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METHOD OF HOT ROLLING STRIPS

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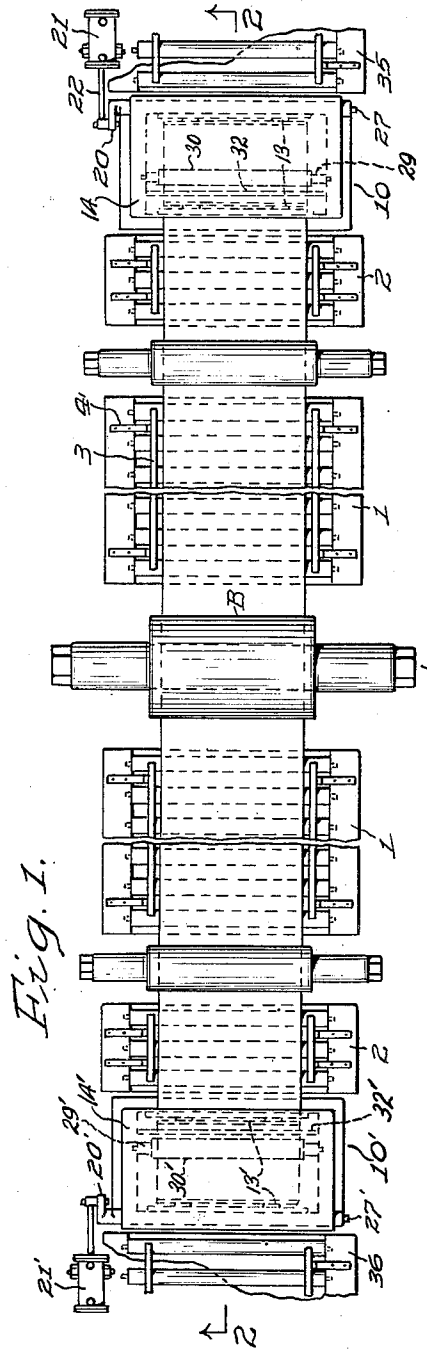


Fig. 1.

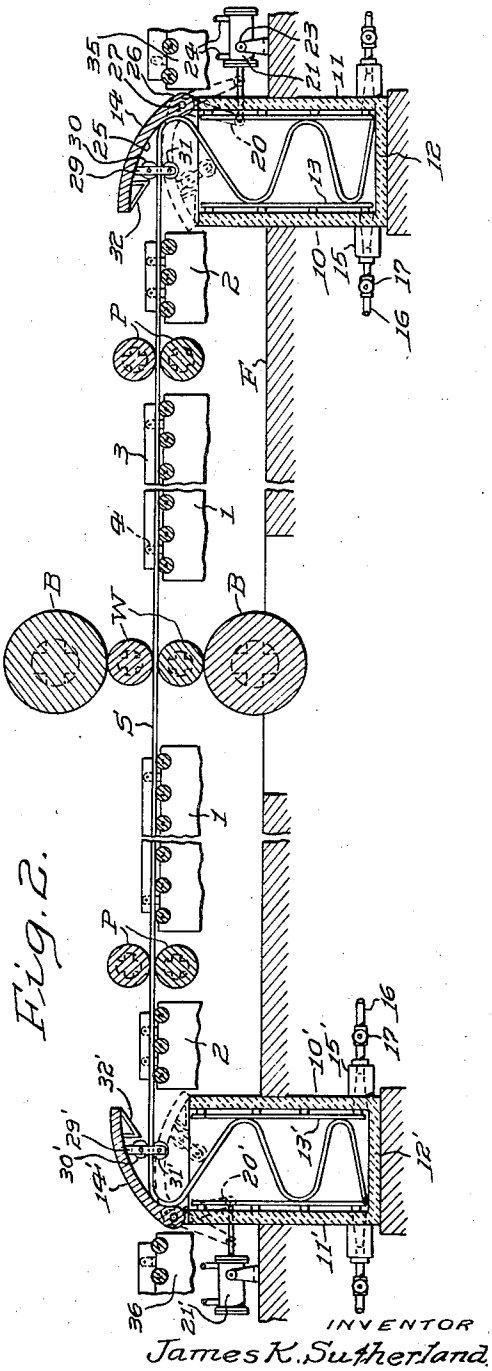


Fig. 2.

