Oct. 1, 1968 A. F. EISEL 3,403,541

METHOD AND APPARATUS FOR COOLING WORKPIECES

Filed March 25, 1965 3 Sheets-Sheet 1

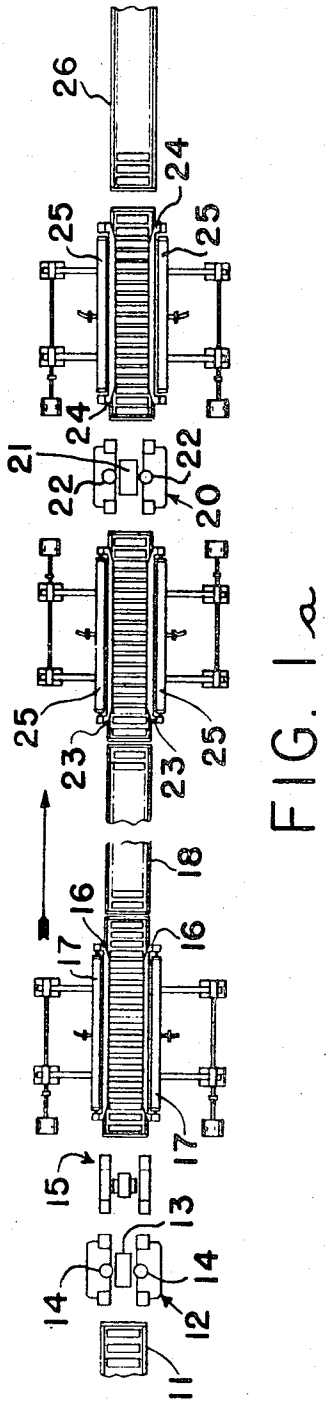


FIG. 1a

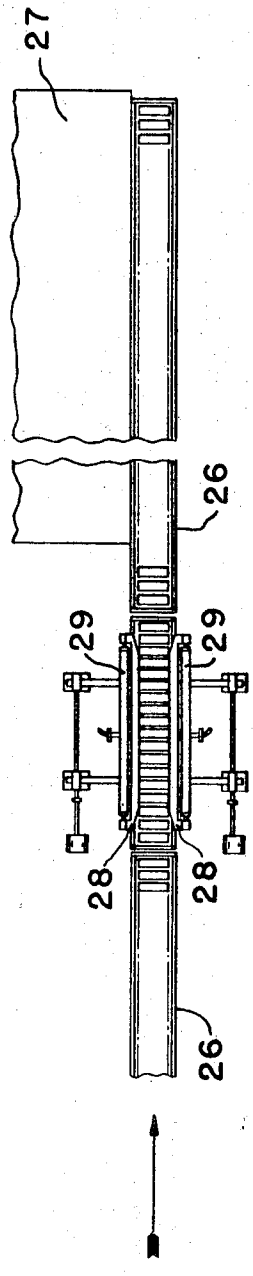


FIG. 1b

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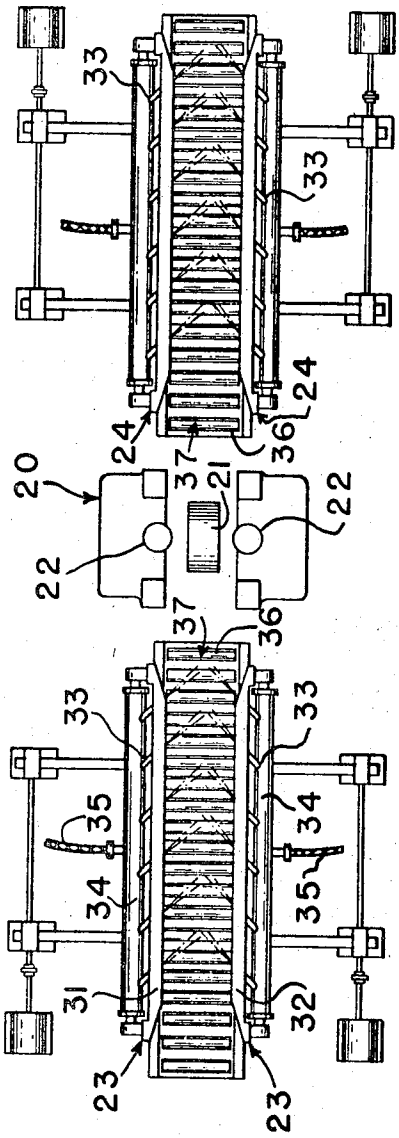


FIG. 2

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Filed March 25, 1965 3 Sheets-Sheet 3

