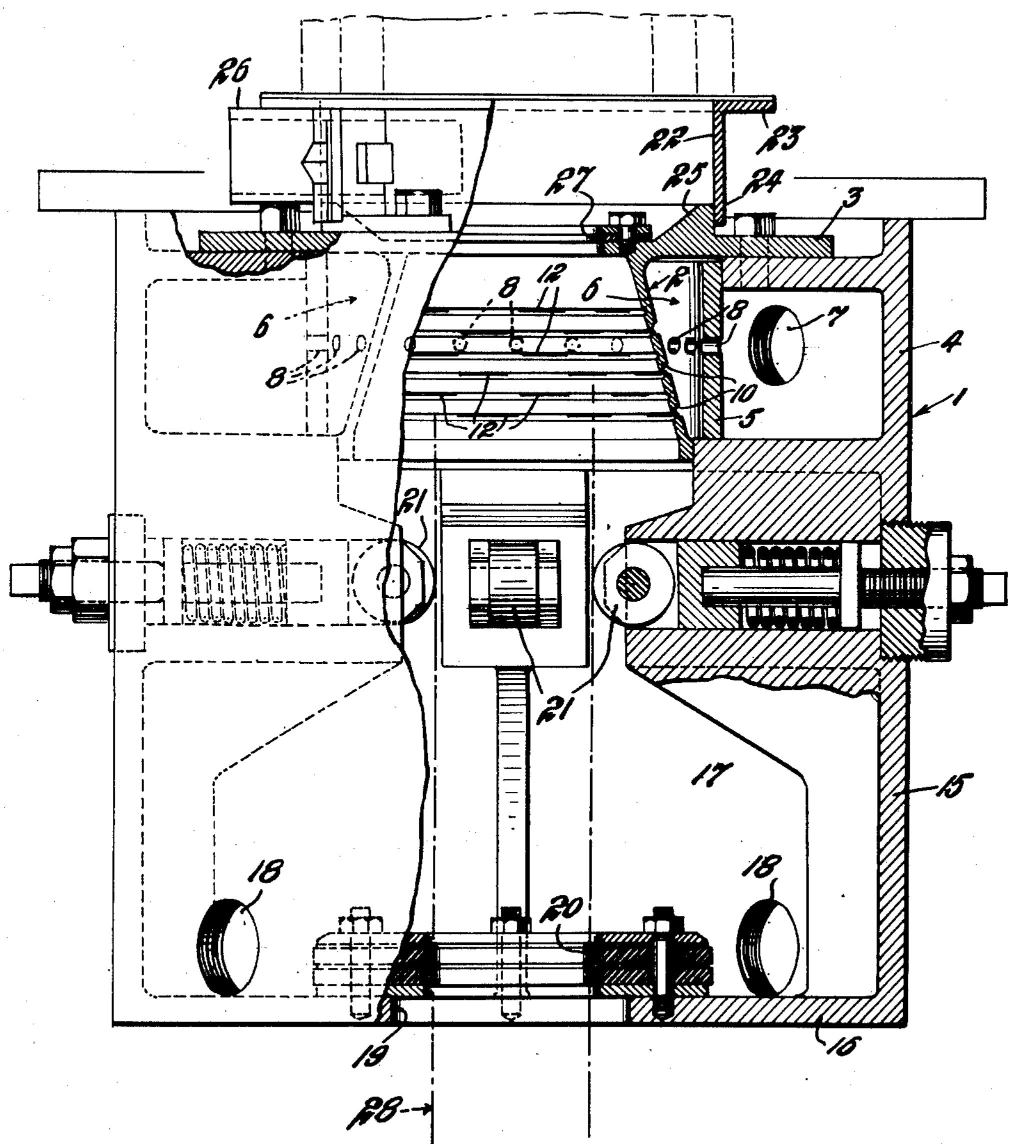
Dec. 30, 1952 R. H. WADDINGTON ET AL 2,623,531

SPRAY COOLING DEVICE

Filed Oct. 2, 1948 2 SHEETS—SHEET 1

Fig. 1.



