July 18, 1933. R. M. KEENEY ET AL 1,918,968

ROLLING MILL

Filed Jan. 12, 1928 3 Sheets-Sheet 1

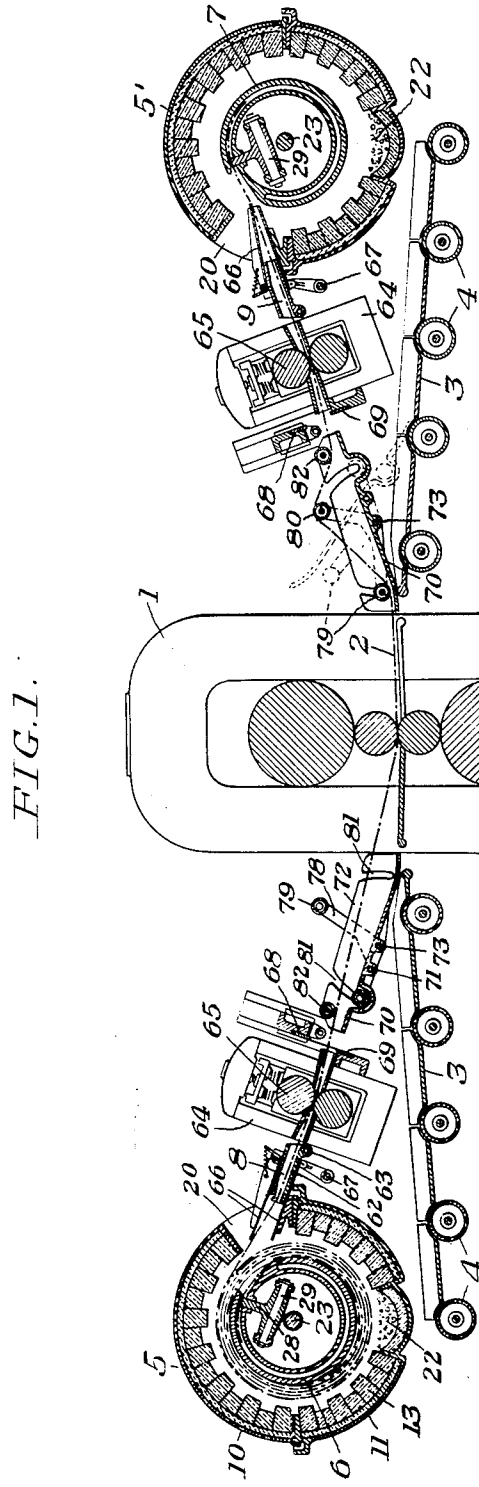


FIG. 1.

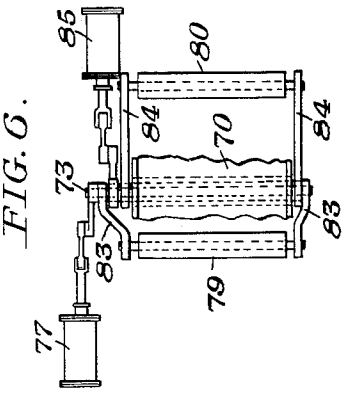


FIG. 6.

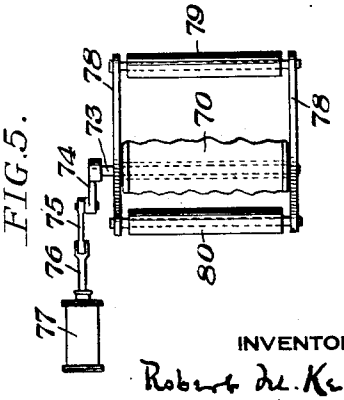


FIG. 5.

INVENTORS

Robert M. Keeney.