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## METHOD OF HOT ROLLING STRIPS

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7 Claims. (Cl. 80—60)

This invention relates to the hot rolling of metal strips, the term "strip" being employed to designate any light gauge elongated piece of metal of any practicable width and not merely pieces of relatively narrow width which are sometimes referred to as strips.

Various methods of and apparatus for reducing a slab or billet to form metal strips have heretofore been utilized, and one mill intended for this purpose comprises besides the usual roll table and reducing rolls, a heating chamber disposed adjacent and above each end of the table with the object of keeping the strip at a proper rolling temperature, and coiling mechanism is contained in each chamber so that as the strip is passed alternately between the rolls its leading end is coiled within one chamber as its trailing end is drawn out from the other. Necessarily each heating chamber or furnace is provided with an opening at or near the bottom to allow the strip to pass into and from the furnace and hence to and from the coiling mechanism, and it has been found in practice that these bottom openings permit frequent and relatively rapid changes in atmospheric conditions within the furnace which result in irregular or "spotty" cooling of the strip and the reels on which it is coiled as well as variation in expansion and contraction of the parts. This not only causes production of an unsatisfactory strip but also enhances the tendency of the reels and other parts of the coiling mechanism to break which renders maintenance costs excessively high and impairs the productive efficiency of the apparatus as a whole.

It is therefore an object of my invention to remedy these disadvantages by the provision of a novel method of hot rolling strip whereby the temperature of the strip can be more satisfactorily controlled, difficulty incident to the use of reels or other coiling mechanism avoided, and production per hour enhanced through avoidance of the necessity for shutting down the mill to repair breakage or other deterioration due to temperature variations in the furnaces.

A further object of the invention is the provision of a hot strip reversing mill embodying novel features and characteristics, which is adapted for the performance of the said method; which is devoid of reels and reeling mechanism; in which the strip heating furnaces are located below the level of the roll table and are of such character that the temperature within them can be controlled with great accuracy; which is simple in construction and comprises parts of such design that they are not liable to get out of order or become damaged in operation in consequence of either temperature variations or any other cause.

The invention further includes other objects, advantages and novel features of design, construction and arrangement hereinafter more particularly pointed out or which will be apparent from the following description of the practice of the method by means of a mill constructed in accordance therewith and diagrammatically illustrated in the accompanying drawing, in which

Fig. 1 is a diagrammatic fragmentary top plan view of the mill and associated mechanism, and

Fig. 2 is a longitudinal central section thereof on the line 2—2 in Fig. 1, the same characters of reference being used to designate the respective parts in both figures.

Essentially, the mill comprises a roll stand generally designated as R, that shown being of the four-high type embodying two relatively small working rolls W and a pair of considerably larger backing-up rolls B but if preferred a two or three-high mill may be utilized, or a mill of the cluster type, and hence the specific design of the rolls and roll stand is a matter of choice. The customary or any other suitable mechanism (not shown) is provided for driving the rolls and adjusting their position in the ordinary way so as to effect the requisite reduction of the strip as it is passed between them.

On each side of the roll stand R at a convenient distance therefrom are disposed a pair of pinch rolls P with suitable driving means (not shown), and roll tables 1, 1 of an ordinary type are interposed between the roll stand and each set of pinch rolls, while other tables 2, 2 extend oppositely outward from the latter. Longitudinal guides 3 supported from the tables by brackets 4 maintain the strip in proper position on the several tables during its passage thereover.

Adjacent and slightly beyond the outer ends of the tables 2 are located heating furnaces 10, 10' the refractory walls and bottoms of which may conveniently extend somewhat below the level of the work floor F, and as both furnaces and their associated mechanism hereinafter described are of similar construction, reference to one of them, for example the furnace 10 at the right hand side of the drawing, will suffice, the corresponding parts of the other furnace being designated by like numerals but with the addition of a prime (').

The furnace 10 is preferably rectangular in horizontal section and wide enough, measured in a direction parallel to the axis of the rolls, to

readily receive the widest strip which the mill is designed to produce. The preferably vertical side walls 11 and the bottom 12 of the furnace are desirably constructed of refractory material, the side walls being provided with vertical spaced guards 13 the purposes of which will hereafter appear, and the furnace top is open except for a movable guide cover 14 which, when closed down on the furnace top, lies just below the plane of the adjacent roll tables.

