APPARATUS FOR REDUCING THE WIDTH OF METALLIC SLABS

United States Patent

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ABSTRACT: Disclosed are two embodiments of apparatuses for performing work on metallic slabs to substantially reduce their width. In the first embodiment there is provided a pair of driven slab reducing rolls, each rotatably supported in a housing. The rolls are adjustably positioned relative to each other to reduce the slabs to a desired width. Concentrically carried on each roll are a pair of spaced anvil collars, one of which is adjustably positionable relative to the other to accommodate slabs of different thicknesses. In the second embodiment there is provided a pair of adjustably positionable slab squeezer heads, one of which is reciprocated relative to the other. Pairs of platens adjustably support and locate the slab in a direction normal to the movement of the reciprocating squeezer head.
1. APPARATUS FOR REDUCING THE WIDTH OF METALLIC SLABS

BACKGROUND OF THE INVENTION

The present invention relates to an apparatus for making large or substantial reductions in the width of metallic slabs to provide slabs having predetermined widths for further processing by rolling mills to produce billets, plates, strip, and the like. The invention is particularly useful in combination with a continuous casting machine.

In present-day steel plants a continuous casting machine may be employed to produce from molten metal a casting of certain cross-sectional dimensions and an undetermined length which is immediately cut into slabs of a desired length. The slab, at this point, may be subject to a conventional rolling operation well known in the art per se for any one of a number of purposes. The slabs are then transferred to some other location where they are prepared for further processing in a rolling mill to produce plate, strip, and like products. It is important to note that the width of a cast slab is a function of the continuous casting mold size and, therefore, it is necessary to employ a particular size mold to yield a desired slab width. Usually, a set of molds is made available to produce the various slab widths consistent with a desired dimension of the slab to be further processed in the rolling mills. The number of continuous casting molds making up a set—and there may be several mold sets—will vary according to various factors, but it is contemplated that as many as 20 molds per set may be required to cast slabs within given ranges of widths, e.g., 32 inches to 74 inches wide.

With reference now to the aforementioned rolling operation, immediately following the slab being cut to length, it is known in the art to employ edge rolling machines to do work on the width of the slab. However, when large or substantial reductions in the slab width are taken, there is a inherent tendency of the resulting slab to have a bulging or thickened portion adjacent each side where the reduction in width has taken place. The cross-sectional shape of such a slab has been described as dogbone-shaped or hourglass-shaped. One proposed solution to eliminate such an undesirably shaped slab is disclosed in U.S. Pat. Nos. 3,358,358 and 3,367,162. In both of these patents the proposed solution involves the use of tensioning the workpieces during rolling, which is not employed according to the present invention. While placing the workpieces under tension during the time when drastic reduction in width is carried out may give acceptable results, the additional massive and expensive equipment and substantial space it requires contributes materially to large capital expenses to employ this process.

It is an object of the present invention to provide an apparatus for making substantial reductions in the width of workpieces incident to further processing by a rolling mill. It is another object of the present invention to substantially reduce the number of molds for a continuous casting machine that would otherwise be required to produce cast workpieces within a predetermined range of widths.

It is a further object of the invention to provide an apparatus to substantially reduce the width of metallic slabs while aligning the work piece adjacent to and in a direction normal to the work piece engaging means, the constraining means being constructed and arranged to minimize local increases in workpiece thickness during reduction of the widths of the workpiece; and means for adjusting the relative distance between the constraining means.

DESCRIPTION OF THE DRAWINGS

These features and advantages, as well as others, will be better understood when the following description is read in light of the accompanying drawings, of which FIG. 1 is a plan view of a continuous casting installation incorporating the features of one embodiment of the present invention; FIG. 2 is a plan view of one of the slab edge rolling machines illustrated in FIG. 1 incorporating the features of the present invention; FIG. 3 is a sectional view taken along lines III-III of FIG. 2; FIG. 4 is a sectional elevational view of a slab squeezing machine which represents a second embodiment of the present invention; and FIG. 5 is a sectional view taken along lines V-V of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates a continuous casting line 10 which includes a continuous casting machine 11 constructed in a manner well-known in the art. One suitable form of such a machine is disclosed in U.S. Pat. No. 3,370,641, issued to the assignee of the present invention. It will be apparent to those skilled in the art that the casting machine and, particularly, the open-ended, fluid-cooled mold forming a part thereof will be constructed to produce a solidified casting having predetermined cross-sectional dimensions, for example, 74 inches wide and 12 inches thick. Such a casting is generally indicated by the numeral 12, the cross section of which is indicated by the numeral 12a, at a point along conveyor table 13 subsequent to being divided into the desired length by the shear 14. Also incorporated in the conveyor table are two tandemly arranged slab width reducing machines 15 and 16, each constructed according to the preferred embodiment of the present invention and employed to materially reduce the width of the cast slabs a predetermined amount such as is shown at 17 and in cross section at 17a. While two slab width reducing machines are illustrated, three or more machines may be arranged in tandem to reduce the width of the slabs to such an extent whereby further processing in a rolling mill will yield finished or seminished strip, plate, or the like having the desired width.

