenching medium is substantially free of turbulence and the web enters the cooling medium substantially in the absence of liquid splash; continuously sensing the temperature of the liquid quenching medium at substantially the region where the web enters the bath; and regulating the flow rate of additional liquid quenching medium introduced into said bath to maintain a selected temperature differential between said second material and said bath at said region of web entry.

8. A method for continuously quenching a web of material differentially coated on each side with a second material in a substantially molten state, said method comprising the steps of: feeding said coated web through a bath of liquid quenching medium; introducing additional liquid quenching medium into said bath; initially contacting said web with said additional liquid quenching medium at the location where said web enters said bath, and on each side of the web; directing said additional liquid quenching medium, from the time it enters the region of initial contact with the web, inwardly into the bath, away from the surface thereof, along a path extending alongside the web and in the same direction as that in which the web moves, thereby to provide a turbulence-free liquid surface at the region of initial contact between a web surface and the liquid quenching medium; sensing the temperature of the liquid quenching medium on each side of the web at substantially the region of initial contact between the web surface and the liquid quenching medium; and controlling the flow rate and temperature of the additional liquid quenching medium, on each side of the web, in accordance with said sensing step.

9. In an apparatus for continuously quenching a substantially continuously moving web of material coated with a second material in a molten state: means for containing a bath of liquid quenching medium; means for passing said web through said bath; means for flowing additional liquid quenching medium into said bath; means for initially contacting said web with said additional liquid quenching medium at the place where the web enters the bath; means for preventing surface turbulence in the liquid quenching medium in the region of initial contact between the web and the liquid quenching medium; and means for controlling at least one of (a) the temperature and (b) the rate of flow of the additional liquid quenching medium.

10. In an apparatus for continuously quenching a substantially continuously moving web of material having a molten coating on the surface thereof: tank means for containing a bath of liquid quenching medium; means for feeding said web through said bath; means for introducing additional liquid quenching medium into said bath; means for initially contacting said web with said additional liquid quenching medium at the location where the web enters the bath; means for preventing surface turbulence in the liquid quenching medium in the region of initial contact between the medium and the web; said turbulence-preventing means comprising means for directing said additional liquid quenching medium from

the time it enters said region of initial contact, inwardly into said bath, away from the surface thereof, along a path extending alongside said web and in the same direction as that in which the web moves; and means for controlling the temperature of the additional liquid quenching medium.

11. In the apparatus of claim 10: means for varying the liquid level of said bath.

12. In the apparatus of claim 10: means to limit the liquid, in said region of initial contact, substantially to liquid quenching medium the temperature of which is controlled.

13. Apparatus for continuously quenching a substantially continuously moving web of material having thereon a coating in a substantially molten state, said apparatus comprising: tank means for containing a bath of liquid quenching medium; means for passing said moving web through said bath; means for passing a confined flow of additional liquid quenching medium into said bath; means for initially contacting said web with said additional liquid quenching medium at substantially the place where the web initially enters said bath; means for maintaining the region of initial contact between the web and the liquid quenching medium substantially free from surface turbulence; said last-recited means comprising means for directing said additional liquid quenching medium, from the time it enters said region of initial contact, inwardly into said bath, away from the surface thereof, along a path extending alongside said web and in the same direction as that in which the web moves; means for introducing steam into said additional liquid quenching medium before the latter contacts said web; means, disposed substantially at the place of initial contact between the web and the liquid quenching medium, for sensing the instantaneous temperature of the liquid quenching medium; and means, responsive to said sensing means, for controlling the rate at which additional liquid quenching medium passes into said bath.

14. In an apparatus for continuously quenching a substantially continuously moving web of materials having a second material, in a molten state, coating its opposite sides, with the coating being of different thickness on each side of the web: tank means for containing a bath of liquid quenching medium; means for passing said web through said bath; means for introducing additional liquid quenching medium into said bath; means for initially contacting said web, on each side thereof, with said additional liquid quenching medium at the region where the web enters the bath; means for preventing surface turbulence within the liquid quenching medium at the region of initial contact between the web and the liquid quenching medium; said turbulence-preventing means comprising means for directing the flow of said additional liquid quenching medium, from the time it enters said region of initial contact, inwardly into the bath away from the surface thereof along a path extending in the direction of web movement; means for sensing the instantaneous temperature of the liquid quenching medium in said region of initial contact, and on each side of said web; means for controlling the temperature and the flow rate of the additional liquid quenching medium, independently on each side of said web, in response to said sensing means; means to introduce and restrict turbulence in the liquid quenching medium to a sub-surface region of said bath, along said path; and means for removing liquid quenching medium from said bath so that the circulation of liquid quenching medium occurs between said region of initial contact and the liquid removal point.

