Jan. 19, 1960 F. E. DAVIS 2,921,488

METHOD AND APPARATUS FOR COOLING MILL ROLLS

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FIG. 1.

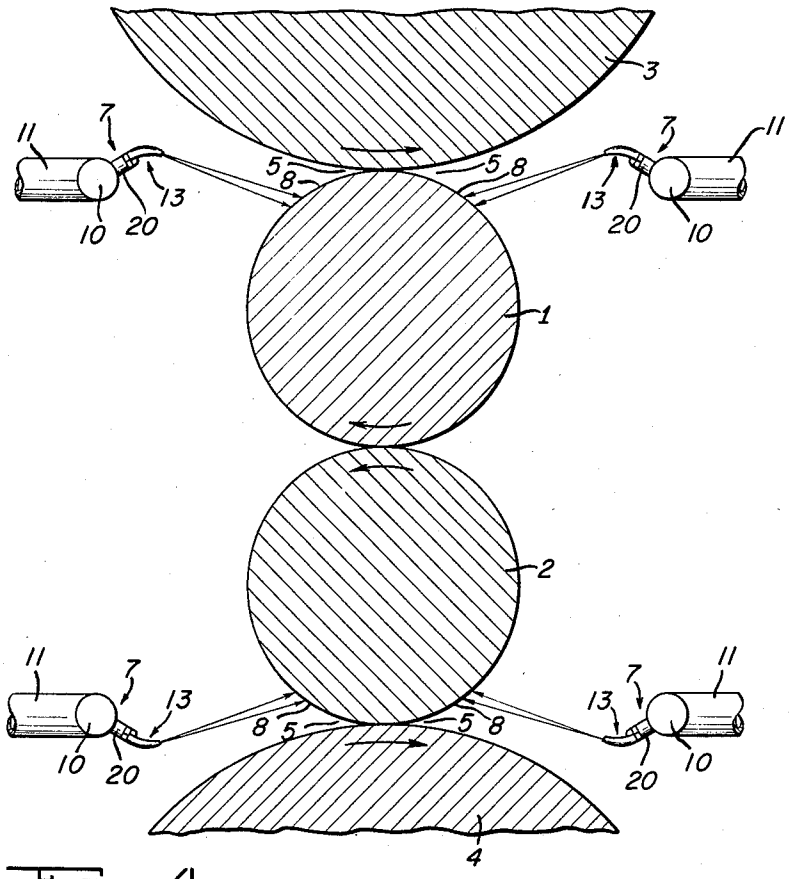


FIG. 4.

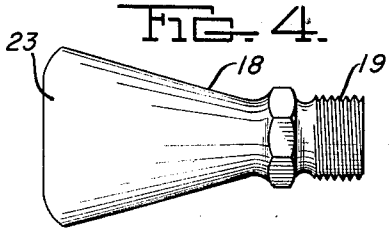


FIG. 6.

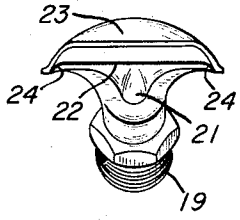


FIG. 3.

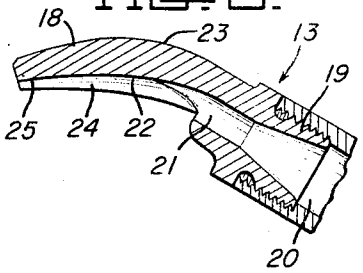
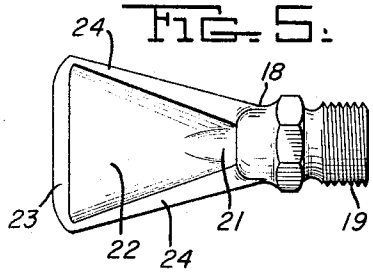


FIG. 5.



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FIG. 2.