John F. Ferguson.

by Christy & Christy

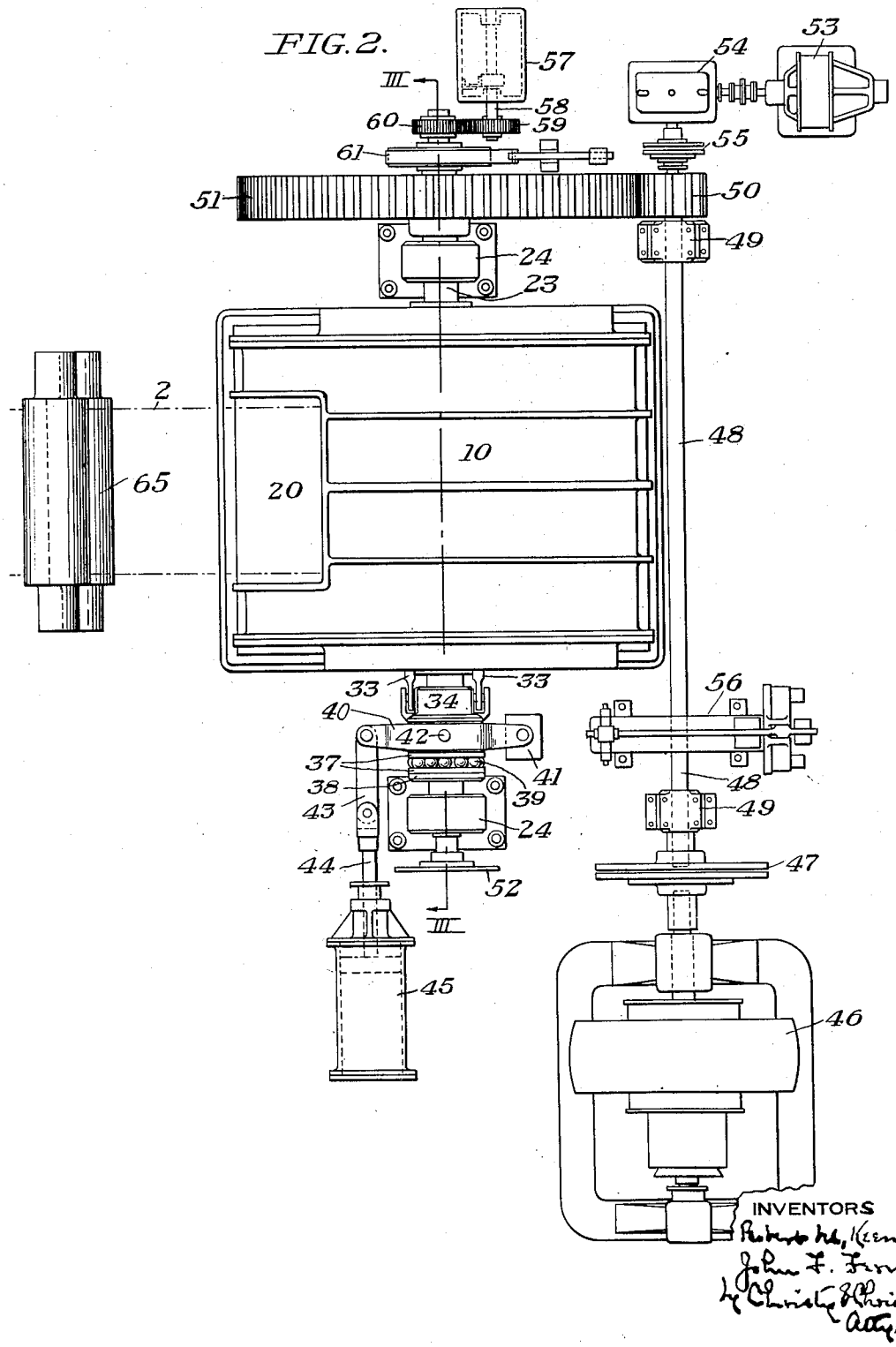
Attys.

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ROLLING MILL

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FIG. 2.



INVENTORS

Robert M. Keeney

John F. Forrer

by Christy & Christy

Attys.

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ROLLING MILL

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FIG. 3.