15. A method for quenching a web of material in a bath of liquid quenching medium, said method comprising the steps of:

introducing said web into said bath of liquid quenching medium;

introducing additional liquid quenching medium into said bath;

contacting a surface of said web with said additional liquid quenching medium, initially at substantially the location where the web enters the bath;

and preventing surface turbulence in said liquid quenching medium in the region of initial contact with said web;

whereby surface imperfections on said material, arising from quenching-bath splash, are avoided.

16. A method as recited in claim 15 wherein said step of preventing surface turbulence comprises moving said additional liquid quenching medium, from the time it enters said region of initial contact, inwardly into said bath away from the surface of the bath along a path extending alongside said web and in a direction substantially the same as that in which the web moves.

17. A method as recited in claim 16 and comprising producing turbulence in said additional liquid quenching medium as it moves along said path, at a location below the surface of the liquid quenching medium.

18. A method as recited in claim 16 and comprising:

controlling the rate of heat removal from the web to the liquid quenching medium at the location of initial contact between the web and the liquid quenching medium and inwardly from said location along said path;

whereby surface imperfections on said material, arising from improper heat removal rates are avoided.

19. A method for quenching a web of material in a bath of liquid quenching medium, said method comprising the steps of:

introducing said web into said bath of liquid quenching medium;

introducing additional liquid quenching medium into said bath;

contacting a surface of said web with said additional liquid quenching medium, initially at substantially the location where the web enters the bath;

and moving said additional liquid quenching medium, from the time it enters the region of initial contact, inwardly into said bath away from the surface of the bath along a path extending alongside said web and in a direction substantially the same as that in which the web moves.

20. A method as recited in claim 19 and comprising:

controlling the rate of heat removal from the web to the liquid quenching medium at the location of initial contact between the web and the liquid quenching medium and inwardly from said location along said path;

whereby surface imperfections on said material, arising from improper heat removal rates, are avoided.

21. A method as recited in claim 20 wherein said step of controlling heat removal comprises controlling the temperature of said additional liquid quenching medium.

22. A method as recited in claim 20 wherein said step of controlling heat removal comprises controlling the rate at which said additional liquid quenching medium is introduced into said bath.

23. Apparatus for quenching a moving web of material in a bath of liquid quenching medium, said apparatus comprising:

means for containing said bath of liquid quenching medium;

means for introducing said web into said bath;

means for introducing additional liquid quenching medium into said bath;

means for contacting a surface of said web with said additional liquid quenching medium, initially at substantially the location where the web enters the bath;

and means for preventing surface turbulence in said liquid quenching medium in the region of initial contact with said web;

whereby surface imperfections on said material, arising from quenching-bath splash, are avoided.

24. Apparatus as recited in claim 23 wherein said means for preventing surface turbulence comprises:

means, cooperable with said moving web, to direct said additional liquid quenching medium, from the time it enters said region of initial contact, inwardly into said bath away from the surface of the bath along a path extending alongside said web and in a direction substantially the same as that in which the web moves.

25. Apparatus as recited in claim 24 and comprising means for producing turbulence in said additional liquid quenching medium as it moves along said path, at a location below the surface of the liquid quenching medium.

26. Apparatus as recited in claim 24 and comprising:

means for controlling the rate of heat removal from the web to the liquid quenching medium at the location of initial contact between the web and the liquid quenching medium and inwardly from said location along said path;

whereby surface imperfections on said material, arising from improper heat removal rates, are avoided.

27. Apparatus for quenching a moving web of material in a bath of liquid quenching medium, said apparatus comprising:

means for containing said bath of liquid quenching medium;

means for introducing said web into said bath;

means for introducing additional liquid quenching medium into said bath;

means for contacting a surface of said web with said additional liquid quenching medium, initially at substantially the location where the web enters the bath;

and means cooperable with said moving web to direct said additional liquid quenching medium, from the time it enters the region of initial contact, inwardly into said bath away from the surface of the bath along a path extending alongside said web and in a direction substantially the same as that in which the web moves.

28. Apparatus as recited in claim 27 and comprising:

means for controlling the rate of heat removal from the web to the liquid quenching medium at the location of initial contact between the web and the liquid quenching medium and inwardly from said location along said path;

whereby surface imperfections on said material, arising from improper heat removal rates, are avoided.

29. Apparatus as recited in claim 28 wherein said means for controlling heat removal comprises means for controlling the temperature of said additional liquid quenching medium.

30. Apparatus as recited in claim 28 wherein said means for controlling heat removal comprises means for controlling the rate at which said additional liquid quenching medium is introduced into said bath.

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