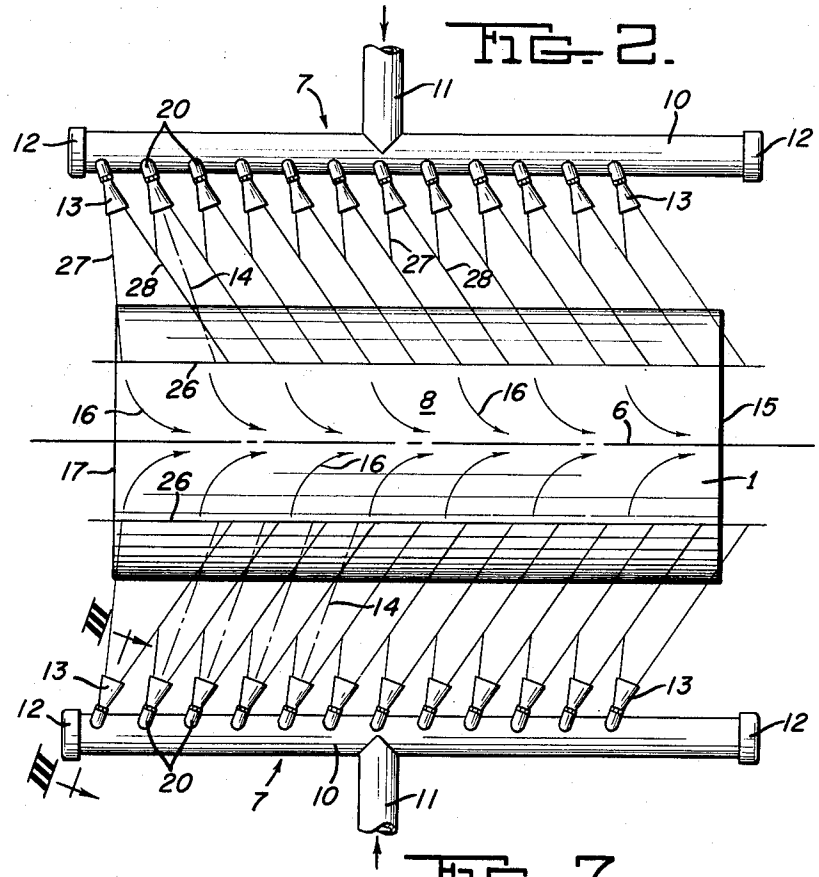
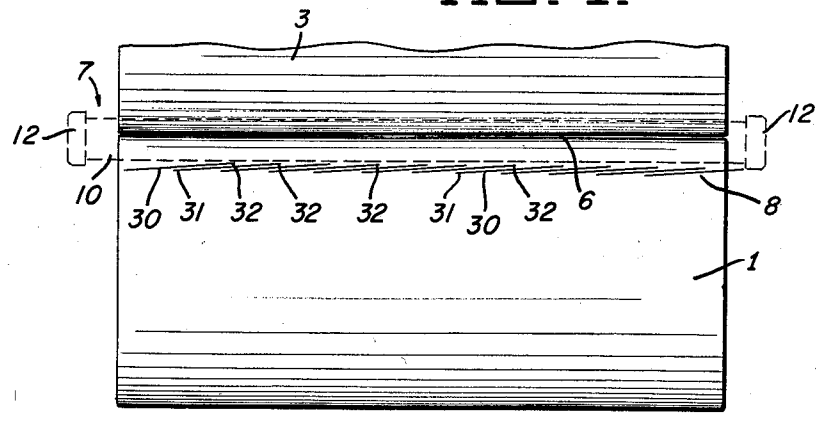


FIG. 7.