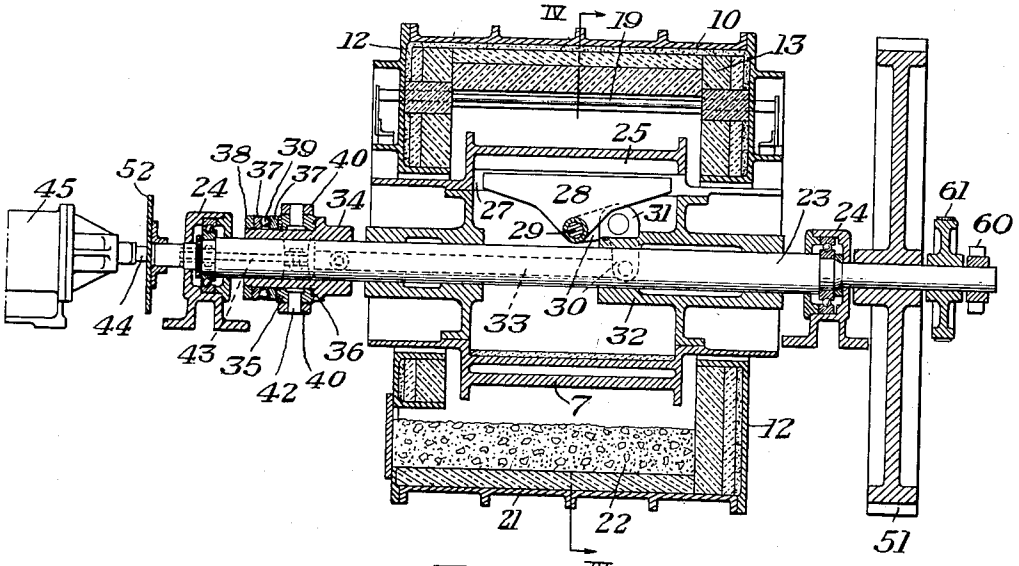
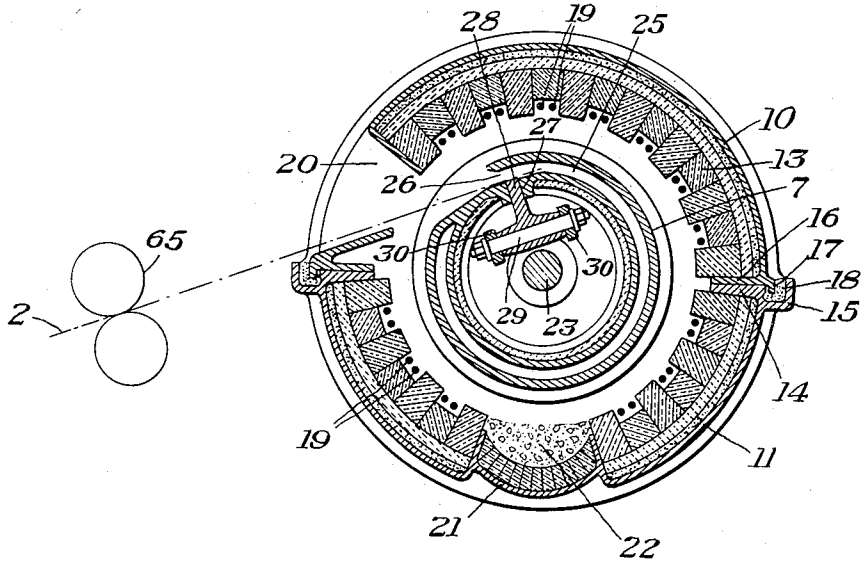


FIG. 4.



INVENTORS

Robert M. Keeney

John F. Ferm

By Christy & Christy

Attys

Patented July 18, 1933

1,918,968

UNITED STATES PATENT OFFICE

ROBERT M. KEENEY AND JOHN F. FERM, OF MIDLAND, PENNSYLVANIA

ROLLING MILL

Application filed January 12, 1928. Serial No. 246,181.

This invention relates to the rolling of metal in strip-like form and while, as herein described, it is particularly applicable to the hot rolling of iron or steel strips or strip sheets of light gauge and great length, it is also applicable in certain of its aspects to the cold rolling of metal in strip-like form. In the manufacture of sheet steel it has been proposed, and in some cases practiced, to supersede the old and common methods of finishing comparatively short lengths of rough-rolled sheets by matching and doubling, by rolling wide and long sheets in a continuous mill. Not only does this require a mill of great length and very accurate relative adjustment of the passes through the successive stands of rolls, but the strip in the process of reduction and elongation loses heat so rapidly that the manufacture of the lighter gauges of sheets in this way has been economically impracticable. It is the primary object of the present invention to provide means whereby long and thin strips can be heated effectively and economically during the process of rolling, and therefore can be reduced to any thinness attainable by hot rolling, and the entire operation, after the initial roughing-down, can, if desired, be carried out in a single stand of rolls.

In the accompanying drawings Figure 1 is a view in longitudinal sectional elevation of the finishing rolls of a strip mill having combined therewith mechanism embodying the present invention. Figure 2 is a plan view of one of the coilers and its operating mechanism. Figure 3 is a section of the coiler on the line III—III of Figure 2. Figure 4 is a cross-section on the line IV—IV of Figure 3. Figures 5 and 6 show alternative means for maintaining tension upon the strip.