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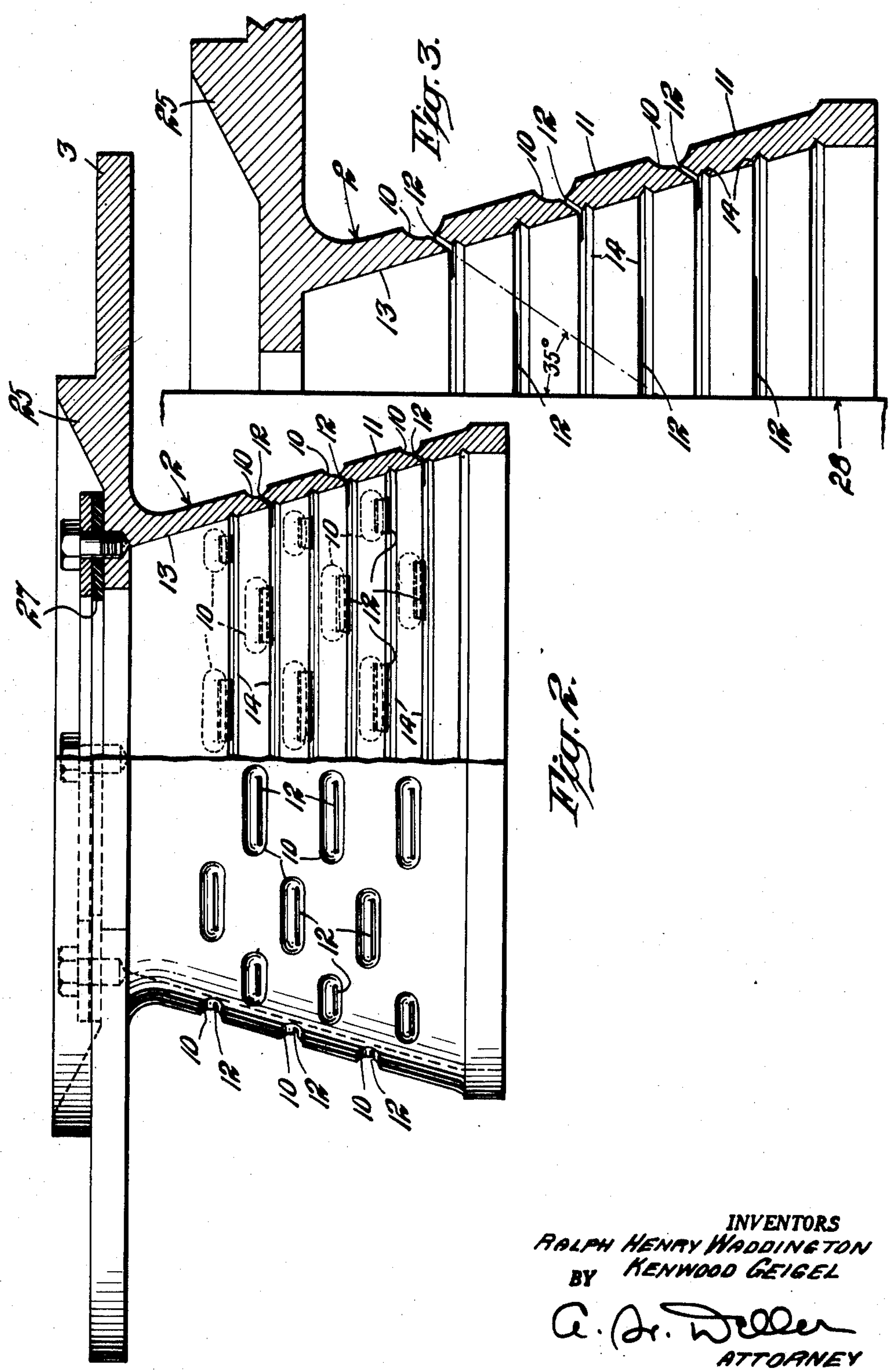

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SPRAY COOLING DEVICE

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The present invention relates to an improved jet cooling device adapted for the cooling of progressively moving hot metal ingots, bars or shapes, such as those produced in casting machines wherein continuous castings of metals or alloys are formed by solidifying and progressively discharging from a cooling and forming mold, especially one having vertically split sections which are vibrated transverse to the movement of hot metal.

A substantial advance in the art of continuously casting metals has been attained by the use of a vibrating, vertically-split mold in which molten metal is poured into the top of the mold and the ingot formed is continuously and progressively withdrawn from the bottom of the mold cavity. The rate at which the molten metal may be poured into the mold, however, is necessarily limited by the rate of withdrawal of the finished ingot and the rate of withdrawal of the finished ingot is in turn limited by the rate at which the ingot solidifies and cools.