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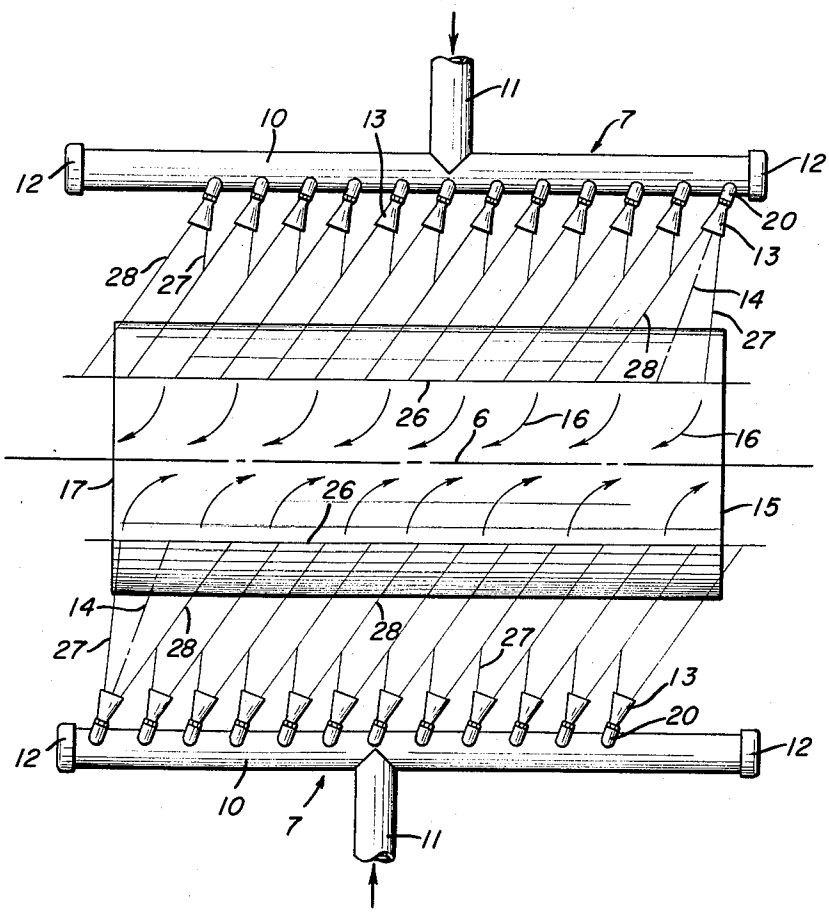
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METHOD AND APPARATUS FOR COOLING MILL ROLLS

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FIG. 8.



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METHOD AND APPARATUS FOR COOLING MILL ROLLS

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Application November 23, 1955, Serial No. 548,636

8 Claims. (Cl. 80—41)

This invention relates to an improved method and apparatus for cooling the work rolls in sheet and plate rolling mills. In a manner to be described, the improvements of this invention are directed to the ends among others of obtaining more efficient cooling of the work rolls and, in the case of upper work roll and more particularly the upper work roll of a 4-high mill, of preventing undesirable cooling of the strip or plate being rolled by excessive spillage of cooling water thereon.

In both hot and cold rolling mills, the work rolls must be cooled to prevent excessive heating which might otherwise result in spalling and cracking of the roll surface or in adherence of scale thereto. For this purpose, the surfaces of the work rolls are literally flooded with cooling water to take up the heat imparted thereto by the working operation and by the metal in hot rolling. Conventionally, this is accomplished by spraying water on the surface of the work rolls from a plurality of nozzles arranged at uniform intervals along the length of each roll. The nozzles are fed water from a common supply conduit in the form of a manifold or header pipe parallel to the axis of the roll being cooled and to which the nozzles are connected in such manner that the axes of the spray jets emerging from the nozzles are normal to the axis of their supply conduit. With nozzle arrangements of this character, the water upon striking the roll surface splashes in all directions and much of it has only momentary contact with the roll surface thereby imparting a minimum of cooling action thereto. In the case of the upper work roll, the water flows downwardly onto the strip or plate being rolled which is cooled unevenly. The uneven cooling of the strip or plate produces a variation in grain structure transversely thereof which is detrimental in the finished product and interferes with uniform working of the strip being rolled. When the flow of water onto the strip is unrestrained, it will usually flow off one edge and thereby cool and harden such one edge more than the other. Since the metal in the cooled and hardened edge will resist reduction by rolling to a greater extent than its other edge, the strip will have a thickness which tapers in a transverse direction. Tightening of the roll to exert a greater force against the cooled edge in an effort to prevent rolling a section with a transverse taper of this character may result in occasional roll neck breakage.

One of the principal objects of this invention is to provide an improved method of and apparatus for cooling rolling mill rolls according to which greater cooling efficiency and more uniform cooling is produced by retaining the cooling water in contact with the roll surface for a longer period of time as compared to conventional cooling practices.

Another object of the invention is to effect cooling of a rolling mill roll by causing a stream of water to flow in an axial direction over its working surface.

Still other objects of the invention are to produce a cooling stream of the character referred to which increases in size from one end to the other of a roll being cooled and to replace the water in the stream by projecting jets of water against the roll at uniformly spaced intervals along its length.

A further object of the invention is to provide a roll cooling apparatus and method which in the case of the upper work roll will prevent spillage of the cooling water on the work without the necessity of employing scrapers in the nature of doctor blades in engagement with the surface of the roll or other forms of control devices for directing the downward flow of water away from the work being rolled.

These and other objects of the invention will be more apparent from the following description.

