METHOD OF CONTINUOUSLY QUENCHING MOLTEN METAL COATINGS

Filed Dec. 28, 1971

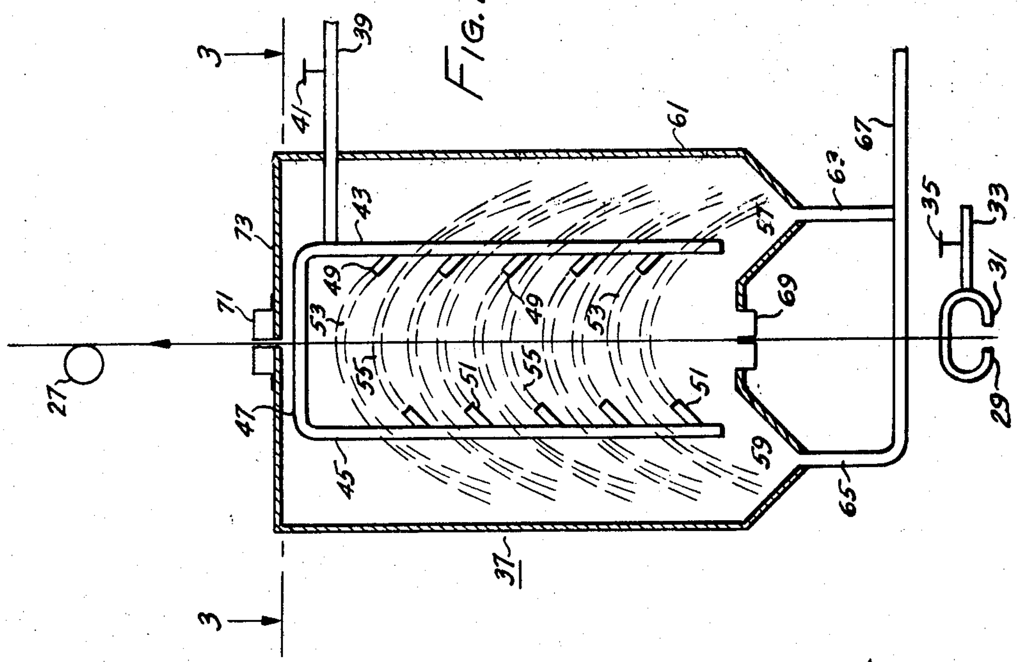

FIG. 2

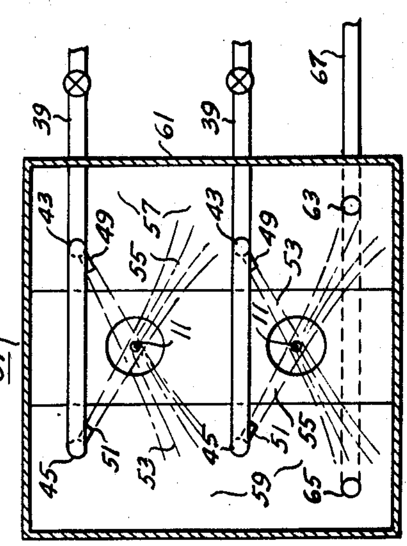

FIG. 3

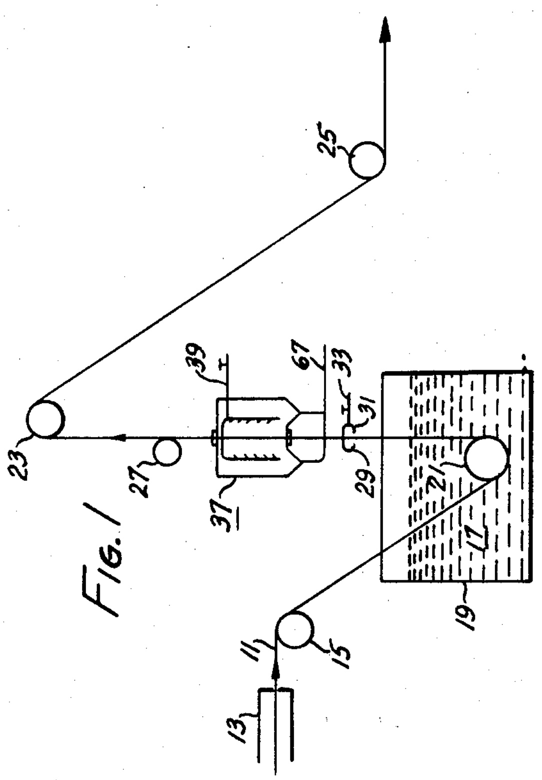

FIG. 1

United States Patent Office

3,743,535

Patented July 3, 1973

1

3,743,535

METHOD OF CONTINUOUSLY QUENCHING MOLTEN METAL COATINGS

George Padjen and Joseph A. Brugger, Bethlehem, Pa., assignors to Bethlehem Steel Corporation

Filed Dec. 28, 1971, Ser. No. 213,143
Int. Cl. C23c 1/00
U.S. Cl. 117—114 R 7 Claims

ABSTRACT OF THE DISCLOSURE

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.

BACKGROUND OF THE INVENTION

The present invention relates generally to the 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 pror 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 a 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 solified shell of coating metal over the surface but should not be sufficient to otherwise disturb the surface. The wire **11** next immediately 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. A method of quickly cooling moving linear material having a molten layer of coating metal upon its surface without marring or otherwise physically disturbing the surface of said molten metal coating comprising:
(a) directing a jet of cooling liquid upwardly at an angle, and
(b) intersecting said jet of cooling liquid at the apex of its free upward movement with the path of the moving linear material.

2. A method of cooling linear material according to claim **1** wherein the linear material consecutively intersects a plurality of jets of linear material spaced lengthwise along its line of travel.