We have discovered that cooling of an ingot emerging from a mold cavity is considerably improved when such cooling is effected by a plurality of downwardly-directed, radially converging bands or streams of water or other cooling medium applied against the surface of the emerging ingot bar or shape with sufficient pressure to break the steam film on the cast bar, and our invention includes the provision of a jet cooling device for producing such a plurality of bands.

It is an object of the present invention to provide a cooling device for directing a plurality of jets of cooling fluid against the surface of an ingot emerging from a continuous casting machine.

Another object of the present invention is to provide such a device in which the jets are in the form of flat, shallow streams or bands and directed inwardly and angularly against the ingot in the general direction of its movement.

A further object is to provide a cooling device by means of which the flat, shallow streams or bands are applied to the surface of the ingot with considerable velocity.

Other objects and advantages of the invention will become apparent from the following description taken in conjunction with the drawings, in which:

Fig. 1 illustrates a side elevational view, partly in section of the cooling device embodying the present invention assembled on the ingot withdrawal end of a continuous casting machine;

Fig. 2 is a more detailed elevational view,

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partly in section, of the spraying device embodying the present invention;

Fig. 3 depicts an enlarged vertical sectional view of one wall of the jet cooling device embodying the present invention showing the jet slot details.

Generally speaking, the jet cooling device embodying the present invention is particularly adapted for use with a continuous casting machine comprising an open-ended mold cavity, into the top end of which molten metal is introduced and wherein the finished casting is withdrawn from the lower end of the cavity at substantially the same rate as the rate of solidification of the molten metal.

In accordance with the present invention, an annular sleeve-like nozzle member, preferably in the form of a truncated cone provided with a plurality of elongated slots or openings through the walls thereof in circumferentially disposed rows, encircles the casting as it emerges from the die cavity. The openings or discharge ports are preferably vertically staggered in alternating rows and are preferably directed downwardly at a substantial angle in relation to the vertical sides of the emerging casting, preferably at an angle of about 35° to the axis of the emerging casting. Means are provided for passing water or other cooling medium through the discharge ports and onto the surfaces of the emerging casting and the total area of opening in the slots is preferably less than the total area of opening in the pipe or other conduit through which the cooling medium is supplied, thereby imparting an appreciable velocity to the plurality of flat shallow streams or bands of cooling fluid as they impinge on the emerging casting. As a result of the staggered vertical disposition of the slots, all of the surfaces of the emerging casting are effectively sprayed and cooled.

Referring now to Fig. 1, the jet cooling device embodying the present invention is arranged in an assembly designated by the reference character 1 and consists of the slotted annular ring or discharge nozzle 2 supported by the flange 3 on an outer cooling fluid chamber member 4, the inner wall 5 of which forms, with the annular ring 2, an inner fluid chamber 6. Water or other appropriate cooling fluid is supplied under pressure to the cooling fluid ring 4 by any appropriate means, such as a standard water pipe inlet 7 of 1½" diameter. The inner wall 5 is provided with a plurality of apertures 8 through which transfer of the cooling medium from within the chamber member 4 to inner fluid chamber 6 takes place. As will be understood, the inner wall 5 may be omitted, in which case the annular ring 2 would become the inner wall of the then undivided fluid chamber. The nozzle ring 2 is formed with a plurality of circumferentially arranged rows of elongated passages or slots 12, the slots in alternate rows being vertically staggered in relation to each other. The arrangement and details of the slots may be more clearly seen in Figs. 2 and 3, in which it will be seen that each of the elongated passages consists of an outer circumferential channel or groove 10 in the exterior of wall 11 of the annular ring 2, and an elongated slot 12 passing from the base of the channel 10 and opening through the inner wall 13 of the ring 2. The slot is preferably directed downwardly at a relatively sharp angle, for example, at 50° to the inner wall 13 of annular ring 2, as shown in Fig. 3. Since the angle of inclination of the wall of ring 2 may be varied within somewhat wide limits, the angle of inclination of the slots 12 is desirably determined with relation to the longitudinal axis of the emerging casting and, as stated hereinbefore, this angle is preferably about 35°. As may be seen in Fig. 2, the slots 12 are preferably in the form of a long, relatively narrow opening, for example, 1¼" long by $\frac{1}{32}$" wide, but in any case the dimensions and the number of such openings are such, as stated hereinbefore, that the total area of slot opening is less than the total area of opening in the cooling medium inlet 7 and it is preferred that the total area of slot opening be about 10% less than the area in the cooling medium inlet. The lower extremity or discharge of the port slot 12 on the inner wall 13 of ring 2 preferably communicates inwardly through a groove or recess 14 as seen in Fig. 3 so that the stream of cooling medium leaving the slot 12 is unimpeded as it emerges from the slot.

