June 27, 1939. G. F. PAUL 2,163,699

METHOD AND APPARATUS FOR ROLLING HOT STRIP MATERIAL

Filed April 16, 1938 2 Sheets-Sheet 1

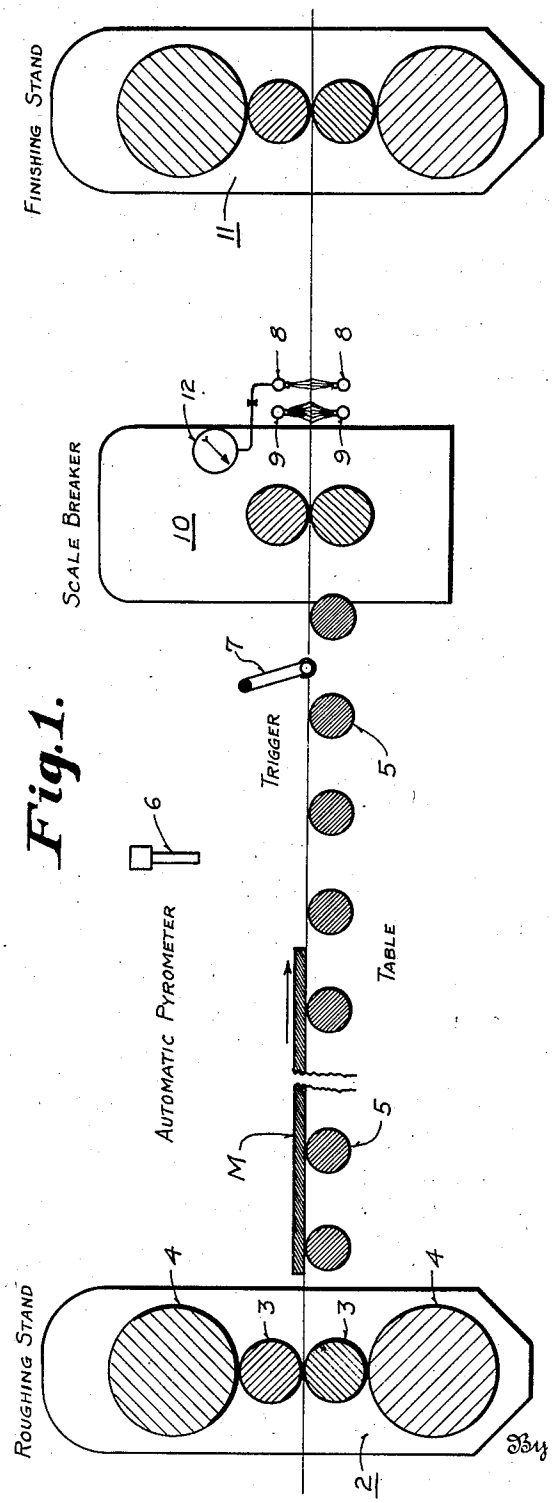


Fig. 1.

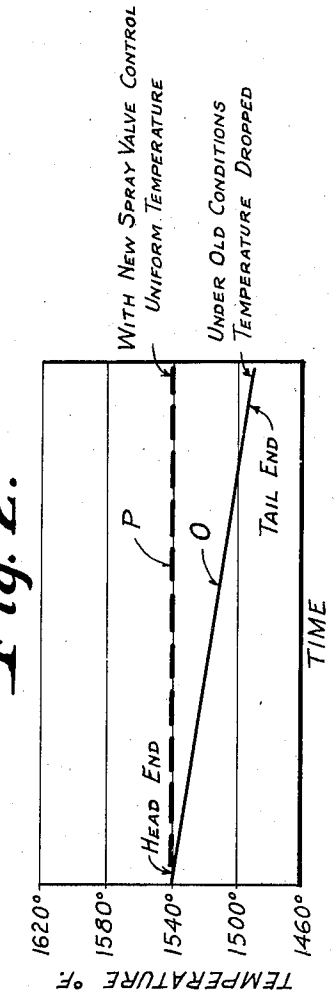


Fig. 2.