With reference to FIGS. 2 and 3, the slab reducing machines are each identically constructed and include a housing frame made up of spaced-apart parallel posts 18 and 19 horizontally supported by a foundation. Crossheads 21 and 22 interconnect the posts at their ends and serve to adjustably position roller assemblies 23 and 24, respectively, relative to each other. Each of the crossheads as shown in FIG. 3, includes a screw 25 having a threaded portion 25a received in a nut 26 that is secured against rotation in the crosshead. The screw 25 is caused to rotate by a worm wheel 27 in mesh with a worm 28 that is, in turn, connected to a motor, not shown. The roller assembly 24 illustrated in FIG. 3 is made up of a bearing chuck 31 engaged by one end of the screw 25 and slidably supported between the posts 18 and 19. An arbor 32 is rotatably carried by the chuck 31 and has a downwardly extending end to which there is connected a universal spindle 33. A drive 34 having bevel gears 35 and 36 transmits torque from the motor 37 to the spindle 33 and, hence, to the roller assembly 24.

Mounted on the upper end of the arbor 32 is a composite roller having two essential elements 38 and 39, each having threads 40 to permit adjustment of the latter relative to the former. The element 38 is formed with a slab edge engaging portion 41 and a slab constraining collar 42 which includes a
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hardened insert 42a. The element 39 has a slab constraining collar 43 provided with a hardened insert 43a. Two pinion gears 44 in mesh with gear teeth formed on the element 38 are rotatably mounted in the ends of each of the shafts on which the pinions 44 are secured there are also secured worm wheels 45, each of which is connected to separate pinions 46 driven by separate motors 47, as shown in FIG. 2. The motors 47 are supported by the element 39 and connected to a source of power through electrical collectors 48.

Thus, it is apparent from the foregoing that operation of the motors 47 causes relative rotation between the elements 38 and 39 of the roller assemblies 23 and 24, thereby adjustably varying the distance separating the hardened inserts 42a and 43a to accommodate slabs of different thicknesses therebetween. During operation of the apparatus shown in FIGS. 1, 2 and 3, the screws 25 are rotated sufficiently to preposition the roller assemblies 23 and 24 relative to each other whereby, when slabs are passed therebetween, the desired final width may be obtained.

With reference now to FIGS. 4 and 5, there is illustrated a second embodiment of the present invention in the form of a slab squeezer 51 to be incorporated in the roller table 13 (FIG. 1) in place of the slab reducing machines 15 and 16. As shown in FIG. 4, both the end 10 and the stationery crossheads 52 and 53 that are secured together by upper and lower tension bars 54 and 55. A horizontally movable bolster 56 is slidably supported by the bars 55 and arranged between the roller table and the crosshead 52. A piston cylinder assembly 57 is supported by the crosshead and arranged to engage the bolster 56 for reciprocating it with a force sufficient to effect substantial reductions in the slab 59. Rigidly secured to both the bolster 56 and the crosshead 53 are nuts 61. Received in each nut is a screw 62 adapted to be rotated by a worm wheel and worm assembly 63 for the purpose of positioning squeezer heads 64 and 65 relative to each other for accommodating slabs of different widths. The squeezer heads 64 and 65, having wear plates 64a and 65a, respectively, secured thereto, extend the full length of the slab to be worked upon. A support frame 66 incorporated in the roller table 10 slidably positions the squeezer heads vertically for engaging a slab at a desired elevation.

