

- [54] **APPARATUS FOR QUENCHING MOLTEN COATINGS**
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122

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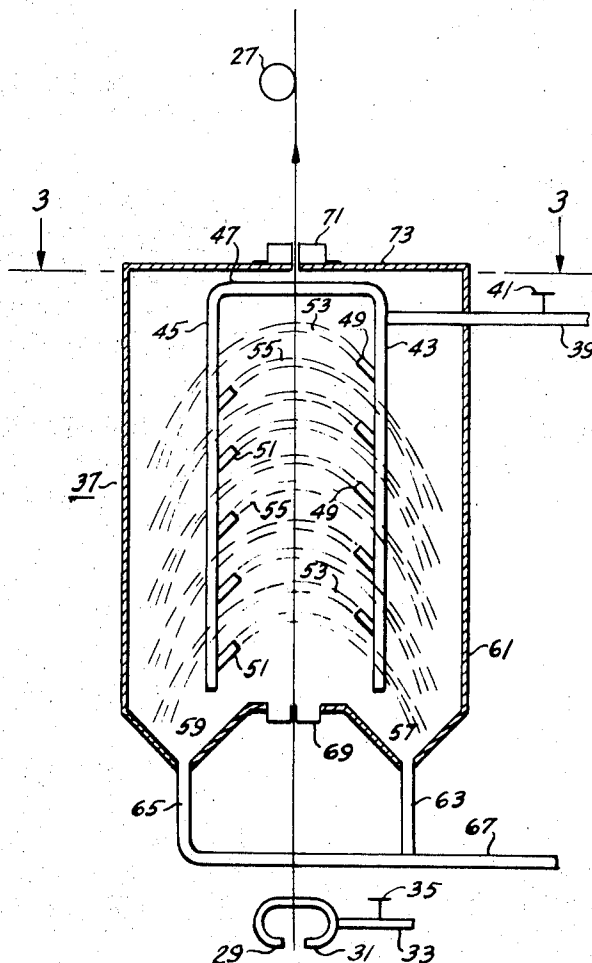
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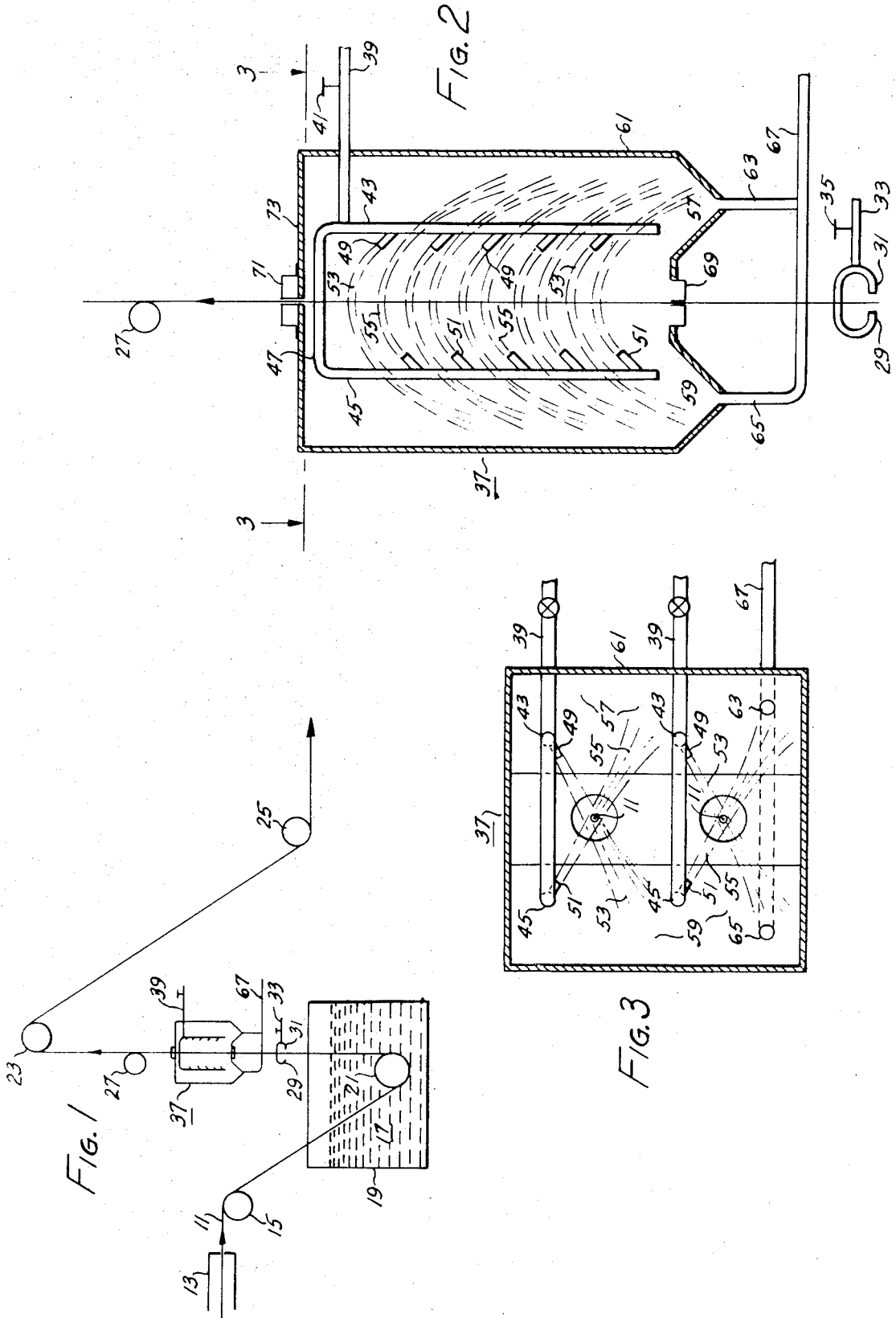
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ABSTRACT