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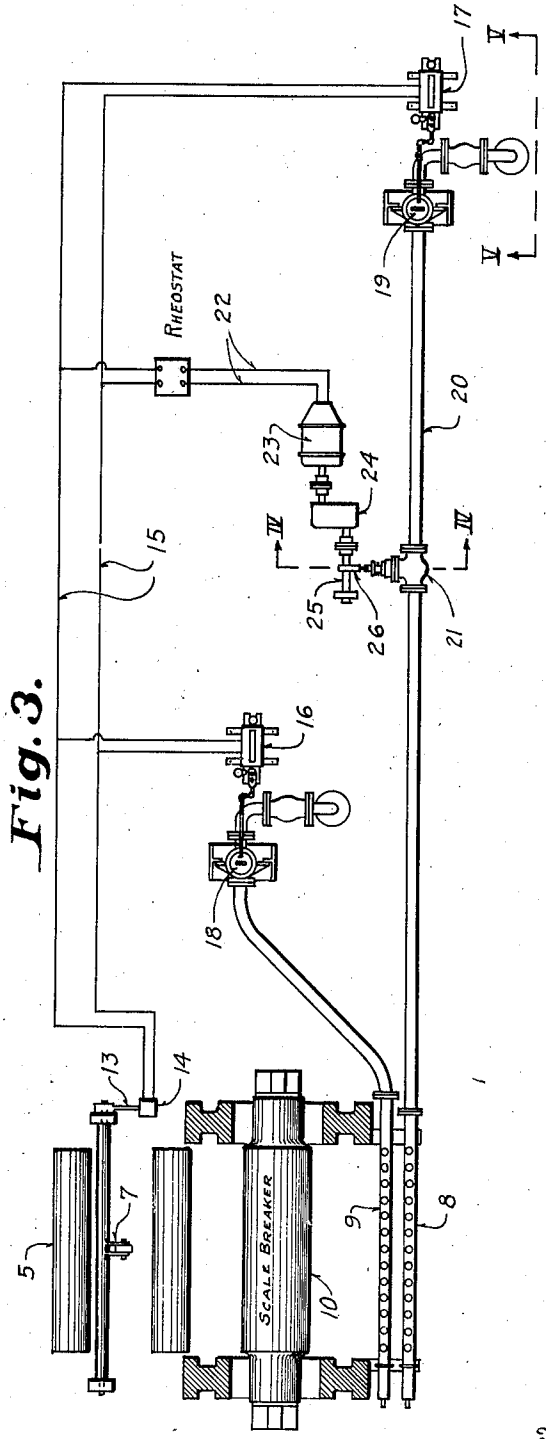


Fig. 3.

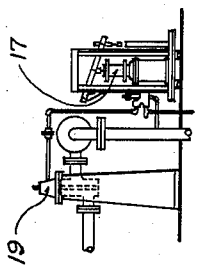


Fig. 5.

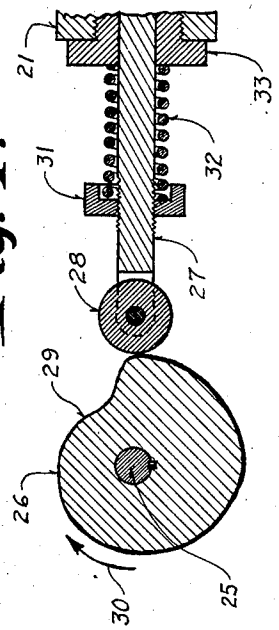


Fig. 4.

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UNITED STATES PATENT OFFICE

2,163,699

METHOD AND APPARATUS FOR ROLLING HOT STRIP MATERIAL

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Application April 16, 1938, Serial No. 202,499

11 Claims. (Cl. 29—17)

This invention relates to the continuous rolling of metal and more particularly to the controlling of the temperature thereof throughout its length, so as to equalize the temperature in each section of the metal as it passes through the rolling mills.

I am aware that broadly the idea of cooling a strip prior to passing it into the finishing mills is old, such as in the F. C. Biggert, Jr., Patent No. 2,095,430. However, in that patent the cooling is accomplished in such a manner that the strip, rather than varying in temperature from the leading end to the trailing end, varies in temperature in successive short sections or strips, depending upon the length of the cooling apparatus. Thus, the condition of non-uniformity in the strip is exaggerated, rather than eliminated, as in the present invention.

By my invention I differentially cool and uniformly change the amount of cooling fluid, so that each increment of strip is cooled differently than the adjoined increment, rather than by sections, steps or jumps, as in the aforementioned patent.