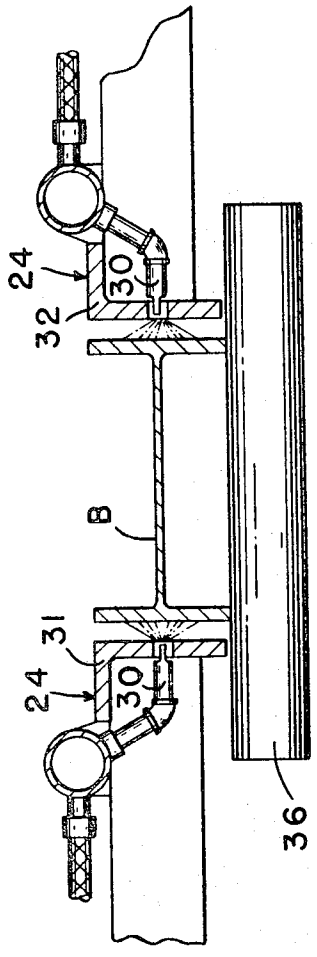


FIG. 3

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United States Patent Office 3,403,541 Patented Oct. 1, 1968

3,403,541

METHOD AND APPARATUS FOR COOLING WORKPIECES

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Filed Mar. 25, 1965, Ser. No. 442,640
Claims priority, application Great Britain, Apr. 22, 1964, 16,761/64
5 Claims. (Cl. 72—201)

ABSTRACT OF THE DISCLOSURE

This disclosure relates to a method and apparatus for use in connection with the manufacture of rolled sections, such as beams. It provides, as to its structure, a cooling device adapted to be mounted in the side guards provided for the rolling mill which cooling device includes a member for directing coolant towards the flange portion of the beam for cooling this thicker portion without substantially reducing the temperature of the thinner portion of the beam. The side guards are positionable relative to the beam so that the coolant can be trained on the workpiece and the non-uniform temperature between the different thickness portions of the beam reduced.

The present invention relates to a method of and apparatus for cooling workpieces during the rolling thereof and, more particularly, to the cooling of structural and other shaped workpieces, such as those now presently produced in a beam mill.

For the purpose of describing the invention, its use in conjunction with the production of wide flange beams has been selected, although as indicated above it may be employed in connection with the manufacture of other forms of workpieces. With reference to the rolling procedures for producing such beams, reference is made to the publication—The Making, Shaping and Treating of Steel, United States Steel, 7th edition, second impression, chapter 29, pages 532–539, inclusive, which contains a rather complete description of some of the more well-known procedures. In view of the general knowledge of prior and present procedures of producing beams, it is believed unnecessary to make reference to them, although particular reference will be made to the present method of cooling the workpieces after they have issued from the last mill stand.

The cooling of the beam is quite critical, as pointed out in the aforesaid publication, both with respect to obtaining the desired mechanical properties and in avoiding warping of the beams, particularly in cooling symmetrical shaped workpieces, such as wide flange beams. It is most important that the beam be allowed to cool uniformly. Presently, cooling is accomplished by the natural circulation of air about the workpieces as they are conveyed over a cooling bed. The rate of cooling is, to a very limited degree, adjustable by controlling the space between the beams as they pass over the bed.

As mentioned, it is extremely important in the production of high quality beams that the mechanical properties be uniform throughout the various components of the beam. Certain difficulties are encountered in the cooling of certain beams due to the difference in thickness that exists between certain sections of the beams, for example, in the area where the web of the beam meets with the flanges, in which there is considerably more metal in the flanges than in the web. This condition, even when the cooling procedure is carefully maintained, may result in objectionable results, not only in non-uniform properties but in structural weakness. This difficulty is greatly

worsened in the new type of beams now proposed to be rolled, wherein the web thickness is considerably smaller than that of flange thickness. In this case, in the cooling of the beam, high concentrations of stresses occur in the areas where the flanges meet the web which causes actual cracking and buckling of the web section.

With reference to what may be referred to as the lightest foot weight standard wide flange beams, the ratio between the flanges and web may be 1.33 or 1.60 to 1, while in the new type of beams, they may have a ratio of 2.5 to 1 or greater. Thus, it can be readily appreciated that during cooling of such beams under present practice, even if the temperature is controlled as carefully as possible, there is great danger of a high concentration of stresses in the area where the web is joined to the flanges resulting in cracking and buckling of the web.

Another problem brought about in the production of beams having a high ratio between the flanges and webs has reference to the fact that the thin webs lose considerably more heat during the rolling process than the thicker flanges, in which connection it is critically important that during the rolling procedure that not only is there maintained as much as possible a uniformity in temperature between the flanges and webs, but of equal importance that the web be prevented from losing too much of its heat prior to final reduction pass.

The present invention relates to a method of and apparatus for cooling workpieces, such as beams, during a rolling process wherein the thicker portion of the workpiece is subject to localized coolant in a manner so as not to cool the thinner portion of the workpiece.

