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Brown et al.

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[54] **WATER QUENCH METHOD AND APPARATUS**

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[52] **U.S. Cl.**.....**266/3 R,** 117/119.4, 148/156

[51] **Int. Cl.**.....**C21d 1/62**

[58] **Field of Search**.....266/3 R; 117/119.4; 148/156

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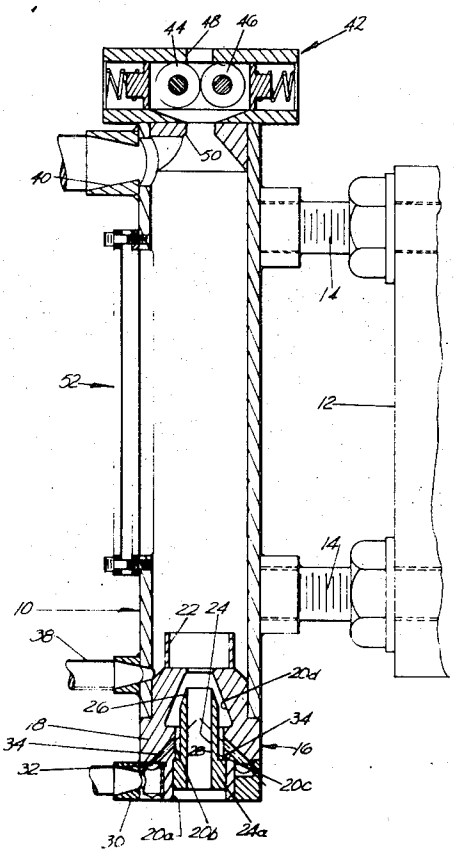
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[57] **ABSTRACT**

Method for liquid quench cooling a heated strand moving in a vertical path of travel by providing a variable height water column through which the strand passes. The column is completely supported by air under pressure so that there is no mechanical apparatus in contact with the heated strand until after it emerges from the water in the column.

The apparatus includes a chamber provided with aligned openings in its top and bottom through which the strand passes with substantial clearance in a vertical path of travel. A cooling fluid is introduced into the chamber and is supported by air under pressure admitted to the chamber adjacent the bottom thereof and surrounding the bottom opening.

11 Claims, 3 Drawing Figures



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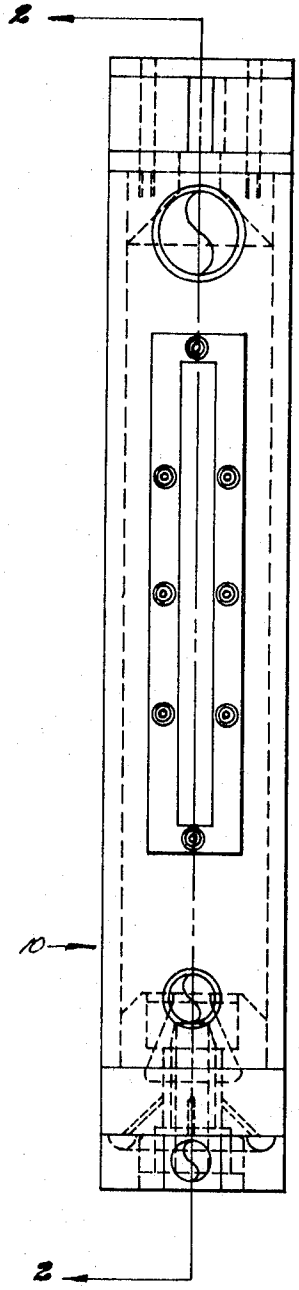