The stand of rolls 1 is shown only conventionally, and it will be understood that suitable means for adjustment of the rolls, and other proper accessories, will be employed. The strip being rolled is designated by the broken line 2. The usual feed-tables 3 having driven rollers 4 are shown on the opposite sides of the stand of rolls 1.

Above the tables and the roll-pass and on opposite sides of the stand of rolls 1 are suitably supported heating-furnaces or chambers 5 and 5′, within which are rotatably mounted reels or drums 6 and 7, and from which the inclined chutes 8 and 9 (to be hereinafter described) lead down to the roll-pass. As shown in Figures 3 and 4, each of the heating furnaces comprises upper and lower semi-cylindrical metallic shells 10 and 11, having closed end walls 12, and lined with refractory 13. The lower shell 11 has an inner flange portion 14 at its top and an outer cup portion 15, and the upper shell 10 has an inner flange portion 16 which rests on the flange 14, and an outer downwardly bent lip 17 which projects into the cup 15, where the joint is packed with loose refractory 18. By reason of this construction the upper half of the furnace may be lifted off the lower half by means of a hoisting crane whenever desired. The resistors 19 are suitably arranged and mounted within the heating chamber for the electrical generation of heat. The transverse opening 20 is formed in the upper shell 10 for the passage of the strip being rolled. I term each heating furnace and reel, with their accessories, collectively a coiler. A trough or basin 21 may be formed in the bottom of the lower shell 11, and be filled with a substance having a greater affinity for oxygen than has the metal strip being rolled, such as coal dust, coke or charcoal 22, so as to protect the strip from injurious scaling.

Each reel or drum 6 and 7 is mounted upon a driving shaft 23 which projects out through suitable openings in the opposite end walls 12 of the heating chamber and is supported in bearings 24. The reel has a transverse slot 25 in its wall adapted to receive the advance end of the strip being rolled, the entrance opening 26 of which is shown in Figure 4 as standing adjacent to the opening 20 in the wall of the coiler. A second transverse slot 27 through the inner wall of the slot 25 near its entrance end connects the slot 25 with the inner open body of the reel, and in this slot 27 works the locking-bar 28, adapted when projected outwardly to bind the advance portion of the strip being rolled against the opposite wall of the slot 25 and thus lock the strip to the reel in the coiler. At its inner end

the bar 28 carries a stub shaft 29, the opposite ends of which are connected to the horizontal arms of rocking-levers 30 pivoted to small standards 31 supported on one of the hubs 32 of the reel, on opposite sides of the driving-shaft 23. The lower ends of the vertical arms of the levers 30 are connected by links 33 to the sleeve 34, which rotates with but can slide upon the shaft 23. A collar 35 is mounted upon the sleeve 34 between an inner shoulder 36 on the sleeve and the rings 37 held in place by a nut 38 screwed upon the outer end of the sleeve. Anti-friction balls 39 are interposed between the rings 37. A bifurcated lever 40, pivoted at one end to the standard 41, is connected at its central points by pins 42 to the collar 35, and at its opposite end is loosely connected by link 43 to the piston-rod 44 of the motor-cylinder 45. Thus by operating the piston in the cylinder 45, the bar 28 will be advanced and retracted to lock and release the end of the strip being rolled.

Mechanism suitable for driving the reel to wind up the strip as it comes from the rolls is also shown in Figure 2. The shaft of the motor 46 is connected by a magnetic clutch 47 to the end of the shaft 48 supported in bearings on the standards 49. At its opposite end shaft 48 has fastened to it the pinion 50 which meshes with and drives the gear wheel 51 which is fastened upon the driving-shaft 23 of the reel. At its projecting opposite end the shaft 23 may carry any suitable indicating device 52, such for example as a pointer, to show the position of the reel within the coiler, and particularly when it is in the proper position to receive the advance end of the strip being rolled, as shown in Figure 4. A separate slow drive is employed for turning the empty reel to the strip-receiving position shown in Figure 4, after the motor has been stopped and the magnetic clutch 47 (which is in the motor-operating circuit) has been opened. A separate motor 53 operates a worm and worm-wheel in the casing 54, the worm-wheel carrying a short shaft connected by a magnetic clutch 55 with the end of the shaft 48, as also shown in Figure 2.