Another disadvantage of the Biggert apparatus is that the structure covers the entire conveyor table between the roughing and finishing mills and is always in the way in case a cobble is produced here, whereas applicant's apparatus is of simple design and closely adjacent to one of the mill stands, so that it is out of the way in case of a cobble.

In the continuous hot rolling process wherein long billets, slabs or bars are being rolled, it has been impossible to control the drop in temperature of the piece of metal from the leading to the trailing end of the material being rolled. It has, therefore, been necessary in any such continuous hot rolling of steels or other metals into products demanding exacting and uniform structures, constant dimensions and uniform physical characteristics to hold the length of the billet, bar or slab to that minimum of length which will insure a temperature drop from the leading end to the trailing end, which will be within the limits that will not seriously affect such qualities.

My present invention includes the method and apparatus whereby a fluid is sprayed against the metal as it passes through the mill in decreasing quantities and so adjusted and controlled in accordance with the length of the material being rolled so as to control the temperature in the piece of the material and make the material uniform from end to end.

I am aware that it has been heretofore attempted to produce such uniform temperatures by overheating the material and then spraying a liquid over an entire surface of the piece, however, this does not overcome the difficulty, as the leading end of the piece will be worked in the mill a considerable length of time before the trailing end goes through the mill, so that the trailing end will have a longer time to cool down, will be harder to roll and, therefore, its gage or thickness will be increased.

My invention has the advantage in affording a simple apparatus for accurately controlling the temperature and making it uniformly vary from end to end in every piece being rolled through the mill and in further controlling the thickness of the piece being rolled, so that it does not vary from one end to the other.

A further advantage of my invention is that the physical characteristics of the metal will be uniform throughout and uniformity of grain structure will be produced.

In most continuous mills is installed a scale breaker stand, which removes the scale from the billet, after which it generally passes through four roughing stands onto a table where the piece is held for lowering the temperature to the proper temperature for finishing the rolling. The piece may pass through another scale breaker and from there into a series of finishing stands, generally six in number.

For my present invention I provide spray nozzles, controlled so as to equalize the temperature through the length of the strip as it passes through a given mill.

Without the use of my invention a typical example of the strip leaving the last scale breaker would be that the head end of the strip would be at a temperature of 1800° Fahrenheit and the temperature of the trailing end thereof would have been lowered, due to increased time of cooling, to 1750°. It is not uncommon to find that in many pieces the trailing end of the piece, unless some temperature equalizing apparatus is used, will finish as much as 80° to 90° Fahrenheit cooler than the leading end of a long piece of material. The average temperature out of the roughing mill is from 1900° to 2000° Fahrenheit, and the piece may or may not be held on the cooling table. In many instances it is passed directly into the finishing mills, however, in case it is held on the cooling table it is continued in motion by reversing the strip several feet either way, so that the table rolls will not cause cold spots on the material. The finishing temperatures of the material will vary, depending upon

the gage and type of material being rolled, from 1480° Fahrenheit to 1640° Fahrenheit. During the rolling, due to the great elongation of the strip, the front end of a piece may pass through the last finishing stand a minute ahead of the trailing end. I, therefore, by this invention cool the front end of the material below the temperature at the trailing end with a cooling medium, preferably water at 1150 pounds per square inch pressure.

My invention can be readily understood by referring to the accompanying drawings, in which like references, are used for corresponding parts in the various figures.

In the drawings:

Figure 1 is a centerline sectional view through part of a continuous hot rolling mill;

Figure 2 is a chart showing a comparison of temperatures using my invention, with temperatures of a piece rolled under the present practice;

Figure 3 is a fragmentary section of part of the mill showing the controlling equipment used in the present invention;

Figure 4 is a section on the line IV—IV of Figure 3; and

Figure 5 is an elevation taken on the line V—V of Figure 3.