Essential to the successful operation of the slab squeezer is the use of slab elevating devices, next to be explained, the function of which is to lift and hold a slab above the conveyor 10 at a predetermined elevation, such that the application of the slab squeezing force will be applied symmetrically to the slab at an elevation coinciding with the centerline of the piston cylinder assembly 57. In this manner, large reductions in the width of the slab can be accomplished without local bulging.

As shown in FIGS. 4 and 5, elongated aprons 71 are arranged between and extend in a direction parallel to the rollers 10a of the conveyor 10. Similarly arranged aprons 72 are space directly above the aprons 71. Aprons 71 are employed to raise the slab to the aforementioned predetermined elevation whereupon the aprons 72 are lowered into engagement with the top surface of the slab to rigidly constrain it during the squeezing operation and thereby materially eliminate any tendency to produce local bulging of the slab. Each of the aprons 71 and 72 is connected to a bell crank 73 and 74, respectively, which, in turn, are pivotally supported by the tension bars 54 and 55 and interconnected by connecting rods 77 and 78. The elements 39 are adapted to be secured by its rod end to the bellcrank 73 to raise the aprons 71 in unison and a piston cylinder assembly 78, connected to the rod end thereof also to the bellcrank 73, is operated to lower the aprons after the squeezing operation. The aprons 72 are lowered and raised in unison by a piston cylinder assembly 79 operatively connected by the rod end thereof to one of the bellcrank 74.

In accordance with the provisions of the patent statutes, we have explained the principle and operation of our invention and have illustrated and described what we consider to represent the best embodiment thereof.

We claim:

1. Apparatus for reducing the width of metallic workpieces, such as slabs, comprising: a pair of working means operating in the plane of the workpiece for engagement with the opposed edges of said workpiece to produce a workpiece having a desired width; drive means connected to each of said working means for generating therebetween a substantial force to reduce the width of the workpiece; adjustment means connected to each of said working means for controlling the relative distance therebetween to produce a workpiece having the desired width; a pair of constraining means including metal reducing surfaces for engaging with the opposed sides of said workpiece in a plane normal to said plane of the workpiece for reducing local increases in workpiece thickness simultaneously with the reduction in width thereof; and means for varying the relative distance between said pair of constraining means.

2. Apparatus according to claim 1 wherein said adjustment means comprises: a support; a nut carried by said support; a screw received in said nut and engageable with said working means; and drive means for causing relative rotation between said screw and said nut to displace said screw and said means relative to said support.

3. Apparatus according to claim 1 wherein said pair of working means comprises: a roller having a work surface constructed and arranged to contact an edge of the workpiece; an arbor rigidly secured to said roller; and a check rotatably supporting said arbor, said drive means coupled to said arbor for transmitting torque to said roller.

4. Apparatus according to claim 3 wherein said pair of constraining means comprises: first and second collars supported by said arbor in a spaced-apart relationship; each of said collars having a workpiece engaging surface arranged in a direction normal to said work surface of said roller.

5. Apparatus according to claim 4 wherein said means for varying the relative distance comprises: drive means supported by said first collar and operatively engaging and rotating said second collar relative to said first collar; and mutually engaging thread surfaces formed on said collars for varying the relative distance therebetween upon operation of said drive means.

6. Apparatus according to claim 1 wherein said pair of working means comprises: a pair of squeezer heads each having work surfaces for contact with the edge of a workpiece at a desired elevation; support means for positioning said squeezer heads at said desired elevation; a crosshead for supporting each of said squeezer heads; and tension rods interconnecting said crossheads for resisting the force generated between said squeezer heads incident to reducing the thickness of a workpiece.

7. Apparatus according to claim 6 wherein said pair of constraining means comprises: a first and second plurality of platens having workpiece engaging surfaces arranged in a direction normal to said work surfaces of said squeezer heads; positioning means connected to said first and second plurality of platens for constraining a workpiece at said desired elevation.

8. A method of producing metallic slabs subsequently to be processed in a rolling mill to produce semifinished of finished products, such as strip, plate, or the like, comprising the steps of: continuously casting molten metal to form a solidified casting having a width greater than the desired width of said products;
dividing the casting into slabs of a desired length suitable for subsequent handling and processing; materially reducing the width of the slabs to a predetermined dimension whereby on subsequent processing products having desired thickness and width dimensions will result; and simultaneously engaging the opposite sides of the slab for reducing local increases in the thickness of the slab due to the width reduction thereof.