In the unwinding of the reel 6 or 7, when the circuit of motor 46 will be broken and the clutch 47 open, it is desirable that the reverse rotation of the reel shall be stopped (and the trailing end of the strip be released) shortly before the strip is wholly withdrawn from the coiler. For that purpose we provide a magnetic brake 56 for the shaft 48, the operation of the brake being controlled by a limit switch in the box 57, and the switch being operated by a shaft 58 having a pinion 59 meshing with a pinion 60 on the end of the reel-shaft 23. Electrical apparatus of this character is well known to those skilled in the art, and detailed description of any of several forms which may be used is therefore unnecessary. The switch is so organized that it will cause the brake 56 to act upon the shaft 48 preferably when the reel has still one complete unwinding revolution to make, and we calculate that the reel will be completely stopped in a half of a revolution more. The trailing end of the strip having been by that time released by withdrawal of the bar 28, the balance of the strip will be free to be drawn out of the coiler. The brake 56 will then be opened and the motor 53 operated to turn the reel to the strip-receiving position shown in Figure 4.

To act as a drag upon the reel during unwinding we provide a band-brake 61 of common form for the shaft 23, having its free end counterweighted, so as to operate only when the shaft is turning in the unwinding direction. This brake is shown in Figures 2 and 3.

At the top of each of the chutes 8 and 9 there is arranged a guide comprising a rear section 62 pivoted at 63 to a bracket or brackets on the housing 64 of pinch-rolls 65 to be mentioned presently and resting upon the lower lip of the entrance 20 into the coiler, and an outer telescopic section 66 which is connected to a rock-shaft 67, and may be moved forwardly and backwardly by turning the rock-shaft by any suitable means. Thus the tip of the section 66 may be projected in close to the reel, as shown at the right-hand side of Figure 1, or it may be drawn back out of the way of the coils on the reel, as shown at the left-hand side.

The pinch-rolls 65, adjustably mounted in the housings 64, are located in the chutes 8 and 9 to feed the strip alternately to the coiler and back to the stand of rolls 1. These pinch-rolls may be driven by any suitable mechanism, but preferably by an electric motor, including in the motor-operating circuit a magnetic clutch operating in the same way as the clutch 47. Adjacent to and immediately below the pinch-rolls is a shear comprising a movable blade 68 and a fixed blade 69.

Below the shear and extending into proximity to the stand of rolls 1 each of the chutes 8 and 9 has a tilting section 70 centrally mounted upon a rock-shaft 71. This tilting section has a floor and preferably opposite side walls 72. The tilting sections are provided so that they may be swung to a horizontal position, on one side of the rolls 1 to admit the strip coming from the roughing rolls of the mill, and on the other side to deliver the finished strip. Or if desired both sections may be swung out of the way and the strip be given one or more passes through the rolls 1 before it enters the chutes and coilers. Also by tilting either section to the position shown in dotted lines at the right-hand side of Figure 1, any crop ends cut off by the shears can be delivered upon the roller

table 3 and disposed of without delaying the operation of the mill.

Means are provided for maintaining tension upon the strip in case it shall loop up between the rolls 1 and the pinch-rolls. Each tilting section carries beneath its floor a transverse rock-shaft 73, operated by a crank 74 at one end, which is connected by a link 75 with the piston-rod 76 of a fluid-pressure cylinder 77, as shown in Figure 5. Adjacent to the opposite ends of the shaft 73 are fastened the bent arms 78 carrying in their ends, respectively, the hubs of rollers 79 and 80, slots 81 being cut in the opposite side walls 72 to allow the passage of the hubs of the rollers as the arms 78 are rocked by means of the described connections. In the operation of the mill the strip on each side of the rolls 1 will pass under the roller 79 and over the roller 80. Tension is maintained yieldingly upon the looped strip, as shown in Figure 1, by means of the fluid-pressure cylinders, and the size of the loop aids the operator in adjusting the speed of rotation of the reel in the coiler to the speed of the reducing rolls. A bearing roller 82 is journaled in the opposite side walls 72 to maintain tension upon the looped strip, if necessary, on the upper side of the roller 80. If desired, the rollers 79 and 80 may be operated independently of each other, as shown in Figure 6. In such case the rollers 79 and 80 are mounted in the ends of independent arms, the arms 83 of the roller 79 being secured to the shaft 73 and operated by the cylinder 77 as in Figure 5, while the roller 80 is mounted in the ends of arms 84 fastened to a sleeve which surrounds the shaft 73, and which is connected to a second fluid-pressure cylinder 85.