Referring now to Figure 1 of the drawings, 2 indicates the last roughing stand of a mill train having working rolls 3—3 and back-up rolls 4—4 these being driven in the usual manner by a motor driving means, not shown. The slab material M being worked upon is indicated as being on the table rollers 5 and is progressing to the right as viewed in the figure. At 6 is located an automatic pyrometer, which is connected to recording equipment and which will indicate to the operator when the material M is at the proper rolling temperature. As the piece M proceeds on across the table it will strike the trigger of actuating the valve means controlling spray pipes 8—8 and 9—9, opening the valves to their fullest extent. This trigger also actuates electrical means, more fully hereinafter described, which starts to decrease the amount of liquid sprayed by the nozzles 8—8, until at the trailing end of the material M the valve in the line leading to the nozzle 8—8 is completely closed. In Figure 1 I have shown these spray nozzles as adjacent to the scale breaker 10, however, it is to be understood that these nozzles can be placed any other convenient and practical location in the mill; that is, they could be suitably located on the first finishing stand 11 shown in the figure.

A gauge 12 is connected to the lines of the spray pipes 8—8 to indicate to the operator what the pressure is to be at the head end of the slab and to indicate the decrease in pressure as the slab passes through the spray station.

Referring now to Figure 2 the chart indicates the relation between the temperature of the strip and the time, which is equivalent to a temperature-length diagram showing various temperatures throughout the length of the strip as it passes between the No. 9 and No. 10 stands of the finishing mill. The line O indicates the temperature variation obtained in the rolling as heretofore practiced, showing that the tail end of the piece is 50° or more cooler than the head end. The line P indicates the uniform temperature obtained by the use of my invention. Of course, it will be apparent the indicated relation between these lines has been adopted arbitrarily and that the position of each, as well as the slope of line O depends on wholly independent factors, so that under some "old" conditions the line O might cut the line P at some point between its ends or even fail to intersect it at all, since rolling temperatures may, and sometimes do, vary widely at the will of the operator and for other reasons, although it is ordinarily desirable to roll most steel strip at about the temperatures indicated. Thus the practice of my invention effectively promotes uniformity of the strip temperature longitudinally of the strip and is not primarily intended for reducing separate, initially non-similarly heated strips to the same temperature; one strip may therefore be finish-rolled at one temperature and the succeeding strip at a different one, if desired, within the contemplation of the invention.

In Figure 3 is shown a lever arm 13 controlling a switch 14, this lever arm 13 being connected to the end of the trigger bar 7, the switch 14 being in an electric circuit 15, which is connected to solenoid valve controls 16 and 17. The solenoid valve control 16 operates a spray valve 18 and the solenoid 17 controls a spray valve 19. Now, as the material M hits the trigger 7 the switch 14 is operated, controlling the solenoid 16, so that valve 18 is opened allowing the spray nozzles 9 to operate. Similarly, through the circuit 15 the solenoid 17 is operated, opening valve 19, admitting fluid to the line 20 and to the valve 21, which controls the fluid spray nozzles 8. Also, connected to the circuit 15 is another circuit 22 controlling motor 23, which through a gear reducer 24 rotates shaft 25, upon which a cam member 26 is located. This cam member 26 operates valve 21 through a valve stem 27 and cam roller 28, so that when the cam is in the position as shown in Figure 4 the valve 21 is completely closed, shutting off the fluid from the spray nozzles 8; however, when the cam roller 28 rests on the surface 29 of the cam 26, the valve is completely open as when the leading end of a piece is passing the spray nozzles 8. Then as the cam 26 rotates in the direction as shown by the arrow 30, the valve 21 is caused to be gradually and predeterminedly closed, thus cutting off the fluid spray from the nozzles 8, as the piece of material M progresses by said nozzles.

Threadedly fastened to the valve stem 27 is a collar 31, which tends to compress a compression spring 32 beween the said collar and a packing gland 33 of the valve 21. This spring 32 thus tends to hold the cam roller 28 in contact with the cam surface at all times.

It will be appreciated by those skilled in the art that the shape of the cam may be varied in any manner required in order to get a predetermined amount of cooling water at any particular position on the material being rolled. It is also apparent that other means than the particular cam construction shown can be used for cutting off the spray through the valve 21, such as by means of gears and a variable speed motor to vary the closing thereof.

It will be further appreciated by those skilled in the art that this invention represents a very desirable improvement in the art from a quality and uniformity of production standpoint.

While I have explained the principle and one mode of operation of my invention with considerable particularity, and have illustrated and described what I now consider to be its best emmodiment, I do desire, however, to have it understood that within the scope of the appended claims changes and modifications in the method, as well as in the apparatus will readily occur to

those skilled in the art, and may be used, if desired, without departing from the spirit and scope of the invention as defined in the appended claims.