Fig 1

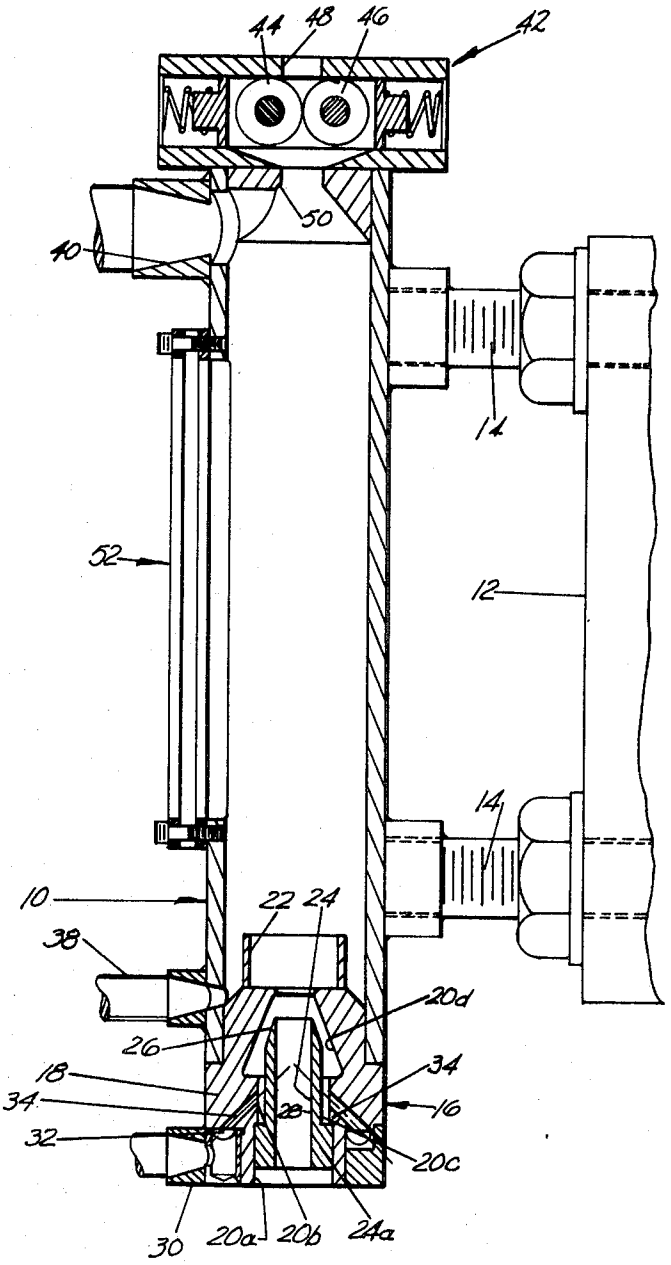


Fig 2

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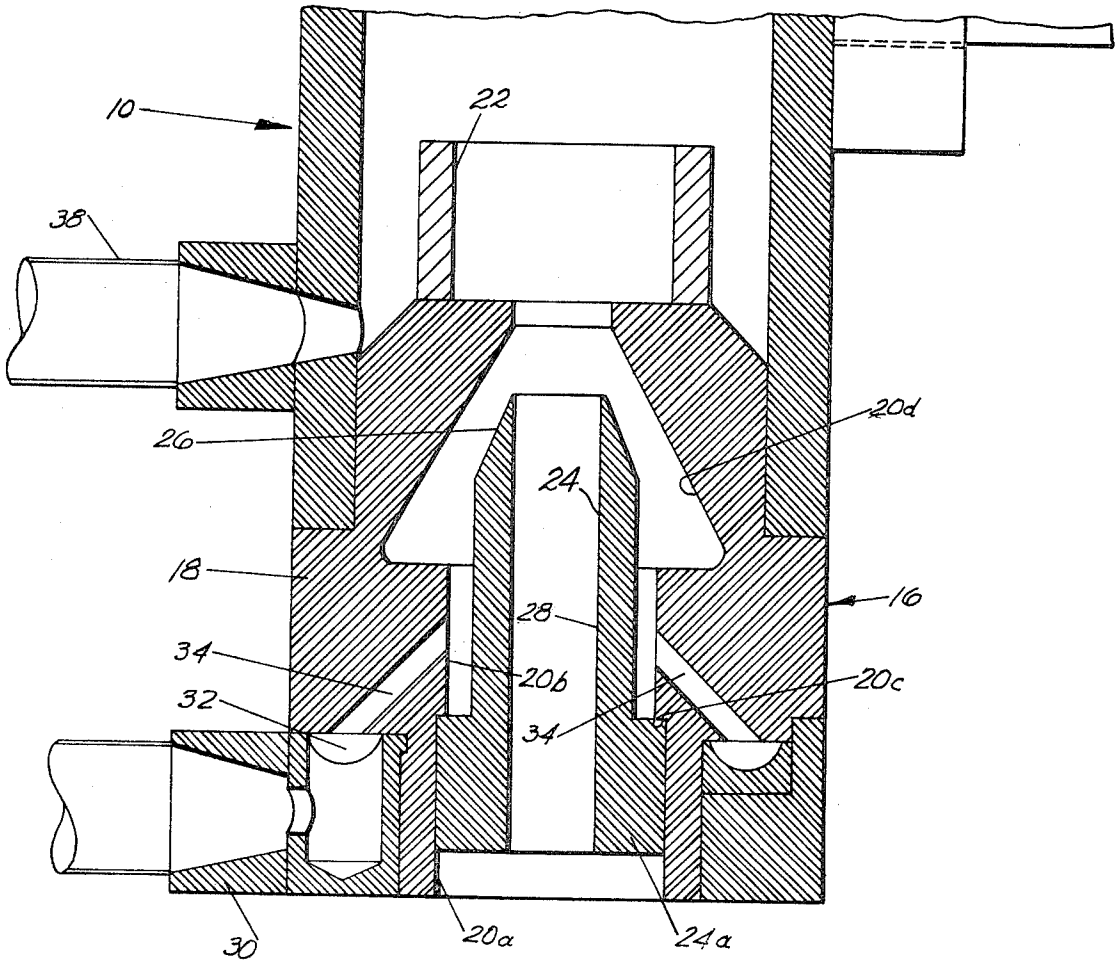


