May 18, 1943 H. E. EMIGH 2,319,309

APPARATUS FOR ROLLING METAL STRIP

Filed July 15, 1940 2 Sheets-Sheet 1

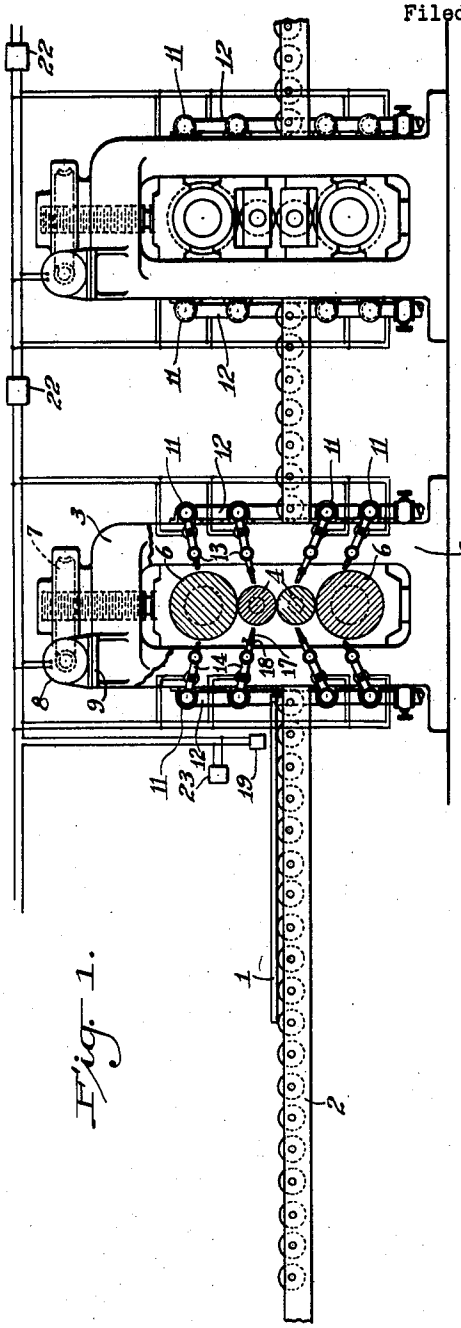


Fig. 1.

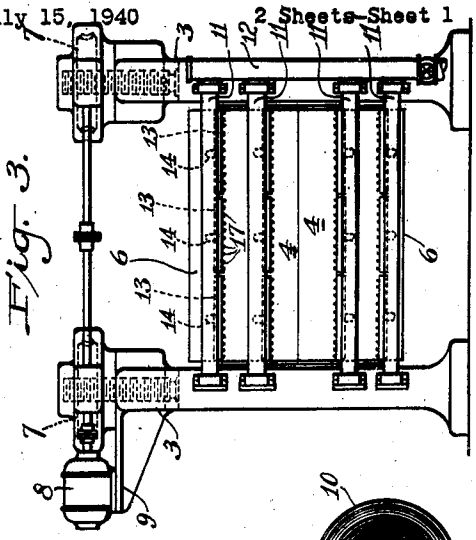


Fig. 3.

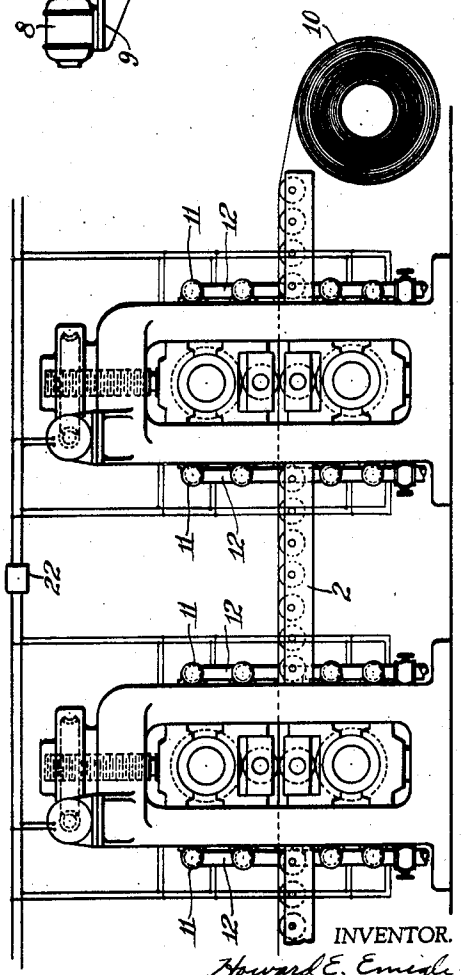


Fig. 2.