A wire passing upwardly after having passed through a molten metal coating bath is contacted with a moving stream of water jetting upwardly through the atmosphere at an angle. The stream of water and the moving wire meet just at the apex of the stream where the energy of movement of the water is least. The cooling stream of water thus causes a minimum disturbance of the still molten coating on the wire.

6 Claims, 3 Drawing Figures





APPARATUS FOR QUENCHING MOLTEN COATINGS

This is a division, of application Ser. No. 213,143, filed Dec. 28, 1971 and now U.S. Pat. No. 3,743,535.

BACKGROUND OF THE INVENTION

The present invention relates generally to apparatus for quenching of coated wire and other linear material and more particularly to the quenching with a fluid cooling medium of a molten metallic coating on a moving continuously coated wire or the like.

It is frequently desirable to cool or quench a moving length of linear material such as wire or narrow strip passing upwardly out of a molten bath of coating metal such as molten zinc, aluminum or copper. Prompt quenching of the linear material is frequently important in order to retard the development of an interfacial alloy layer between the coating metal and the base metal or to solidify the coating metal promptly so that it can be contacted with a guide sheave or the like either to change the direction of the linear material or to damp vibrations in the wire.

If linear material is contacted with any sort of guide prior to substantial solidification of a recently applied molten coating upon the surface, the still molten coating would be marred by the contact, even where the guide only gently contacts, or "kisses," the linear material. On the other hand a molten coating metal deposited upon a moving wire or strip will frequently take a significant period to solidify in ambient shop conditions and if the linear material is moving at a fair speed it can travel long distances before solidification occurs. This long distance is usually arranged to be in a vertical direction upwardly from the coating pot so that the molten metal will not be differentially affected by gravity. The long unsupported length of linear material may, however, be subject to rather severe vibration which frequently will cause lumpy and/or eccentric coatings.

Various quenching means have been used to quench a still molten coating without marring the surface of the coating. In general these quenching devices have involved either blasts of a gas such as air, fine mists of a fluid cooling medium such as water, fine sprays of water or the like or in some cases quenching in a tank of cooling fluid. In general each of these prior devices has suffered from some serious drawbacks either because the cooling action afforded was insufficient or the physical disturbance of the coating by the quenching means was too great.

SUMMARY OF THE INVENTION

The aforesaid difficulties of the prior art in quenching still molten coatings on moving linear material have now been obviated by the present invention. In accordance with the present invention a coated wire, narrow strip or other linear material passing from a molten coating bath or other means for applying a molten coating is quenched by contacting the coating with a moving stream or streams of an upwardly directed cooling fluid, or liquid, at the apex of the upward movement of such stream or streams. The stream or streams of cooling fluid are generally in the form of a fountain of fluid similar to the stream in a drinking fountain. The upwardly directed component of motion of the stream of liquid is just barely exhausted at the apex of movement

of the said fountain type stream so that there is at this point an absolute minimum of movement in the stream of liquid to disturb the still molten coating on the wire while at the same time the cooling liquid contacting the coating is continuously renewed at a rapid rate with fresh cooling liquid to most efficiently quench the coating. Since the upward component of motion of the stream is then exhausted, the only movement of the cooling liquid at the apex is whatever horizontal component of movement the liquid has. This horizontal component can be made as small as desired depending upon where the exhausted liquid is desired to impinge as it descends from the apex of its trajectory and the resulting contact of the cooling fluid with the object being cooled and the coating on it can be adjusted to be only the barest touch while still renewing large quantities of cooling liquid next to the coated surface. The moving liquid thus achieves what has been termed laminar flow cooling but with only very gentle contact on the piece being quenched.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic representation of a portion of a coating line incorporating the quench arrangement of the present invention.