Fig. 3

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WATER QUENCH METHOD AND APPARATUS

BACKGROUND OF THE DISCLOSURE

This invention relates to the liquid quench cooling of a heated strand, and particularly to a method and apparatus for liquid quench cooling of the still molten coating in a hot dip metallic coating operation. The invention is particularly adapted to the liquid quench cooling of a coated strand moving in a vertical path of travel.

Hot dip metallic coating operations, generally considered, all involve a pretreatment of the base metal strand. This pretreatment includes a thorough cleaning of the surface of the strand and is intended to make the surface of the strand receptive to the molten coating metal.

Following the pretreatment, the base metal strand is immersed into a bath of molten coating metal. A variety of coating metals are now in common use, including zinc and its alloys, aluminum and its alloys, terne, and the like.

These aspects of a metallic coating operation do not, per se, form a part of this invention. It will be understood, however, that these steps generally recited above will be carried out prior to the practice of this invention.

The base metal strand, as it emerges from the coating metal bath, will carry with it on its surface a quantity of still molten coating metal. This molten coating metal adhering to the strand may be subjected to a variety of well known finishing actions, including the use of exit rolls or gas jets. These finishing techniques serve to control the coating weight or quantity of molten metal adhering to the strand and to improve its surface characteristics.

It is then necessary to solidify the molten coating prior to coiling or other processing of the strand.

Most modern hot dip metallic coating operations contemplate that the strand emerge from the coating metal bath in a vertical path of travel. It is well recognized by the skilled worker in the art that the vertical path of travel has certain advantages, the primary one being that the influence of gravity will not adversely affect coating concentricity.

Present solidification technique calls for the utilization of cooling air during a portion of this vertically upward travel. This air cooling is continued till the coating has solidified sufficiently to be run over a pulley or sheave at the top of the cooling tower. At this point, the coated strand is generally turned into a horizontally disposed liquid quench trough.

Commercial experience has shown that forced air cooling is relatively slow. As is recognized by the skilled worker in the art, this required a rather long vertically upward path of travel above the bath in order to provide enough time for solidification to take place.

The length of required vertical travel is also known to create alignment problems. That is, pulleys, guides, sheaves, and the like cannot be brought into contact with the coating metal while it is still molten. Therefore, the vertical distance between guides is very substantial.

It has also been recognized in the art that a more rapid cooling, indeed a quenching, of the molten coating adhering to the strand would be desirable for several metallurgical reasons. First of all, it is well known that an alloying takes place at the interface between the base metal and the coating metal. Holding the alloy growth to a minimum will greatly improve coating adherance.

Secondly, it is believed that by quench cooling immediately after finishing, the coated surface is greatly improved, both in appearance and texture of the coated surface.