The annular ring 2 is preferably in the shape of a truncated cone as shown in the drawings. The preferred form of the ring 2 as a truncated cone is functionally advantageous in that it provides an increased space area for steam expansion and increased contact of the steam with the lower water jets for more effective condensation of the vapors.

The assembly 1 is provided with a lower annular wall 15 and a base 16 which together form a collection chamber 17 into which the water or other cooling medium is directed from the finished casting, and suitable drainage outlets 18 are provided through which the cooling medium is carried away. It is preferred that the total area of outlet provided in outlets 18 be considerably greater than the total area of the slots 12 so that there will be substantially no accumulation of water or other cooling medium in the chamber 17. A suitable opening 19 in the base 16 is provided through which the cooled casting passes in its continuous withdrawal from the casting machine and a gasket 20 of suitable contour is provided and forms a fluid-tight seal with the withdrawing casting 28. Intermediate the annular ring 2 and the collection chamber 17, suitable guide rolls 21 are provided. It has been found advantageous to place the guide rolls as close to the mold outlet as is possible, since by this arrangement the emerging casting 28 is maintained straight, and cracks due to bending of the casting are avoided. For convenience and efficiency of operation, therefore, the guide rolls are disposed within the assembly 1 as shown.

The assembly 1 may be joined with the die cavity outlet of the casting machine by any convenient means such as a flanged ring bolted to a similar ring on the casting machine. Preferably, however, a gas ring 22 is provided between the die cavity outlet and the assembly 1, this gas ring being provided with a flange 23 by means of which it may be attached to a similar flange (not shown) on the casting machine. Depending from the flange 23 and integral therewith is an annular leg 24 adapted to engage in gas-tight union with an annular lug 25 on the annular ring 2. The gas ring 22 is provided with a rectangular or otherwise suitably contoured channel member 26, integral with the leg 24 and extending radially therefrom, and a sight glass is fitted into this channel member. A gas inlet (not shown) is provided in the channel member 26 and a gas outlet (not shown) is provided on the opposite side of the gas ring 22. A reducing or other suitable gas is circulated within the gas ring 22 during operation of the casting machine. The upper end of annular ring 2 is provided with a gasket or seal 27 which, as shown, consists of an annular gasket, a gasket ring and a bolt or other retaining means. The gas ring, however, and the method for its assembly do not form a part of the present invention.

In operation, a dummy bar or starting plug is inserted into the die cavity from below and pouring of the molten metal into the die cavity is started. Starting of the withdrawal mechanism is proceeded with when the initially poured metal has solidified sufficiently to couple with the starting plug. With the starting of the withdrawal mechanism, water inlet 7 is opened and cooling fluid flows through the apertures 8 and thence through the elongated slots 12, or directly through these slots if inner wall 5 is dispensed with. Since, as stated hereinbefore, the total area of opening in the slots 12 is less than the total area of opening in the water inlet 7, the long, shallow streams or bands of water issuing from the inner wall of the slotted annular ring 2 will impinge with an appreciable velocity on the surface of the emerging casting.

Although the water jet cooling device of the present invention has been described with respect to a preferred embodiment thereof, it will be understood that various modifications and variations may be resorted to, as those skilled in the art will readily understand. Such modifications and variations are to be considered within the scope of the invention as described by the specification and defined by the appended claims.

We claim:

1. A device adapted for cooling a hot metal ingot, bar, shape or the like as it is progressed therethrough comprising a member provided with a chamber and a coolant intake opening thereto, said chamber member having an inner wall coaxial with and formed to encircle the shape in spaced relation thereto and formed with a plurality of vertically spaced rows of circumferentially spaced and elongated slots extending through the wall at an angle to the longitudinal axis of the shape and in the direction of its movement, the slots of the adjacent rows being in circumferentially staggered relation, and said inner wall being of truncated conical formation having its axis extended generally vertically and outwardly flared in the direction of movement of the shape as it is passed therethrough.