FIG. 2 is an enlarged sectional view of the quenching device of the invention.

FIG. 3 is a plan view of FIG. 2 at 3—3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 a wire 11 passes from a pretreatment apparatus 13 which may frequently be a preheating furnace but which may also be a cleaning apparatus or flux applying apparatus. As the wire 11 leaves the pretreatment apparatus 13 it passes over guide sheave 15 which directs the wire downwardly into a molten metal coating bath 17 containing a molten coating metal such as aluminum, zinc or copper. The molten metal comprising bath 17 is contained in a molten metal coating pot 19. Wire 11 passes downwardly under sinker roll 21 submerged under the surface of the bath 17 and then upwardly out of the molten bath 17 to dancer roll 23 where the wire 11 changes direction and passes downwardly under guide sheave 25 which directs the wire away from the coating pot 19 to some other treatment or coiling operation, not shown. The distance from the surface of the molten bath 17 to the dancer roll 23 is frequently substantial to allow time for the molten coating to solidify before contacting the roll 23. In order to cause accelerated solidification of the molten coating on the wire 11 after it leaves the bath 17, so that the wire may be contacted with a vibration damping contact roll 27 and also to decrease the growth of an interfacial alloy layer between the coating metal and the underlying base metal of the wire — if such an interfacial alloy tends to form between the base metal and the particular coating metal — the wire 11 first passes through a light forced air stream from dual nozzles 29 and 31 connected by header 33 to a source of compressed air, not shown. A valve 35 in the header 33 may be used to regulate the flow of air from nozzles 29 and 31 so that the forced air flow is sufficient to just cool the surface of the coating. Such air flow may be adequate to place a very thin solidified shell of coating metal over the surface but should not be sufficient to otherwise disturb the surface. The wire 11 next imme-

diately passes to a fountain type quench apparatus 37 where the surface of the coating is quickly cooled below the solidification point and the entire wire is subjected to accelerated cooling by a laminar flow of a cooling liquid such as water past and around the surface of the wire.

The quench apparatus 37 is constructed as shown best in FIGS. 2 and 3 so that a series of discrete streams or jets of water 53 and 55 are projected upwardly at an angle calculated to intersect with the upward path of the wire or wires 11 just as the upward movement of the said streams or jets of coolant has reached its highest point or elevation. The stream of flowing water thus has a bare minimum of motion when it intersects the wire 11 and only a very gentle contact with the surface of the coating takes place. The coolant water, however, is still quickly removed, or moved past the wire, so that a good laminar flow type cooling of the molten metal coating on the wire is attained.

In the quench apparatus 37 cooling water from an external source, not shown, enters the apparatus from a main header 39 regulated by a valve 41. From the main header 39 the water enters two vertically disposed descending headers 43 and 45 and a cross over or connecting header 47. Spaced at intervals along the descending headers 43 and 45 are upwardly inclined cooling nozzles 49 and 51, respectively, positioned at angles such that a stream or jet of water 53 and 55 issuing from each of the nozzles 49 and 51 respectively intersects the wire 11 at the apex of the stream and then falls in a descending arc downwardly into sumps 57 and 59 in the bottom of the casing 61 of the quench apparatus 37. Drains 63 and 65 connect with a main 67 and serve to remove the water from the various streams from the sumps 57 and 59.

As seen in FIG. 2 the two sets of nozzles 49 and 51 are positioned upon their respective descending headers 43 and 45 so that the streams or fountains of water 53 and 55 issuing from them intersect the wire 11 at different levels to prevent the splashing which would otherwise take place if several streams intersected the wire at the same point. As seen in FIG. 3 the nozzles are also positioned so that the streams or fountains 53 and 55 do not impinge upon the opposing headers or nozzles as the streams fall into the sumps 57 and 59. FIG. 3 also shows that more than one wire 11 may be passed through the quench apparatus and cooled without interference with adjoining fountains or streams of coolant. It will be understood that in FIGS. 1 and 2 additional wires 11 passing through the apparatus may be hidden behind the wire 11 visible in the respective views. In FIG. 3 duplicate numbers are used to identify duplicate headers and nozzles used to apply cooling streams to additional wires 11.