Keeping the foregoing comments in mind, it is a primary object of this invention to provide a method and apparatus for the liquid quench cooling of a heated strand moving in a vertical path of travel. It is a more specific object of this invention to provide in a hot dip coating operation, a liquid quenching method and apparatus which will, by its more rapid cooling effect, hold alloy formation to a minimum and improve coating adherance.

It is a further object of the invention to provide a liquid quench cooling method and apparatus which will improve the surface characteristics of the coated product.

Still another object of the invention is to provide a method and apparatus for liquid quench cooling the molten metal coating on a base strand which will greatly reduce the required vertical travel above the bath, thereby permitting better alignment of the strand pass line.

Still a further object of the invention is to provide a liquid quench cooling method and apparatus which will utilize a relatively small amount of actual coolant.

A further object of the invention is to provide a liquid quench cooling method and apparatus for a heated strand moving in a vertical path of travel, which does not require apparatus contacting the strand surface until after the quenching is completed.

SUMMARY OF THE INVENTION

In its broadest terms, this invention contemplates the suspension of a variable height water column through which the heated strand passes in a vertical path of travel, by means of a contained column of air under pressure.

In more specific terms, a chamber may be provided having top and bottom openings aligned to define a vertical path of travel for the heated strand. Strand will pass through these aligned openings with substantial clearance. A coolant fluid is introduced into the chamber and suspended by a column of air under pressure admitted at the base of the chamber.

DESCRIPTION OF THE DRAWING

FIG. 1 is a side elevational view of an exemplary apparatus for carrying out the invention.

FIG. 2 is a cross sectional view along the line 2—2 of FIG. 1.

FIG. 3 is an enlarged view of the bottom portion of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As already indicated, this invention relates to the liquid quench cooling of a heated strand, and particularly to the quench cooling of a molten metallic coating on a heated strand moving in a substantially vertical path of travel. It will be assumed that the surface of the base strand has been properly prepared in accordance with well known practice, and that the proper time-temperature relationship during actual immersion is observed.

As also indicated earlier, it will be assumed that the coating apparatus in general is arranged to provide a generally vertical path of travel for the strand upon emergence from the coating metal bath.

The embodiment illustrated in FIGS. **1** and **2** of the drawings show apparatus for the liquid quench cooling of a metallic coating on wire or cylindrical base stock. It will of course be understood that the invention is equally applicable to the liquid quench cooling of a base stock in strip form.

The apparatus includes a cylindrical member **10** through which the wire having a still molten coating on its surface passes. The cylindrical member may be rigidly affixed to any suitable supporting structure **12** as by the bolts **14.**

At its lower end, the cylindrical member **10** is provided with a nozzle structure indicated generally at **16.** This nozzle structure may be secured to the cylindrical member **10** in any suitable manner. It will be seen that the nozzle includes the female portion **18** which has a central bore extending all the way therethrough. This bore includes the lowermost cylindrical portion **20***a*, and a smaller diameter cylindrical portion **20***b* defining therebetween a shoulder **20***c*. The upper portion of the bore **20***d* is of generally frusto-conical configuration. It will be observed that the female member **18** is provided in the embodiment shown with the water dam **22** at its upper end.

The male member of the nozzle structure includes the generally cylindrical portion **24** having the enlarged end portion **24***a*. It will be observed that the male member is received within the bore in the female member, with the portion **24***a* seated against the shoulder **20***c*. The two portions of the nozzle structure just described may be suitably secured together in this position in any satisfactory manner.

It will be seen that the outside diameter of the cylindrical portion **24** of the male member is somewhat smaller than the inside diameter of the bore **20***b* and **20***d*, in effect defining a plenum chamber therebetween. It will be seen that the upper end of the male member is tapered as at **26** to define an annular nozzle opening between these members when assembled together as described.

The male member is provided with an internal bore **28** which is of a size such that the coated wire can pass with substantial clearance. It will of course be understood that on the one hand, the clearance must be great enough to insure against mechanically contacting the still molten coating carried upward by the wire. On the other hand, too great a clearance about the coated strand will make it difficult to maintain sufficient pressure in the chamber as described hereinafter.