WITNESSES.
A. B. Wallace.
V. A. Peckham.

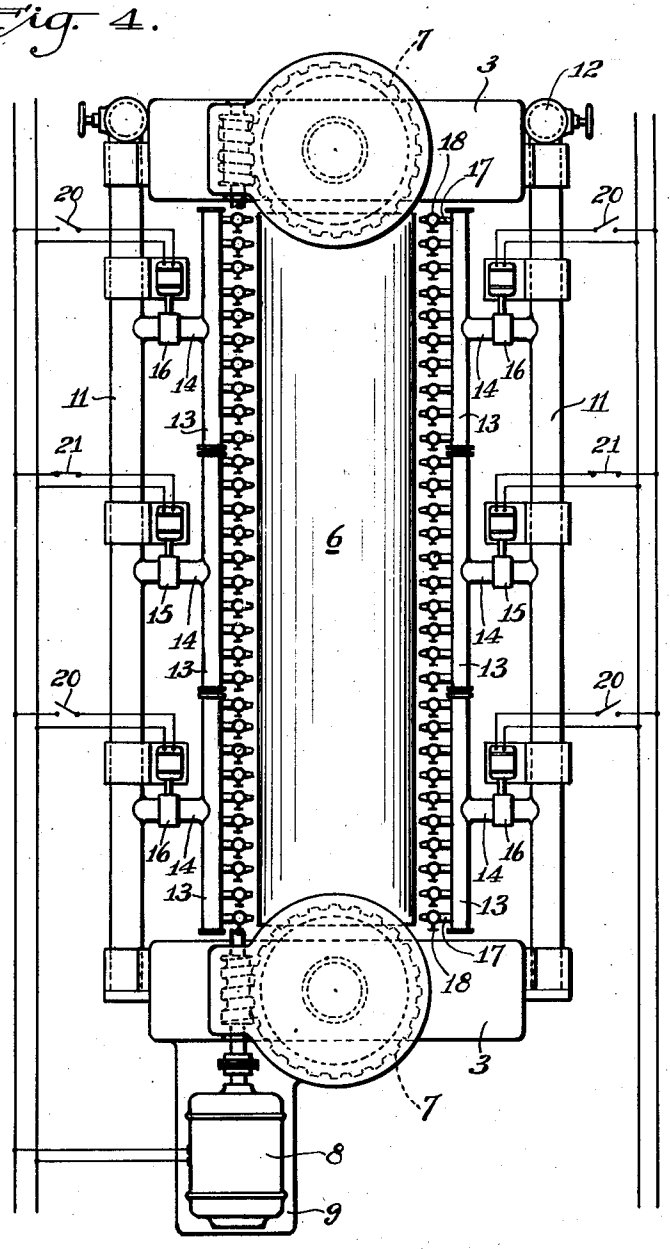
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Fig. 4.



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2,319,309

APPARATUS FOR ROLLING METAL STRIP

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Application July 15, 1940, Serial No. 345,499

2 Claims. (Cl. 80—35)

This invention relates to apparatus for rolling metal strip, either from a hot slab or from a thicker strip.

In the hot rolling of metal strip, as is well known, the trailing portion of the hot strip or slab becomes chilled as it is fed to the mill rolls. Progressively greater pressure is therefore required as this portion of the work piece is approached in order to reduce it as much as the preceding portion. As a result, the pressures exerted by the screw-downs on the ends of the rolls become so extremely high as to cause them to bow apart and form a convex pass. Such a pass causes the edges of the strip to be overrolled whereby ripples are formed, which in some instances even become so great as to overlap and produce folds that in the case of tandem mills pass through succeeding stands of the mill in such manner as to mark the work rolls. To avoid this difficulty it is common practice not to attempt to roll the rear end portion of the strip as thin as the rest of it, due to which a large portion of the finished strip must be cut off and sold at a lower price than the rest or rerolled at an increased cost. In modern mills the strip produced is normally from 350 to 600 feet long, and the off gauge length produced is generally from 35 to 150 feet long which is a very substantial loss as will be apparent. This same general problem is met with in the case of rolling cold metal strip in either a tandem mill or a single stand reversing mill. In such mills the strip comes to the mill with thickened end portions, and if they are to be rolled down to the gauge of the rest of the strip so much more pressure must be applied by the screw-downs as to cause the rolls to bow apart and form a convex pass with its attendant disadvantages.