3. A method of cooling linear material according to claim **2** wherein the surface of the molten metal coating on the linear material is contacted with a forced air stream prior to intersection of said linear material with said jet of cooling fluid.

4. A method for suppressing vibrations of wire passing from a molten coating bath after being coated comprising:
(a) passing the wire substantially vertically upwardly from the surface of a molten metal coating bath,
(b) establishing a jet of fluid cooling material passing upwardly at an angle inclined from the vertical,
(c) intersecting the fluid jet at its apex with the path of the wire to cool the molten coating with a laminar flow of cooling liquid, and

(d) contacting the cooled surface of the wire with a vibration damping means subsequent to passage through said cooling liquid.

5. A method for suppressing vibration of wire according to claim 3 wherein the wire is contacted with a forced air stream between the surface of the molten coating bath and the jet of cooling fluid of (b).

6. A method for suppressing vibrations of wire according to claim 5 wherein the cooling fluid is water.

7. A method for suppressing vibrations of wire according to claim 6 wherein the wire passes consecutively through a plurality of jets of cooling fluid.

References Cited

UNITED STATES PATENTS

2,166,249	7/1939	Herman	117—128 X
2,266,322	12/1941	Jominy	73—15.4
2,588,439	3/1952	Ward	117—119.4 X
2,732,319	1/1956	Cree	117—119.4
2,914,419	11/1959	Oganowski	117—114 A X
2,950,991	8/1960	Seymour	117—128 X
3,148,080	9/1964	Mayhew	117—114 A X
3,148,081	9/1964	Ross	117—114 A X
3,235,960	2/1966	Carreker, Jr.	117—114 R UX
3,260,577	7/1966	Mayhew	117—114 A X
3,369,923	2/1968	Laidman	117—114 A X

ALFRED L. LEAVITT, Primary Examiner

J. R. BATTEN, Jr., Assistant Examiner

U.S. Cl. X.R.

117—114 A, 114 B, 114 C, 119.4, 128; 118—63, 69; 134—64