In operation, assuming that the table 3 at the right-hand side of Figure 1 leads from the roughing mill, the roughed-down strip will be carried on this table into and through the initial pass between the reducing rolls 1, which also act to feed the strip up the chute at the left and between the pinch-rolls, which are being driven at that time and which feed the strip on into the coiler, the guide 62, 66 being in advanced position to direct the leading end of the strip into the slot 25 in the reel. As soon as the leading end of the strip enters the slot 25 it is locked by the bar 28, and the coiler-motor is started and the strip is wound on the reel, the pinch-roll motor being stopped and the driving-shaft disconnected by opening of its magnetic clutch, so that during the winding operation the pinch-rolls act as idle guide rollers. If during the rolling and winding operation the strip should loop up between the reducing rolls and the pinch-rolls, fluid pressure will be admitted to the cylinder 77 to maintain the proper yielding tension upon the strip by means of the roller 80 and the opposite flanking rollers 79 and 82, while the operator synchronizes as nearly as may be the winding speed with the speed of the reducing rolls. As soon as the trailing end of the strip passes the reducing rolls and before it reaches the pinch-rolls, the reel in the coiler is stopped and its motor disconnected from the drive shaft. The reducing rolls are then adjusted and started in the opposite direction, and the pinch-rolls are then driven in the opposite direction to feed the strip back through the reducing rolls, whence it goes to the coiler 5′ at the right-hand side of Figure 1, and is wound upon the reel 7 in the same manner as already described. During this reducing operation the pinch-rolls at the left turn idly, and the reducing rolls unwind the strip, the unwinding speed of the reel 6 being controlled by the drag-brake 61. When the last unwinding revolution of the reel 6 is reached, the locking-bar 28 is retracted and the brake 56 is automatically applied to the shaft 48. Thus the reel 6 is stopped, and the reducing rolls draw out the unlocked trailing end of the strip. Then the brake on the shaft 48 is released and the reel 6 is turned to receiving position by the motor 53. The strip may be given as many passes through the reducing rolls as may be desired, the rolls being adjusted between reductions by any of the well-known means, and since the strip is being repeatedly heated in the coilers, its proper rolling temperature will be maintained and it can be reduced to any thinness practicable by hot rolling. And since the strip while coiled loses its heat comparatively slowly, under some conditions the reducing operation may be performed without supplying heat to the coilers.

In efforts to roll single lengths of wide, very thin strip difficulties have been encountered in properly entering and delivering the strip into and from the reducing rolls. In the practice of the present invention such difficulties can be eliminated by making the final reducing passes while retaining the opposite ends of the strip in the opposite coilers, or at least back of the pinch-rolls, and shearing off the short unreduced opposite end portions, which will be only a negligible part of a long strip. In such case, after the final pass from left to right, the reducing rolls can be opened and the unreduced end drawn through and sheared off, and the finished strip then fed down onto the left-hand delivery-table 3 and the opposite end sheared off.

It will be noticed also that if the tilting sections of the chutes are turned to horizontal position, the mill with the opposite tables 3 may be used for rough rolling in the usual manner.

It is obvious that the coilers may be heated by the combustion of fuel instead of by electrically generated heat, and it is also the fact that many changes may be made in the structure and the various operating means here-

in shown and described without substantial departure from the invention as defined in the respective appended claims.

In the introductory part of this specification we have described this invention as particularly applicable to the hot rolling of iron or steel strips or strip sheets of light gauge and of great length. Heretofore in the art the term "strip" has been used to designate a long, thin piece of metal which is comparatively narrow, say of a maximum width of sixteen inches. Our invention is not limited to the manufacture of such pieces, but it is the intention to cover in the appended claims the manufacture of long, thin pieces of metal of any practicable width, and designated by us generally (whether narrow or wide) as thin metal strips.

We claim as our invention:

1. In a rolling-mill for the manufacture of hot-rolled thin metal strips, the combination with reducing rolls, of a pair of heating-chambers arranged one on each side of said rolls each having an opening for the passage of strip, means for supplying heat to each chamber, a winding-reel mounted in each chamber, means for guiding the strip from the rolls to each reel, means connected to each reel for alternately securing and releasing the strip, and means for operating each reel and winding the strip thereon.