It is among the objects of this invention to provide a rolling apparatus which is capable of reducing strip that is uniform in gauge throughout substantially its entire length, which preserves a substantially parallel pass regardless of the pressure applied by the screw-downs, which avoids rippling of the edges of the strip, and in which the pass is automatically controlled by the condition of the portion of the blank about to enter the first roll pass.

In accordance with this invention the strip is rolled between a pair of work rolls to the ends of which pressure is applied by the usual motor-driven screw-downs. There may be several consecutive stands of rolls, as in a tandem mill, or there may be only one reversing stand. As an end portion which is thicker or appreciably cooler than the preceding portion of the strip approaches the first pass the screw-down pressure is increased in order to reduce it. To insure proper rolling by doing this, means is provided for effecting at this time a difference in temperature between the central and end portions of at least one of the rolls forming the pass so as to provide a central roll portion which is hotter than its end portions. When the central portion of the roll is so heated its crown is increased and compensates for the bowing of such central portion away from the pass, whereby the pass is maintained parallel. Preferably, the temperature of the roll is controlled by water normally applied substantially throughout the length of the roll for cooling purposes, but the application of water to the central portion of the roll can be retarded or stopped when desired in order to permit that portion of the roll to heat up and expand. In some instances it may be found desirable to normally apply no water to the roll, but to cool the end portions thereof with water when it is wished to increase the crown. Or, the roll contour can be controlled for the purpose of this invention by the application of auxiliary heat to the central portion of the roll. Although the screw-down motor and the water supply may be controlled by hand, they preferably are controlled by an electric circuit which in turn is controlled by the condition of the blank adjacent the entering side of the first stand of rolls in the case of hot rolling, or by a flying micrometer in the case of cold rolling. In a tandem mill a time delay relay in the circuit between each pair of mill stands causes their screw-downs and water controls to be actuated in succession because, of course, the more difficultly rolled portion of the strip does not reach the second or succeeding stands until some time after it has passed through the preceding stand.

The invention is illustrated in the accompanying drawings in which Fig. 1 shows two stands of rolling mills with the first one partly in section; Fig. 2 shows two more stands of the same mill which in practice are in line with the first two; Fig. 3 is a side view of one of the stands; and Fig. 4 is an enlarged plan view thereof.

Referring to Fig. 1 of the drawings, a hot slab 1 is delivered over a run-out table 2 from a furnace (not shown) to the first stand of a tandem hot mill that may contain any suitable number of stands, four being shown in the drawings (Figs. 1 and 2) for convenience. As the stands are all substantially identical only the first one will be referred to in detail. Mounted in the

roll housings 3 is a pair of working rolls 4 backed up by large backing rolls 6, and all of the rolls are forced downwardly and toward each other by means of the usual screw-downs 7 which are driven by an electric motor 8 mounted on a bracket 9 secured to one side of one of the housings. In passing through the several stands of the mill the slab is reduced to a long strip that is wound on reel 10 (Fig. 2). Before the rear end of the slab enters the mill, that portion of the slab will have cooled considerably, thus becoming more resistant to reduction and requiring greater rolling pressure if it is to be reduced to the same gauge as the forward portion of the strip. In the past, as previously mentioned, the necessary increased pressure could not be obtained wthout bowing the rolls and over-rolling the edges of the strip.

It is a feature of this invention that the contour of the rolls is controlled so as to avoid a convex pass when the necessary pressure is exerted on their ends by the screw-downs, whereby the cooler portion of the strip can be satisfactorily reduced to the same gauge as the hotter portion. Accordingly, attached to the mill housings on both sides of each working roll, and also preferably on both sides of each backing roll, are horizontal pipes 11 closed at one end and terminating at the opposite end in a vertical header 12 (Fig. 3) connected to a suitable source of cooling liquid, such as water. Between each pipe and the adjacent roll are a plurality of short spray pipes 13 (Fig. 4), preferably three in number, disposed in axial alignment along the roll face. Pipes 13 are connected to the spray pipes by branch pipes 14 provided with motor operated valves 15 and 16. Each of the spray pipes is provided with a plurality of longitudinally spaced spray nozzles 17 directed toward the adjacent roll, and each of the nozzles is preferably provided with a manually operable valve 18. When all of these valves are open, water is sprayed along the face of each roll from end to end.