Air or other gas under pressure from a suitable supply is introduced into the plenum chamber just described by means of the connection **30,** the annular chamber **32,** and a plurality of radial ports **34** in the female portion **18.**

A cooling liquid medium will be supplied to the interior of the cylindrical portion **10** through the inlet fitting **38.** Adjacent its upper end, the cylindrical member **10** is provided with an overflow opening **40.**

It is believed that operation of the apparatus thus far described should be clear. Water or other suitable quenching medium is introduced into the cylindrical member **10** via the fitting **38.** Simultaneously, a supply of air under pressure via the fitting **30,** annular passage **32,** radial passages **34,** and the plenum chamber will be introduced into the lower end of the cylindrical member **10.** This air under pressure will support a column of water within the cylindrical portion **10.** Of course, the height of the water column may be adjusted by varying water supply and/or air pressure. If desired, the water can be continuously recirculated through the cylindrical portion **10** by adjusting the top of the column to be at or above the overflow opening **40.**

At the top of the cylindrical member **10** may be provided the guide structure indicated generally at **42.** This includes the spring loaded guide rollers **44** and **46.** It will be noted that the apertures **48** and **50** at the top and bottom, respectively, of the guide structure **42** are of sufficient size to permit the coated strand to pass with substantial clearance.

In the event the quench cooling liquid medium within the cylindrical portion **10** is not recirculated, a sight glass indicated generally at **52** may be provided so that the level of the water can be checked and monitored.

An exemplary embodiment of the invention which has been utilized successfully in the quench cooling of aluminum coated wire gauge sizes from **12** to **4** included a cylindrical member **10** having an inside diameter of approximately two inches. The inside diameter of the internal bore **28** was approximately one-half inch. Air at a pressure of 6 psi was supplied to the fitting **30,** and was sufficient to support a water column 15 inches high.

It will be apparent that many modifications can be made without departing from the scope and spirit of the invention. Accordingly, no limitations are intended except as specifically set forth in the claims which follow.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Apparatus for liquid quench cooling a heated strand moving in a vertical path of travel comprising:

a. a chamber having aligned top and bottom openings through which said strand passes with substantial clearance in a linear, vertical path of travel;

b. a supply of gas under pressure;

c. means for introducing said gas under pressure into said chamber adjacent the bottom thereof;

d. a supply of cooling liquid; and

e. means for introducing said cooling liquid into said chamber above said gas under pressure, whereby said gas under pressure is effective to support a liquid column in said chamber through which said strand passes.

2. The apparatus claimed in claim **1** including a nozzle structure associated with said bottom opening in said chamber, said means for introducing gas under pressure into the chamber communicating with said nozzle structure.

3. The apparatus claimed in claim **2** wherein said nozzle structure is arranged to direct said gas under pressure upwardly around said strand.

4. The apparatus claimed in claim **2** wherein said nozzle structure includes a female member having a central bore; and a male member received in said female member and having a central opening for the passage of said strand, the end portion at least of said male member being of reduced diameter to form an annular opening, said annular opening being in communication with said supply of gas under pressure.

5. The apparatus claimed in claim 4 wherein the upper end of said central bore in said female member is conical, and wherein the upper end of said male member is similarly configured and spaced therefrom to define said annular opening for directing said gas under pressure upwardly at said strand passing therethrough.

6. The apparatus claimed in claim 1 including means for recirculating said cooling liquid.

7. Apparatus for liquid quench cooling a heated strand moving in a vertical path of travel comprising:

a. vertical wall means for confining a supply of cooling liquid in a vertical column; and

b. a bottom structure secured to said vertical wall means; said bottom structure having

i. an aperture for the passage of said strand therethrough, and

ii. nozzle means for introducing gas under pressure into said vertical wall means above said bottom structure whereby to support said vertical column of cooling liquid.

8. The apparatus claimed in claim 7 wherein said nozzle means includes an annular opening surrounding said aperture.

9. The apparatus claimed in claim 7 including means for introducing said cooling liquid into said vertical wall means, said last mentioned means being disposed above said bottom structure.

10. The apparatus claimed in claim 7 including means for determining the height of said column within said vertical wall means.

11. The apparatus claimed in claim 7 wherein said heated strand includes a molten coating.

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