2. In a rolling-mill for the manufacture of hot-rolled thin metal strips, the combination with reducing rolls, of a pair of heating-chambers arranged one on each side of said rolls each having an opening for the passage of the strip, means for supplying heat to each chamber, a winding-reel mounted in each chamber, means for guiding the strip from the rolls to each reel, means for securing the strip to each reel, means for operating each reel and winding the strip thereon, and means for returning the strip from each reel to the rolls.

3. In a rolling-mill for the manufacture of hot-rolled thin metal strips, the combination with reducing rolls, of a winding-reel adapted to receive the strip from the rolls, means for securing the strip to the reel, means for operating the reel and winding the strip thereon, and yielding means for exerting tension upon the strip between the rolls and the reel.

4. In a rolling-mill for the manufacture of hot-rolled thin metal strips, the combination with reducing rolls and mill tables arranged on opposite sides of said rolls, of a pair of winding-reels arranged one on each side of said rolls and above said tables, and chutes leading from said rolls to said reels, each of said chutes having a movable lower section.

5. In a rolling-mill for the manufacture of hot-rolled thin metal strips, the combination with reducing rolls, of a winding-reel adapted to receive the strip from the rolls, a guide for the strip adjacent to the reel, and means for moving the guide to and away from the reel.

6. In a rolling-mill for the manufacture of hot-rolled thin metal strips, the combination with reducing rolls, of a winding-reel adapted to receive the strip from the rolls, means for securing the strip to the reel, means for operating the reel and winding the strip thereon, and means for exerting tension upon the strip between the rolls and the reel, said tension-exerting means comprising a pair of spaced shiftable rollers adapted to bear one upon each face of the strip and fluid-pressure means for shifting said rollers.

7. In a rolling-mill for the manufacture of hot-rolled thin metal strips, the combination with reducing rolls, of a winding reel having an orifice adapted to receive the advance end of a strip delivered from the rolls, a movable locking-member adapted to lock the strip against the wall of the orifice, means for operating the locking-member, and means for operating the reel and winding the strip thereon.

8. In a rolling-mill for the manufacture of hot-rolled thin metal strips, the combination with reducing rolls, of a winding-reel adapted to receive the strip from the rolls, means for securing the strip to the reel, a motor detachably connected to the reel for rotating the reel and causing it to wind up the strip, means for disconnecting the motor, means for returning the strip to the rolls and thereby causing reverse rotation of the reel, and means for automatically stopping such reverse rotation at a predetermined point.

9. In a rolling-mill for the manufacture of hot-rolled thin metal strips, the combination with reducing rolls, of a winding-reel having a strip-receiving orifice adapted to receive the strip from the rolls and means for securing the strip to the reel, a guide for the strip adjacent to the reel, a motor detachably connected to the reel for rotating the reel and causing it to wind up the strip, means for disconnecting the motor, means for returning the strip to the rolls and thereby causing reverse rotation of the reel, means for stopping such reverse rotation, and a second motor for moving the reel to strip-receiving position with said orifice in alignment with said guide.

10. In a rolling mill for the manufacture of hot rolled thin metal strips, the combination with reducing rolls and mill tables arranged on opposite sides of said rolls, of a pair of winding reels arranged one on each side of said rolls and above said tables, and chutes leading from said rolls to said reels, said chutes being movable at least in part so as to lie clear of material on said mill tables.

11. In combination with a mill, a mill table on either side of the mill arranged to support material while the same is rolled back and

forth through the mill, means for effecting coiling of the material on either side of the mill as it issues therefrom, and pinch rolls for engaging the issuing material prior to the coiling thereof, the pinch rolls being so arranged as to be out of the way of material rolled back and forth on the mill tables.

12. In the method of rolling in a mill, the steps consisting in supplying a generally flat piece of material, rolling the same back and forth in the mill while it is in substantially flat form, continuing the rolling back and forth in the same mill and alternately coiling and uncoiling the rolled material.

13. In the method of rolling strip material in a mill, the steps consisting in rolling material back and forth while in substantially flat condition, and, after it has reached a desired thinness, rolling it back and forth in the same mill to effect a further reduction and coiling the same after each pass.

14. In the method of rolling in a mill, the steps consisting in rolling the material back and forth, engaging the surfaces of the issuing material after each pass so as to feed the same forward and exert a tensic ı thereon, coiling the material beyond the point of engagement by the pinch rolls, and uncoiling and feeding it back through the pinch rolls to the mill.