In operating this mill the screw-downs are manipulated to place the desired pressure on the rolls which may be crowned so that under ordinary rolling pressures the tendency for them to bow apart will do no more than create a substantial parallel pass. Likewise, in the preferred embodiment, water is sprayed on the rolls from all of the nozzles 17 unless it is desired to alter the contour of the rolls, in which case some of the nozzle valves 18 can be closed. Slab 1 is then moved over the table 2 from the furnace and fed into the mill. The major portion of the slab is reduced to strip of substantially uniform gauge because the temperature of the slab is high enough to permit rolling with little, if any, increase in pressure by the screw-downs. But before the entire slab has passed through the first stand its rear end portion will have cooled considerably so that materially more pressure is required if it is to be reduced to the same gauge as the rest of strip. Accordingly the screw-downs are then manipulated in order to increase their pressure on the rolls. At substantially the same time the water supplied to the central spray pipes 13 is turned off by valves 15, or at least its flow is decreased, whereby the central portion of each roll is no longer cooled like the end portions. The heat of rolling therefore heats up the central portion and causes it to expand, thus counteracting the bowing of the working roll away from the pass so that the pass will remain substantially parallel even though greater pressures are now being used. This permits the cooler portion of the slab to be reduced to the same gauge as the rest of the strip without rippling the edges of the strip.

Although the screw-downs and water valves may be controlled manually and in other ways, it is preferred to control them electrically by a circuit (shown diagrammatically) which in turn is controlled by the temperature of the portion of the slab about to enter the first pass. Temperature responsive means for controlling electric circuits are well known and need not be described in detail. When the temperature of the portion of the slab in front of the first stand reaches a predetermined minimum the temperature responsive means 19 acts upon the electric circuit to cause the screw-downs of the first stand to be screwed down and to partially or completely close its central valves 15 to arrest the supply of water to the central portions of the rolls for the purpose set forth above. In this method of rolling end valves 16 need not be electrically controlled because they remain open all of the time. However, they are shown in the circuit but the circuit to them is broken by open switches 20 so that temperature responsive means 19 can not close them. The reason for connecting them in the circuit is to make it possible, by closing switches 20 and opening switches 21 connected to center valves 15, to operate with the rolls normally uncooled and to cool only their end portions when it is desired to increase their crown. In such a case valves 15 should be closed all of the time and end valves 16 should be adjusted so that they will be opened only when temperature responsive means 19 calls for more rolling pressure by closing the electric circuit.

Temperature responsive means 19 as shown is adapted to control the electric circuits for all of the screw-downs and motor valves of the mill, but disposed in the circuit between each pair of stands is a time delay relay 22 so adjusted that the screw-downs and valves of each successive stand are not actuated until a selected time after those of the preceding stand. This is because the rolling pressures of a stand should not be changed until the cooler portion of the strip, which requires the increased pressure, is about to enter that stand. Of course, this does not occur until after that portion has passed through the preceding stand.

A manual control 23 may be placed in the circuit so that the roll pass can be controlled by a skilled operator if, for any reason, the temperature responsive device is not used. This manual control is also useful in the case of cold rolling when it is the thickness of the incoming strip, and not its temperature, that determines the screw-down pressure that is required. However, even then an automatic gauge-responsive device may be used.

As soon as the rear end of the strip leaves a mill stand the screw-downs are backed off to their normal pressure, and water is again admitted to the central spray nozzles so that the diameter of the central portion of the roll will be reduced.

According to the provisions of the patent statutes, I have explained the principle and mode of operation of my invention, and have

illustrated and described what I now consider to represent its best embodiment. 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. The combination with a plurality of rolling mill stands arranged in tandem relation and each including a pair of work rolls forming a substantially parallel pass through which metal strip is adapted to be rolled, and means normally applying a predetermined pressure to the ends of the rolls to urge them toward each other, of means for normally cooling each pair of rolls substantially throughout their length, an electric circuit connected to said pressure applying means and cooling means, means controlled by the temperature of the portions of the strip adjacent the entering side of the first pass for controlling said circuit to increase said predetermined end pressure on the first pair of rolls when said temperature decreases and for substantially simultaneously arresting the cooling of the central portions of said first pair of rolls, and means delaying the action of said circuit on each successive pressure and cooling means until it has acted upon the pressure and cooling means in the preceding stand.

2. In combination with a rolling mill equipment with work rolls and means for adjusting the work rolls to control the roll pass of means for selectively modifying the temperature of the rolls across the length thereof to thereby control the roll contour and means responsive to the condition of the strip entering the rolls to automatically control the operation of the roll adjusting means and thereby vary the operating pressure between the rolls to control the gauge of the strip delivered from the mill, and means also controlled by said means responsive to the condition of the strip entering the mill for controlling the operation of the means for regulating the temperature of the rolls along the length thereof to thereby automatically control the contour of the rolls in accordance with the pressure operative between the rolls.

HOWARD E. EMIGH.