With reference to the method, the present invention provides in a rolling mill a process for cooling a workpiece either after the last primary reduction step or prior to or after the final reduction step, wherein coolant is applied to the workpiece in a localized area against the thicker part thereof in a manner that the thinner part is not subject to the coolant.

With reference to the novel apparatus the invention provides, in a rolling mill arrangement, an apparatus for applying coolant to a workpiece, which may be either gas or liquid, against the thicker portion or portions of the workpiece which is so constructed and arranged that the coolant will not be applied to the thinner portion or portions of the workpiece.

In one form of the herein-disclosed method and apparatus, there is provided in combination with a wide flange beam mill workpiece restraining side guards, said guards carrying means for delivering a cooling media against the outside faces of the flanges of a beam in a manner that the cooling media will not be applied to the web thereof.

As will be more fully pointed out hereinafter, particularly with reference to a wide flange beam mill, the cooling can be applied either after the workpiece has been subjected to its final reduction in the roughing mill or before or after it passes through the finishing mill, in which in the latter mill only one reduction pass will be taken.

These advantages as well as others will be better appreciated when the following description is read along with the accompany drawings of which:

FIGURE 1*a* is the first part of a schematic plan view of a rolling mill arrangement for producing wide flange beams,

FIGURE 1*b* is the second part of a schematic plan view shown in FIGURE 1*a* showing, in particular, the cooling bed provided for receiving the workpiece from the rolling mill illustrated in FIGURE 1*a*,

FIGURE 2 is an enlarged view of the finishing mill shown in FIGURE 1*a*, and

FIGURE 3 is an enlarged view, partly in section, of the side guards illustrated in FIGURE 2.

With reference now to these figures and in referring first to FIGURE 1*a*, there is shown a roughing mill, including a mill entry table **11** which conveys a beam to a universal roughing mill **12** which, in part, consists of a pair of horozontal rolls **13** and a pair of vertical rolls **14**. On the delivery side of the universal roughing mill **12** there is provided a customary edging mill **15**. Following the edging mill **15** there is provided a pair of side guards **16** each of which, as will be more fully discussed hereinafter, is provided with cooling facilities **17** for cooling portions of the beams.

Following the side guard **16** there is a long table **18** which conveys the beams to a finishing mill which, as indicated, includes a universal finishing mill **20** consisting of a pair of horizontal rolls **21** and a pair of vertical rolls **22**. On either side of the universal finishing mill **20** there is arranged a pair of side guards **23** and **24**, which are constructed similar to the side guards **16** which, also, have cooling facilities **25** for cooling portions of the beams. Following the universal finishing mill **20**, as shown in FIGURES 1*a* and 1*b*, comes a runout table **26** which conveys the beam to a cooling bed **27**, it being noted that before the beams pass into the cooling bed **27** they pass between a pair of side guards **28** constructed similarly to the side guards **16**, **23** and **24** which also has cooling facilities **29**.

In the present mill arrangement the beams will be given a number of reduction passes in the universal roughing mill **12** and edger mill **15**, where the beam is reduced to almost its final shape, after which it is conveyed to the universal finishing mill **20** where a single and final reduction pass is taken.

With reference now to FIGURE 2 which is an enlarged view of the universal finishing mill **20** shown in FIGURE 1*a*, particular reference is made to the two pairs of side guards **23** and **24** provided on the entry and delivery side of the mill **20**, respectively. It is to be appreciated that the side guards are identical in construction and since they follow the usual practice, their details and the means for advancing and retracting them relative to the center line of the mill has not been shown. In referring only to the pair of side guards **23**, it consists of traversing heads **31** and **32**, both of which have vertical surfaces which are adapted to be brought into an adjacent position relative to the beams to maintain them relative to the rolls of the mill **20**. Within each head **31** and **32** there is provided a series of openings arranged on an angle into which pipes **33** are secured, the pipes being connected to a common header **34** mounted on and carried by each of the side guard heads **31** and **32**. Fluid, such as water, is delivered to the headers **34** by flexible hoses **35**. It will be appreciated that the cooling facilities of the side guards, i.e., **16**, **23**, **24** and **28**, are similarly constructed and, therefore, the other guards will not be specifically described.

With reference now to FIGURE 3, for the purpose of illustrating the feature of the invention more clearly, a wide flange beam B has been shown which, as indicated by its shape, represents the beam as it passes from the universal finishing mill **20**, hence, the pair of guards shown in FIGURE 3 are the guards **24** provided at the delivery side for the finishing mill **20**. Particular attention is addressed to the location of the cooling pipes **30** which, as shown in the drawing, are so located as to concentrate the liquid at the center of flanges of the beam B. In this manner the areas of the flanges most adjacent to the regions where the flanges and the web join are cooled independently of the web, thereby obtaining a more uniform thermal condition between the flanges and web in this particular region, but yet not reducing the thermal condition of the web. This, of course, will relieve the buildup of stresses otherwise resulting from non-uniform cooling in this area and permit the web to retain sufficient heat for rolling.