In order to maintain a suitable temperature within the furnace, burners 15 are desirably horizontally disposed adjacent its bottom each connected with a fuel pipe 16 and controlling valve 17. An additional similarly controlled pipe (not shown) for supplying air to each burner may be provided if desired, or a combustible mixture of gaseous fuel and air may be introduced through the pipes 16, or any other convenient means may be employed to produce the requisite heating of the furnace.

The guide cover 14 to which reference has been made comprises a relatively thick curved cover plate horizontally hinged adjacent the top of the furnace and opening toward the roll stand. A crank arm 20 is secured to the cover for raising and lowering it on its hinges and is actuated from a fluid cylinder 21 the piston rod 22 of which is connected to the free end of the crank arm. The cylinder 21 is preferably mounted on horizontal trunnions 23 to permit slight oscillation during its operation, and a suitable actuating fluid is supplied through flexible connections 24 provided with control valves (not shown). This mechanism which I prefer to employ for raising and lowering the furnace cover is well adapted for its intended purpose, but of course any other convenient means for performing like functions may be utilized if desired.

The major part of the inner concave curved surface 25 of cover 14 conforms substantially to the convex curvature of its outer surface but its radius of curvature decreases rapidly adjacent its hinged inner edge before reversing to form the curved enlargement 26 through which is extended the shaft 27 hingedly supporting the cover.

On the under side of the cover adjacent its opposite or free edge suitable brackets 29 support a pair of spaced guide rolls 30, 31, and an angular guide plate 32 is disposed between these rolls and the free edge to guide the strip to and between the rolls.

In the operation of the apparatus just described a billet or slab is first reduced to an elongated strip S by hot rolling between the working rolls in the usual way. Thus, the heated slab is brought to the mill from the heating furnace or other source, along a roll table 35 to the right of furnace 10, and is then passed over the guide cover 14 which, with cover 14' of furnace 10', is maintained in lowered position during this period as indicated in dotted lines in Fig. 2. The slab is then introduced to the mill rolls, the vertical spacing of the pinch and working rolls being of course properly adjusted for its passage therebetween under the desired pressure, and is then rolled back and forth between the working rolls until its reduction in thickness and resultant elongation render it of sufficient length to extend from the working rolls to or beyond the furnaces. The covers of the latter are then raised to the positions shown in full lines in Fig. 2 so that during further reduction of the strip its leading ends respectively, depending on the direction of rolling, are guided by the furnace covers and attached mechanism into the furnace itself. When it reaches sufficient length the strip is thus deposited in the furnaces in folds or layers as indicated in Fig. 2, guards 13, 13' preventing it from contacting the furnace walls and causing undue abrasion of the refractory material of which they are constructed.

The strip is thus maintained at elevated temperature by the furnaces throughout the rolling operation, its major portion, after the preliminary reduction and elongation, being passed back and forth from one furnace to the other while the portions adjacent its ends are drawn from their respectively corresponding furnaces, rolled in both directions and promptly returned, and all portions of the strip are consequently prevented from falling below proper rolling temperature.

After the strip has been sufficiently elongated and reduced to the desired thickness, the cover of furnace 10' is lowered upon withdrawal of the adjacent end of the strip therefrom during its last pass from left to right in Fig. 2 and on the final pass in the opposite direction this end of the strip then moves over the cover of furnace 10' onto the roll table 36 to the left thereof which conducts the strip to a coiler, continuous pickling machine or other apparatus for whatever further treatment, if any, is desired.

It results that the strip is maintained at proper rolling temperature throughout the rolling operation, and by suitable regulation of the furnace heating means this temperature may be readily controlled and adjusted to the strip thickness, rolling speed and other determining factors. Moreover, all portions of the strip are in one furnace or the other a relatively large percentage of the time during which rolling is in progress, being withdrawn therefrom only just prior to being acted upon by the working rolls and thereafter rapidly passed to the other furnace or returned to the same one, as the case may be, the end portions of the strip of course being only passed back and forth between the rolls and their respectively adjacent furnaces. Appreciable loss of heat from the strip, its unequal cooling and/or heating and/or that of the mechanisms with which it is associated are thereby avoided, the productive efficiency of the mill materially enhanced and its operative life prolonged.