In the drawings there is shown a preferred embodiment of the invention. In this showing:

Figure 1 is an end elevational view showing the application of the method and apparatus of this invention to a 4-high rolling mill in which the work rolls and their respective back-up rolls are illustrated diagrammatically and in vertical section;

Figure 2 is a plan view of the upper work roll and cooling apparatus therefor shown in Figure 1;

Figure 3 is a sectional view of one of the cooling spray nozzles taken along the line III—III of Figure 2;

Figures 4 and 5 are respectively top and bottom plan views of the nozzle shown in Figure 3;

Figure 6 is an end view looking from the left of Figure 4;

Figure 7 is a fragmentary side elevational view of the upper portion of the top work and back-up rolls shown in Figure 1 and on which the pattern of the spray contact therewith has been drawn for explanatory purposes; and

Figure 8 is a view similar to Figure 2 showing a modified form of apparatus.

As indicated above, the method and apparatus of this invention are particularly adapted to the cooling of the upper work roll of a 4-high mill of the type shown somewhat diagrammatically in Figure 1. In this showing, the numerals 1 and 2 respectively designate the upper and lower work rolls and the numerals 3 and 4 designate the back-up rolls in rolling engagement therewith. Each of the rolls has a conventional mounting in a mill stand housing (not shown) and the rolls 1 and 2 define a working pass between which strip or plate is rolled from right to left as viewed in Figure 1 upon rotation in the direction indicated by the arrows. The surfaces of the upper set of rolls 1 and 3 define a pair of troughs 5 which are essentially V-shaped and which face outwardly in opposite directions from their line of rolling contact which is designated in Figure 2 by the numeral 6. The lower set of rolls 2 and 4 similarly defines a pair of V-shaped troughs 5 facing outwardly from their line of rolling contact. Identical spray assemblies, respectively designated as a whole by the numeral 7 are provided for spraying each work roll surface 8 which forms one side of a trough 5.

As best shown in Figures 2 and 8, each spray assembly 7 comprises a header or manifold pipe 10 which has a water supply connection 11 at its center and closure caps 12 at its ends. Each of the pipes 10 is mounted in a position opposite one of the troughs 5 with its axis parallel to the roll axes and has brackets (not shown) at its ends by which it is supported in a conventional manner on the mill stand housing. A plurality of nozzle assemblies, respectively designated as a whole by the numeral 13, are provided at uniform intervals along the length of each pipe 10.

The conduits 10 supply water to the nozzle assemblies 13 which respectively project a flat fan-shaped jet of water against a trough surface 8 in the direction shown in Figure

1. As best shown in Figure 2, the axis 14 of each nozzle assembly 13 forms an acute angle, preferably 70°, with the axis of the water supply conduit 10 and is thus angularly inclined toward the end 15 of the roll 1. When the jets of water strike the working roll surface 8 as viewed in Figure 1, the water is deflected and moves inwardly over the working roll surface 8. By reason of the angular inclination of the nozzle assemblies 13 toward the roll end 15 as shown in Figure 2, the water from each jet moves in the direction indicated by the arrows 16 and in a direction axially of the roll 1 toward its end 15. While the axial force produced by each of the jets adjacent the roll end 17 is insufficient to carry the water from such jet to the end 15 of the roll 1 and would otherwise gravitate downwardly over the surface 8 of the roll after its axial force was overcome, each succeeding jet forces the water from a preceding jet inwardly into the trough 5 and moves it with a boosting action toward the end 15. In this manner, streams of water are produced in each trough 5 which flow from the roll end 17 to the roll end 15 and are discharged from the work roll surface at the end 15. Due to the accumulating effect of the water from the nozzles 13, such streams have a size which progressively increases in the direction of stream flow from the roll end 17 to the roll end 15, the water in the streams being continuously replaced by the water from the nozzle assemblies 13 at uniformly spaced interval along its length.

As best shown in Figures 3 through 6 each of the assemblies 13 comprises a nozzle 18 having a threaded inner end 19 which has threaded engagement in the outer end of a supply tube 20. As shown in Figures 2 and 8, each of the supply tubes 20 has an integral connection with a supply conduit 10. The inner end of each nozzle has a concentric and axially extending orifice 21 through which a circular jet of water is projected against the undersurface 22 of a deflector and attenuating hood 23 at the nozzle outer end. The hood 23 has a fan shape, as best shown in Figures 4 and 5, and depending flanges 24 along its edges. The flanges 24 diverge angularly outwardly with respect to the orifice 21 and define the side edges of the surface 22. The circular jets of water from the orifice 21 are flattened and spread over the surface 22 with an attenuating action so that they are projected therefrom in a direction tangential to the curved outer end 25 of the surface 22 in the form of a flattened and fan-shaped jet. The specific structure of the nozzles 18 is conventional.