Since practically all of the cooling water from each of the nozzles 49 and 51 passes freely around and past the wire 11 and continues in more or less discrete streams into the sumps 57 and 59, it will be seen that very little water is left over to run down the wire or wires 11 into the coating pot 19. Likewise there is very little splashing caused by the wire or wires passing through the apex of each cooling stream of water. Any water which clings to the wire is drawn upwardly and away with the moving wires and is also usually rapidly evaporated from the still relatively hot surface of the wire. The fountain type quench of the invention is, therefore, particularly suitable for placement directly

over a molten coating bath where any substantial dripping or splashing of water or other cooling liquid upon the bath would be intolerable. This is an important advantage since it is usually advantageous to pass a wire or other elongated material vertically up from a molten bath until the outer coating solidifies in order that the molten coating will not be differentially affected by gravity. The quench apparatus of the instant invention can be placed on the vertical run of the linear material from the bath without any significant moisture escaping downwardly from the apparatus even though there are no seals around the wires. (Seals might damage the still molten coating.) A relatively large entrance orifice 69 may thus be provided in the bottom of the apparatus equal or even greater in size than the exit orifice 71 for the linear material positioned in the top 73 of the apparatus.

The use of the initial gentle blast or flow of cooling air directed upon the linear material from nozzles 29 and 31, while very desirable prior to passage of the wire through the fountain type quench of the invention, is by no means necessary for use with the quench if the air is not desired. The cooling air stream from the air nozzles 29 and 31 will tend to form a very thin skin or incipient skin of solidified coating material upon the surface of the wire which skin, when the wire passes through the fountain type quench, is just sufficient to prevent any disturbance at all of the surface of the still unsolidified coating as it passes through the apex of the stream of coolant in the fountain quench apparatus. The combined use of the forced air cooling followed immediately by the fountain type quench of the invention is particularly effective and desirable if there is a fair component of horizontal movement of the coolant streams at the apex of said streams. On the other hand, however, it is by no means necessary to use the initial forced air cooling prior to quenching, particularly if the angle of the streams of coolant is arranged so that the horizontal component of motion is minimal at the apex of said streams, or if a very minor or negligible disturbance of the coating surface is not regarded as seriously detrimental.

It is likewise not always necessary to use the vibration damping contact roll 27 with the quench apparatus 37. The dancer roll 23 can instead be moved down closer to the coating pot 19 to replace the damping roll 27 if vibration damping is desired, or if vibration is not deemed important, and quenching is accomplished in the particular operation merely to decrease interface alloy formation, the dancer roll 23 may be left in the same position. The use of the additional vibration damper roll 27, which may be adjusted by suitable biasing mechanism to just "kiss" the wire after the quench, is particularly effective and desirable, however.

We claim:

1. Apparatus for cooling moving molten material coated wire-like material comprising:

- a. a cooling chamber defining a vertical path for said wire-like material,
- b. means to form at least one liquid cooling jet within said cooling chamber, said means being arranged to direct said cooling jet as a discrete free stream of liquid upwardly at an angle other than vertically with the path of said stream intersecting the path of said wire-like material at the apex of the path of said discrete stream of cooling liquid where sub-

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stantially all vertical components of the movement of said stream is dissipated,

c. said means for forming said liquid cooling jet comprising header means for conveying cooling liquid from an external source into the vicinity of the cooling chamber and nozzle means connected to the header means and inclined upwardly at an angle such that a stream of cooling liquid ejected from the nozzle means is projected upwardly at an angle such that the stream of coolant intersects the path of the wire-like material at the apex of the stream of coolant just prior to beginning to fall in a descending arc downwardly from the said apex, and

d. means to collect said descending coolant.

2. Apparatus for cooling wire-like material according to claim 1 wherein the liquid cooling jet is comprised of a single undivided stream of liquid adapted to cool the wire-like material with a gentle laminar flow of liq-

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uid past the surface of the wire-like material.

3. Apparatus for cooling wire-like material according to claim 2 wherein there are means establishing a multiplicity of liquid cooling jets along the line of travel of the wire-like material through said chamber.

4. Apparatus for cooling moving wire-like material according to claim 1 wherein the liquid cooling jet is comprised of water.

5. Apparatus for cooling moving wire-like material according to claim 4 wherein the cooling chamber of (a) is preceded by a forced air cooling means impinging streams of relatively cool air upon said linear material.

6. Apparatus for cooling moving wire-like material according to claim 5 wherein the cooling chamber of (a) is followed by a vibration damping means physically contacting the wire-like material adjacent to said chamber.

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