Additionally, as the strip is introduced into each furnace it is bent back and forth in opposite directions along longitudinally spaced transverse lines, and any scale which may adhere to its surfaces is thereby loosened and cracked off. The folds are substantialy uniformly spaced longitudinally of the strip at distances determined primarily by the width of the furnace but elongation of the strip during each pass prevents excessive bending of any portion of the strip through shifting the metal relatively to the points at which the folds are made. During reduction of a slab to relatively thin strip substantially all portions thereof are severally subjected to this bending or folding action to some extent, and the finished strip is therefore virtually scale-free and is possessed of a substantially uniform grain structure in consequence of the combined rolling and bending operations performed upon it during its reduction while the openness of the folds, as distinguished from the close contact of adjacent convolutions when the strip is coiled, insures uniform heating of the strip throughout its entire extent.

While I have herein described with considerable particularity certain apparatus which I deem con-

venient for the performance of the method herein disclosed, it will be understood that the practice of the latter is not to be considered as confined to or requiring any specific apparatus as it may be performed with any mechanism adapted for the purpose, and that various changes and modifications in the manner of its performance will readily occur to those skilled in the art and may be made if desired without departing from the spirit and scope of the invention as defined in the appended claims.

Having thus described my invention, I claim and desire to protect by Letters Patent of the United States:

1. The method of rolling strip metal which comprises the steps of folding the strip in opposite directions upon itself in a heating chamber, progressively unfolding the strip and rolling it while moving it to another heating chamber, folding the strip in opposite directions upon itself therein, and periodically reversing the direction of rolling to feed the strip successively back and forth in the same plane from one chamber to another while successively folding the strip upon itself in opposite directions and unfolding it during its passage into and from each chamber.

2. The method of rolling strip metal which comprises the steps of oppositely folding a major portion of the strip upon itself in a heating chamber with one end projecting outwardly therefrom, passing said end into another heating chamber and folding a major portion of the strip upon itself at spaced points in opposite directions therein while rolling the strip between the chambers, periodically reversing the direction of rolling to feed the strip back and forth from one heating chamber to the other while reducing its thickness and increasing its length, and successively folding and unfolding the strip in the respective heating chambers.

3. In a method of rolling an elongated metal strip to reduce its thickness and increase its length, the steps of moving the strip longitudinally while progressively subjecting it to rolling pressure, intercepting the leading end of the moving strip and deflecting it downwardly into a heating chamber and thereafter progressively deflecting the major portion of the remainder of the strip downwardly into said chamber while successively and periodically folding the strip in opposite directions therein.

4. In a method of rolling an elongated metal strip to reduce its thickness and increase its length, the steps of progressively passing the strip between a pair of rolls, intercepting the leading end of the strip after its passage from the rolls and deflecting said end downwardly into a heating chamber, thereafter progressively deflecting the major portion of the remainder of the strip downwardly into said chamber while successively and periodically folding the strip in opposite directions therein and then moving the strip in the opposite direction and subjecting it to rolling pressure while progressively withdrawing it from the chamber and concurrently unfolding it.

5. In a method of rolling a strip, the steps of progressively moving the strip in opposite directions along a rectilinear path while subjecting it to rolling pressure, deflecting a leading end of the strip from said path into a subjacent heating chamber and thereafter folding said strip upon itself in opposite directions in the chamber during movement of the strip in one direction, then moving the strip in the opposite direction and subjecting it to rolling pressure while unfolding the folded portions thereof and progressively withdrawing them from the chamber, deflecting the other end of the strip into a heating chamber disposed with respect to said path oppositely to the first mentioned chamber and progressively folding the strip upon itself in opposite directions therein, and thereafter rolling the strip in one direction while maintaining its leading end substantially in the plane of said path.

6. The method of reducing a metal slab to produce a thin strip of relatively great length which comprises the steps of initially rolling the slab successively in opposite directions to effect preliminary reduction and elongation thereof and thereby produce a relatively thick elongated strip, thereafter successively introducing the respective ends of the strip into and withdrawing said ends from spaced heating chambers while progressively further rolling the strip back and forth in opposite directions, in each chamber successively folding portions of the strip upon itself in opposite directions, and simultaneously withdrawing from the other chamber and unfolding other portions of the strip.

7. In the method of hot reversing mill rolling, the steps comprising subjecting the hot material to successive reducing passes to thin it to an extent that it will readily bend upon itself, preserving the rolling heat of the material from a position below the roll pass, and collecting the material in the heating means by bending it upon itself in opposite directions, substantially as described.

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