2. A device adapted for cooling a hot metal

ingot, bar, shape or the like as it is progressed therethrough comprising an annular member provided with a coolant chamber, said annular member having an inner wall coaxial with and formed to encircle the shape in spaced relation thereto and formed with a plurality of vertically spaced rows of circumferentially-spaced and elongated slots extending through the wall at an angle to the longitudinal axis of the shape and inclined in the direction of its movement, the slots of the adjacent rows being in circumferentially staggered relation, and said inner wall being of truncated conical formation having its axis extended generally vertically and outwardly flared in the direction of movement of the shape as it is passed therethrough, means for introducing a cooling fluid to the chamber under pressure and means disposed beneath the annular member for collecting and removing the coolant.

3. A device adapted for cooling a hot metal ingot, bar or shape as it progresses therethrough comprising an annular member provided with a chamber and a coolant intake opening and with an inner wall coaxial with and formed to encircle the shape in spaced relation thereto, said inner wall being formed with a plurality of vertically spaced rows of circumferentially spaced elongated slots extending therethrough at a downward angle to the longitudinal axis of said shape, the slots of the adjacent rows being in circumferentially staggered relation, the total area of opening in said slots being less than the total area of intake opening into the chamber so as to direct jets of the coolant to impinge on the surfaces of said shape at substantial velocity, said inner wall being of truncated conical formation having its axis extended generally vertically and outwardly flared in the direction of movement of the shape as it is passed therethrough, and means beneath the chamber member for collecting and removing of the coolant.

4. A device adapted for cooling a hot metal ingot, bar or shape as it progresses therethrough comprising an annular member provided with a chamber and a coolant intake opening and with an inner wall coaxial with and formed to encircle the shape in spaced relation thereto, said inner wall being formed with a plurality of vertically spaced rows of circumferentially spaced elongated slots extending therethrough at a downward angle of about 35° to the longitudinal axis of said shape and said slots of alternate rows being disposed in staggered relation, the total area of opening in said slots being less than the total area of intake opening into the chamber so as to direct jets of the coolant to directly impinge on the full surface area of said shape at substantial velocity, said inner wall being of truncated conical formation having its axis extended generally vertically and outwardly flared in the direction of movement of the shape as it is passed therethrough, and means beneath the chamber member for collecting and removing of the coolant.

5. A device adapted for the cooling of an ingot, bar, shape or the like emerging from a continuous casting machine, comprising an annular chamber member encircling the ingot and having an inner wall coaxial with and adjacent the ingot, means for passing a fluid cooling medium under pressure into said chamber member, said inner wall being formed with a plurality of vertically spaced rows of circumferentially spaced elongated slots extending through the wall at a downward angle of about 35° to the axis of the ingot to form jets of said cooling medium, the slots of the adjacent rows being in circumferentially staggered relation, the total area of openings in said slots being about 10% less than the total area of openings in said fluid passing means whereby the jets are projected at substantial velocity onto the surfaces of the ingot, said inner wall being of truncated conical formation having its axis extended generally vertically and outwardly flared in the direction of movement of the ingot as it is passed therethrough, and means beneath said channel member for collecting and removing the spent fluid of said jets.

6. A device adapted for cooling a hot vertically descending metal ingot, bar, shape or the like emerging from an auxiliary machine comprising an annular member coaxially encircling said shape, said member having an upper cooling medium circulating chamber portion provided with a cooling medium inlet thereto, a lower cooling medium disposal chamber portion having a cooling medium outlet therein of substantially greater capacity than said inlet, a plurality of rollers intermediate said chambers serving to maintain the axial alignment of said emerging shape, said upper chamber portion having an inner wall coaxial with and lying adjacent the sides of said emerging shape and formed with a plurality of vertically spaced rows of circumferentially spaced elongated slots extending through the wall at a downward angle of about 35° to the axis of said shape, the total area of openings in said slots being about 10% less than the total area of opening in said cooling medium inlet, the slots of the adjacent rows being in circumferentially staggered relation, said inner wall being of truncated conical formation having its axis extended generally vertically and outwardly flared in the direction of movement of the shape as it is passed therethrough, and means for supplying a cooling medium under pressure to said upper chamber through said inlet.

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