Referring to Figure 1, it will be noted that the nozzle connecting tubes 20 are inclined vertically at an angle of approximately 30° with respect to the axis of the water supply tubes 10. The water jets moving at this angle through the nozzle orifices 21 are flattened and directed in an opposite vertical direction by the nozzle hoods 23 so that the fan-shaped jets projected therefrom are directed toward the working roll surfaces 8. The mounting of the supply conduits 10 and the angular connection of the supply tubes 20 therewith are designed in such manner that the jets of water strike the surfaces 8 along an axially extending line 26 (see Figures 2 and 8). It has been found that the best results are obtained by having the jets impinge along a line 26 which is spaced below the line of rolling contact 6 a distance not greater than ⅛ of the diameter of the work rolls.

In Figures 2 and 8, the lines 27 and 28 indicate diagrammatically the edges of the water jets which are projected from the nozzles 13, the up-stream edge of each jet being indicated by a line 27 and the down-stream edge of each jet being indicated by a line 28. The angular inclination of the nozzle axes 14 is such that the up-stream jet edges 27 extend in a direction normal to the axis of the work rolls as viewed in Figure 2 and the down-stream edges 28 have a greater angular inclination toward the end of the roll 15 than the axes 14. In addition, it will be noted that the spacing of the nozzle assemblies 13 is such that the jets have an overlapping relation along the lines of impingement 26 as viewed in Figures 2 and 8. This overlapping relation is shown in Figure 7 wherein the intersection of each water jet with a roll surface 8 is indicated by a line 30 on the roll surface 8. The nozzles 18 are preferably rotated to a position in their tubular supports 20 so that each spray contact line 30 has an angular inclination of approximately 4°, as illustrated, with respect to a horizontal plane containing the axis of the supply conduit 10, the contour and relative position of which in Figure 7 is shown in dotted lines. By reason of this arrangement, the up-stream end 31 of each spray contact line 30 subsequent to the first is positioned under the center of the spray contact line 30 of a preceding jet and the down-stream end 32 is positioned over the center of a following spray contact line 30. While the water striking at the points 31 has no down-stream component, such water will be deflected inwardly into the trough 5 and be intermingled with and moved downstream by the water from a preceding jet. This arrangement has been found effective to retain in the troughs 5 substantially all of the water projected from the nozzles 13 without back spillage onto the surface of the metal sheets or plates being rolled in the case of the upper work roll 1 and to move all of such water in the form of a stream axially through the troughs 5 to the roll end 15 where it is discharged. In this manner, the water from the nozzles 18 is merged in streams which flow axially through the troughs 5 and over the work roll surfaces 8 thereby subjecting such surfaces to the maximum cooling action.

As will be apparent from Figure 1, the spray assemblies 7 for the lower work roll 2 occupy an inverted position relative to those for the upper work roll 1. In connection with the lower set of assemblies 7, it will be understood that the water will not flow through the troughs 5 in the same manner described in connection with the showings for the upper work roll 1 in Figures 2 and 8. In the case of the lower roll 2, there will be some back spillage of water in a direction downwardly over the back-up roll 5 but this will not be detrimental in that such water will not contact the work being rolled.

In the showing of Figure 2, it will be noted that the flow of water from each of the assemblies 7, as designated by the arrows 16, is in the same axial direction toward the roll end 15. This arrangement subjects the portion of the roll 1 adjacent its end 15 to the cooling action of a relatively greater quantity of water than its other end. To provide more uniform cooling, the assemblies 7 may be constructed as shown in Figure 8. In this showing, the nozzles 13 on the assemblies 7 are inclined in opposite angular directions so that the streams of cooling water formed thereby will flow in opposite axial directions. One stream will be discharged at the roll end 17 instead of both being discharged at the roll end 15 as in Figure 2. With this modification, each portion of the roll surface will be subjected to substantially the same quantity of cooling water and a more uniform cooling action will be had.