It is to be further understood that this invention, while particularly valuable while rolling flat strip material, is not limited in its use to such material and the word strip as used in these claims is meant to include long lengths of material such as flat strip material, shapes, bars, etc. regardless of the cross-sectional shape.

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

1. A rolling mill for the hot rolling of metal strip material comprising at least one roughing stand, conveyor tables and at least a finishing stand, a cooling station on said conveyor table between the last roughing stand and the first finishing stand, a pair of spray nozzles, one above and one below said conveyor table, a trigger arm in the path of material moving over said table, a switch operatively connected to said trigger, a motor operating in a circuit containing said switch, a cam actuated by the motor and a valve operated by said cam and located in the supply line connected to one of the nozzles.

2. The method of rolling hot strip, which comprises passing a slab through a roughing mill at a temperature which delivers it to the finishing mill at a higher finishing mill temperature, cooling each increment of strip a progressively diminishing amount as it passes a spraying station, and then finishing rolling the strip to a uniform gage.

3. A rolling mill for the hot rolling of metal strip material comprising a mill stand, a conveyor table in combination with said mill stand, two sets of spray nozzles adjacent said conveyor table, a nozzle of one of the sets being above the table and one below the table, a nozzle of the second set being above the table and one below the table, control means in the line of said first set of nozzles to provide a uniform flow of fluid therethrough as the metal material passes therebetween, other control means in the line of said second set of spray nozzles for continuously decreasing the flow of fluid therethrough as the metal material moves past said second set of nozzles.

4. A rolling mill for the hot rolling of metal strip material comprising at least on roughing stand, conveyor tables and at least a finishing stand, a cooling station on said conveyor table between the last roughing stand and the first finishing stand, a pair of spray nozzles, one above and one below said conveyor table, a trigger arm in the path of material moving over said table, a switch operatively connected to said trigger, a motor operating in a circuit containing said switch, an adjustable valve in the line supplying said spray nozzles and means operated by said motor for continuously operating said adjustable valve as the metal material passes said spray nozzles.

5. A rolling mill for the hot rolling of metal strip comprising one or more roughing stands, a conveyor table for receiving the strip as it issues therefrom, a finishing stand disposed to receive the strip from said conveyor table, a spray nozzle adjacent said conveyor table and arranged to spray a fluid against the strip in its passage over the table, and means for continuously decreasing the flow of fluid through said spray nozzle in timed relation with the progress of the strip past said nozzle.

6. The method of hot rolling metal strip, which comprises passing a slab at a high temperature through a roughing pass and cooling the resultant strip at a cooling station as the strip passes thereby and to the desired finishing temperature by applying a cooling medium to the strip in an amount continuously diminishing in timed relation with the movement of the strip past said station.

7. The method of rolling a hot slab into strip material, which comprises passing a slab through a roughing mill, then passing the material to a scale breaker, cooling the strip evenly and in progressively diminishing amount proportional to the strip movement from the leading end to the trailing end so that the leading end of the strip passes through the first finishing stand at a lower temperature than the then temperature of the trailing end and then passing the strip completely through the remaining finishing stands.

8. The method of rolling a hot slab into strip material, which comprises passing a slab through a series of roughing stands and onto a holding table, permitting the slab to cool to a pre-determined temperature, then continuing its forward movement past a cooling spray while continuously diminishing the spray and then finish rolling the material.

9. The method of rolling hot strip, which comprises passing a slab through a roughing mill at a temperature which delivers it to the finishing mill at higher than finishing mill temperature, cooling the strip a continuously diminishing amount from its leading end to its trailing end as it passes a spraying station and then finish rolling the strip to a substantially uniform gage from end to end.

10. A mill for the hot rolling of metal strip comprising in combination a mill stand, a conveyor table, spraying means adjacent the table adapted to spray material as it moves along the conveyor, a fluid supply line connected with, and an adjustable valve controlling the flow of fluid to said means and means for continuously adjusting the valve to progressively and continuously diminish said flow while the material is moving past said spraying means.

11. In metal rolling apparatus the combination of a mill stand, a conveyor table, a spray nozzle, means for actuating the nozzle in accordance with the position of the metal being worked with respect to the conveyor table and means for continuously diminishing the flow of fluid through said nozzle in accordance with said position of the metal.

GEORGE F. PAUL.