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APPARATUS AND METHOD FOR COOLING OR QUENCHING

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This invention relates to an apparatus for delivering a cooling or quenching medium in non-turbulent flow to the surface of a workpiece and for distributing the supply over the surface of the work, it is desired to cool.

When delivering the quenching medium, for instance in surface hardening processes, either for treating the entire surface at the same time or progressively, the prevention of soft spot formation is known to be a matter of the utmost importance. In this connection a large number of proposals have already been made, and even these proposals substantially consist in allowing the quenching medium to be delivered through a slot extending over the entire width of the work. Attempts have also been made by employing various angular dispositions to control the delivery of the liquid in such a manner that it will form an even film over the surface, and it was recognized that the selection of an appropriate angle is a matter of especial importance. However, if the liquid is fed to the slot through one or a plurality of pipes the desired result could not be achieved because the liquid tended to form a pronounced surge in the vicinity of the end of each delivery pipe. The distribution of the liquid along the length of the slot was not therefore sufficiently uniform. The surge causes a non-laminar flow in the film and this produces further irregularities.

To deal with this problem a distributing chamber was provided into which the liquid was discharged from the feed pipes, and the liquid was then delivered to the space immediately preceding the slot through a plurality of holes. However, the provision of such a distributing chamber does not by itself provide the necessary conditions for the creation of an evenly distributed laminar film of medium over the surface of the work, nor has it been previously recognized why this should be so.

On the face of the problem it might have been expected that if the chamber were made sufficiently large and the delivery openings were sufficiently evenly spaced the desired uniform distribution of the medium would be bound to result. However, experience has shown that this is not so, and that other factors also influence the result. Proposals have been made to use distributing chambers of comparatively large size, and to have the even distribution of the delivery openings, but it has not been realized that it is essential for the liquid inside the distributing chamber to be subjected essentially to static pressure and to rely on dynamic pressures between the chamber and the opening through which the medium is finally discharged without the creation of considerable static pressure in the liquid flowing from the chamber to the slot from which it emerges.

The present invention is based on the recognition of this condition, and the invention therefore proposes to construct the quenching apparatus in such a manner that the cross-sections of the flow channel between a preliminary chamber in which a practically exclusively static pressure is built up actually increase between the discharge opening from the chamber (inlet to the channel) and the delivery opening from which the liquid emerges from the channel on to the surface of the work. If this is the case the desired laminar film that will cling to the surface of the work and ensure the desired quenching effect, can be obtained. It is possible by increasing the volume of liquid delivered to the preliminary chamber to regulate the quantity of quenching medium within the required limits.

It is possible steadily to increase the cross section between the preliminary chamber and the slot. However, it is a considerable advantage if the flow sections are increased in discontinuous steps, a simple solution being to increase the flow sections of holes in the partition walls between one or more intermediate chambers. The features of the invention are applicable to any quenching devices with a delivery slot, irrespectively as to whether the device is intended for quenching flat surfaces, such as sheets and the like, or cylindrical bodies, in which case the slot must be of annular shape.

With reference to the accompanying drawing a ring-like form of construction including an annular slot and suitable for quenching cylindrical work will be hereinafter more particularly described as an illustrative example of the invention. The drawing shows a vertical section through the ring-shaped body of the apparatus. Arranged inside the hollow ring is a preliminary chamber 1 which receives the liquid from a pipe 2 of large cross-section. The preliminary chamber is created within the hollow body by the provision of a partition wall 3. Following chamber 1 is a further chamber 4 created by the above mentioned partition wall 3 and a further partition wall 5. The slot through which the medium emerges in the form of a funnel-shaped film on to the surface of the work, not shown, is indicated at 6.

The liquid flows from chamber 1 through the opening 7 into chamber 4 from where it passes through openings 8 into the chamber 9 which directly precedes the slot 6. According to the invention the flow sections are such that the total flow section through the openings 7 is the smallest section of the channel from chamber 1 to slot 6. The flow section offered by the openings 8 is greater than that of 7, but it is smaller than the flow section through the discharge opening at 6.

These comparative sections refer to the total cross section available for the passage of the liquid. It must be determined in each individual case whether it may be better to provide a small number of large section holes or a large number of correspondingly smaller section holes of circular or some other shape for the passage of the medium at 7 and 8. In view of the large cross-section 2 of the delivery pipe into the preliminary chamber and the small exit openings at 7 a substantially static pressure will be created inside this chamber. However, since the flow sections increase from the openings 7 to the slot 6 relatively to the flow section of opening 7, dynamic pressure rather than static pressure is produced in this part of the path of the medium which will not occur easily and without turbulence from the slot to form the desired film. The effect is the same if the slot is linear instead of an annulus, as would be required for treating flat work.

It will be readily understood that in certain circumstances the one chamber 4 may be replaced by several such chambers. However, as a general rule, one chamber should be sufficient.

The features of the present invention are directly opposed to the characteristic features of known devices which insist, at least in the region of the slot opening, on a reduction in the section of flow. Generally speaking, the flow paths provided in known apparatus tend to decrease between the actual supply and the final opening through which the medium is discharged on to the sur-
face of the work. The apparatus according to the invention which is somewhat schematically exemplified by the drawing, is particularly suited to the quenching of rolls, especially cold rolls, which have been inductively heated to the temperature incidental to hardening by the continuous progression method. The quenching device would be associated with the inductor and follow the same. However, there is no reason why an apparatus according to the invention should not be adapted to the quenching of such, and other types of work, when heating to the requisite temperature is achieved by means of burners.

What I claim is:

1. Apparatus for distributing a cooling medium over the surface of a workpiece to be cooled, comprising at least one annular preliminary chamber wherein the medium is adapted to be subjected to only substantially static pressure and an annular discharge channel comprising an inlet from said preliminary chamber constituted by at least one opening and a delivery opening for discharge of the cooling medium, said channel comprising at least three constrictions, the first of which forms the said inlet and the last of which forms the said delivery opening, each said constriction in the direction of the discharge flow being greater in flow section than the preceding constriction, and each pair of constrictions being separated by an enlargement of the channel.

2. Apparatus according to claim 1, comprising a chamber having a wall in which the delivery opening is situated, said chamber being divided by partitions into at least three compartments, each said partition having at least one flow-controlling opening, one compartment forming the said annular preliminary chamber and the other compartments comprising part of the said annular discharge channel, the opening in the partition which forms one wall of the preliminary chamber forming the said inlet and the compartment remoted from the said preliminary chamber having the said delivery opening and the openings in each partition permitting communication between the compartments on either side of it and the controlling flow area of the partition openings being greater from partition to partition in the direction of discharge but less than that of the delivery opening.

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