From the foregoing, it will be apparent that this invention provides for water cooling of a work roll by flowing a stream of water in an axial direction over its work surface. In this manner, the cooling water is retained in contact with the roll surface for longer periods of time as compared to conventional cooling practices and a more efficient cooling action is had. Attention is particularly directed to the fact that the water in each stream is continuously replaced by jets of water from nozzles 13 at uniform intervals along its length and that the stream, as a consequence, has a size which increases progressively in the direction of its flow. Attention is also directed to the fact that the force components causing axial stream flow of the cooling water are produced by inclining the nozzles 13 in the direction in which axial flow is desired.

While the above describes a preferred embodiment of

the invention as applied to the work rolls of a 4-high mill and particularly to the upper work roll thereof, it will be understood that the principles of the invention are applicable to other types of rolling mills and that such adaptations and modifications are contemplated and may be made without departing from the scope of the following claims.

I claim:

1. In a method of cooling a roll in a rolling mill wherein it forms one side of a V-shaped trough along its line of rolling contact with a back-up roll therefor, the steps which comprise projecting plural jets of water into said trough from a plurality of points at uniformly spaced intervals along its length, collecting the water from said jets into an elongated body having a progressively increasing size from one end to the other of said trough, moving said body in an axial direction over said one trough side toward said other trough end, and discharging said body from said other end, said jets being projected into said trough in a direction with their axes inclined angularly in a direction toward said other trough end.

2. A method as defined in claim 1 characterized by each of said jets having a flattened fan-shape and impinging against said one trough side in overlapping relation with the downstream edge of each jet positioned above the upstream edge of an adjacent jet.

3. A rolling-mill cooling apparatus comprising, in combination with a pair of rolls in rolling contact with each other and forming a V-shaped trough along their said line of rolling contact, of means for forming and moving a stream of water in an axial direction through said trough comprising a water supply conduit spaced outwardly from said trough and arranged parallel to the axes of said rolls, a plurality of nozzles having connections with said conduit at uniformly spaced intervals along its length and respectively having attenuating deflector hoods for delivering flattened fan-shaped jets of water against the side of said trough defined by one of said rolls, said nozzles being angularly inclined toward one end of said trough and arranged relative to each other and said rolls in such manner that said jets impinge against said trough side in overlapping relationship and with the line of intersection of each fan-shaped jet with said trough side inclined relative to said line of rolling contact whereby the downstream end thereof, which is adjacent said one trough end, lies over an opposite and upstream end of the line of intersection formed by an adjacent jet.

4. An apparatus for cooling the upper work roll of a rolling mill comprising, the combination with said work roll and a back-up roll therefor which form a V-shaped trough along their line of rolling contact, of means for forming and moving a stream of cooling water through said trough in an axial direction and over the surface of said work roll comprising, a water supply conduit spaced outwardly from said trough and arranged parallel to the axes of said rolls, and a plurality of nozzles connected with said conduit at spaced intervals along its length for delivering jets of water against the side of said trough defined by said upper work roll, each of said nozzles having an angular inclination in a direction axially of said rolls and toward one end of said trough, whereby the water in said jets forms a stream increasing progressively in size and flowing toward said one end.

5. A work roll cooling apparatus as defined in claim 4 characterized by the said angular inclination of each of said nozzles being such that its axis forms an angle of substantially 70° with the axis of said water supply conduit.

6. A work roll cooling apparatus as defined in claim 5 characterized by each of said nozzles having a deflector and attenuating hood for forming said jets into flattened fan-shapes, and for training the direction of their movement so that they respectively intersect with the surface of said work roll along a line extending substantially axially thereof.

7. A work roll cooling apparatus as defined in claim 6 characterized by said lines of intersection of said fan-shaped jets with said work roll surface having an overlapping relation with the end of each line in the direction of flow of said stream being positioned above an opposite and upstream end of an adjacent and downstream line.

8. A rolling mill cooling apparatus comprising, in combination with a pair of rolls in rolling contact with each other and forming a V-shaped trough along their said line of rolling contact, of means for forming and moving a stream of cooling water in an axial direction through said trough comprising a water supply conduit spaced outwardly from said trough and arranged parallel to the axes of said rolls, and a plurality of nozzles connected with said conduit at spaced intervals along its length for delivering jets of water against a side of said trough defined by one of said rolls, each of said nozzles having an angular inclination in a direction axially of said rolls and toward one end of said trough, whereby the water in said jets forms a stream increasing progressively in size and flowing toward said one end.

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