FIGURE 3 shows the beam being carried by a roller **36** which, for completeness, it will be noted that this roller is one of a series that go to make up the entry and delivery tables **37** of the mill **20**.

With reference again to FIGURES 1*a* and 1*b*, while in the preferred arrangement, the beams are cooled as they pass into and from the finishing mill **20**, wherein the central zone of the opposite sides of the flanges are subject to the cooling liquid, as previously mentioned, it may be also beneficial to apply coolant as the beam issues from the roughing mills **12** and **15**. In order to avoid cooling the flanges excessively the coolant may only be applied against the flanges after the last reduction pass is taken in the roughing mills. Also, in a given case, beneficial results can be obtained by applying fluid to the flanges just prior to the beams being advanced to the cooling bed **27** by employing the side guards **28**. In a given case the guards could be eliminated and the headers carried by a more simply constructed traversing mechanism.

As previously mentioned, in rolling wide flange beams, having a great ratio between the flanges and web, it is quite important to roll the beams in a manner that as much heat as possible is retaied in the thin webs. In this regard the present invention has particular advantage, since the application of the coolant, as previously noted, is done in such a manner that the webs are not contacted by the coolant. In a given case applying coolant on one or both of the sides of a finishing mill **20** may be sufficient. Depending upon the particular workpiece, however, and the other attendant circumstances, it may be advantageous to apply coolant to the flanges as it leaves the roughing mills **14** and **15** and before and after it enters the finishing mill **20**, along with additionally cooling the flanges prior to the beam passing to the cooling bed **27** or any combination of these.

In accordance with the provisions of the patent statutes, I have explained the principle and operation of my invention and have illustrated and described what I consider to represent the best embodiment thereof. However, I desire to have it understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. In a rolling mill plant having a pair of workpiece side guards between which a heated workpiece passes for positioning relative to a rolling mill for passage through the rolling mill plant, said workpiece being characterized by disproportionate portions that tend to set up detrimental stresses due to non-uniform cooling of said portions, a thicker portion constituting a flange portion of the workpiece, coolant discharge means including a member trained to direct coolant towards the flange portion of the workpiece for cooling the thicker portion without substantially reducing the temperature of a thinner portion, said guards being positionable relative to the workpiece whereby the coolants can be trained on the workpiece and the non-uniform temperature between the disproportionate portions of the workpiece may be reduced.

2. A rolling mill plant according to claim **1**, including a header for receiving coolant, a plurality of orifices in said header arranged to direct coolant to a said workpiece, said header being carried by said side guards.

3. A rolling mill plant according to claim **2**, including a universal beam mill adapted to roll the flanges and the web of a hot beam, said flange and web being subject to different degrees of reduction in thickness and possessing different heat radiation losses, a flange cooling apparatus arranged adjacent to one side of said mill so that a workpiece passes it during the rolling of the workpieces, means for furnishing coolant to said apparatus, means for training the coolant only against the flanges of the beams so as to cool the flanges and reduce the stresses between the flanges and webs, caused by the difference in temperature thereof.

4. In a method of producing a structural member from a heated workpiece, said structural member characterized by disproportionate portions in the form of a web portion joined by opposed flange portions, the flange portions being substantially thicker than the web portion, such that detrimental stresses tend to build up in the structural member due to the non-uniform cooling of the web and flange portions, comprising the steps in sequence of, first, rolling a heated workpiece to the approximate final shape of the structural member; second, cooling the thicker portions of the workpiece without substantially reducing the temperature of the thinner portion by the application of a coolant to the sides of the flanges opposite the web, thereby to reduce the non-uniform temperature between the disproportionate portions of the workpiece; and, third, rolling said heated workpiece to the final shape of the structural member.

5. In a method of producing a structural member from a heated workpiece, said structural member characterized by disproportionate portions in the form of a web portion joined by opposed flange portions, the flange portions being substantialy thicker than the web portion, such that detrimental stresses tend to build up in the structural member due to the non-uniform cooling of the web and flange portions, comprising the steps in sequence of, first, rolling a heated workpiece to the approximate final shape of a structural member; second, rolling said heated workpiece to the final shape of the structural member; and, third, cooling the thicker portions of the workpiece without substantialy reducing the temperature of the thinner portion by application of a coolant to the side of the flanges opposite the web, thereby to reduce the non-uniform temperature between the disproportionate portions of the workpiece.

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