15. In the method of rolling in a mill, the steps consisting in rolling material back and forth in substantially the flat state, and thereafter continuing the rolling by successive passes in said mill but diverting the material from its path and effecting coiling of the same.

16. In combination with a mill, a table on either side of the mill of such character as to support a flat piece of material from the time of issuance thereof from between the rolls of the mill until it has been fed back through the mill, the tables being effective for supporting the material while it is relatively thick and in an uncoiled state, and coilers adapted for automatically reeling and paying out material rolled on the mill when the same has been thinned and elongated.

17. In combination with a mill, a table on either side of the mill of such character as to support a flat piece of material from the time of issuance thereof from between the rolls of the mill until it has been fed back through the mill, the tables being effective for supporting the material while it is relatively thick and in an uncoiled state, coilers adapted for automatically reeling and paying out material rolled on the mill when the same has been thinned and elongated, and means for maintaining the coiled material at elevated temperature.

18. In combination with a mill for rolling material first in one direction and then in the other, a roll table on either side of the mill whereby a piece in flat or slab-like condition may be rolled back and forth and supported substantially in its entirety on the tables during such rolling, and coilers adapted for automatically reeling and paying out material rolled on the mill after the same has been thinned and elongated.

19. In combination with a mill for rolling material first in one direction and then in the other, a roll table on either side of the mill whereby a piece in flat or slab-like condition may be rolled back and forth and supported substantially in its entirety on the tables during such rolling, coilers adapted for automatically reeling and paying out material rolled on the mill after the same has been thinned and elongated, and means for guiding the material to the coilers.

20. In combination with a mill for rolling material first in one direction and then in the other, a mill table on either side of the mill arranged to support material in a flat condition while the same is rolled back and forth through the mill, means for effecting coiling of material on either side of the mill as it issues therefrom, and means for diverting material from the plane of a mill table into a path to be engaged by the coiler.

21. In combination with a mill for rolling material first in one direction and then in the other, a mill table on either side of the mill arranged to support material in a flat condition while the same is rolled back and forth through the mill, means for effecting coiling of material on either side of the mill as it issues therefrom, pinch rolls for engaging the issuing material prior to the coiling thereof, and means for diverting material from the plane of a mill table into a path to be engaged by the coiler.

22. In combination with a rolling mill, a mill table on either side of the mill arranged to support material while the same is rolled back and forth through the mill in the flat state, means for deflecting material upwardly from the plane of the tables, and a coiler on either side of the mill for engaging and coiling the deflected material.

23. In combination with a rolling mill, a mill table on either side of the mill arranged to support material while the same is rolled back and forth through the mill in the flat state, means for deflecting material upwardly from the plane of the tables, a coiler on either side of the mill for engaging and coiling the deflected material, and chambers above the plane of the tables containing the coilers, the chambers being arranged to prevent loss of heat of the coiled material.

24. In a method of rolling strip in a mill adapted to roll material first in one direction and then in the other and having pinch rolls on the opposite sides thereof, the steps including reducing the strip in the mill and passing it through the pinch rolls on the exit side of the mill and coiling the material be-

yond said pinch rolls, continuing the rolling until the trailing end of the strip passes through the mill rolls, stopping the material, and utilizing said pinch rolls to feed the material back to the mill.

25. In a method of rolling strip in a mill adapted to roll material first in one direction and then in the other and having pinch rolls on opposite sides thereof, the steps including driving the pinch rolls on the entering side of the mill to feed the leading end of a strip toward and through the mill and through the pinch rolls on the exit side, coiling the material beyond the last-mentioned pinch rolls, continuing the rolling until the trailing end of the strip passes through the mill rolls, and reversing the last-mentioned pinch rolls to feed the strip back toward and through the mill.

26. In a method of rolling strip in a mill adapted to roll material first in one direction and then in the other, and having pinch rolls on opposite sides thereof, the steps including reducing the strip in the mill, passing the leading end of the strip through the pinch rolls on the exit side thereof and coiling the material beyond said pinch rolls, continuing the rolling until the trailing end of the strip passes through the mill rolls, stopping the material before the trailing end has passed through the pinch rolls, and utilizing the pinch rolls for feeding such end of the strip back to the mill.

ROBERT M. KEENEY.
JOHN F. FERM.