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J. E. MONTGOMERY ET AL

2,102,184

METHOD AND APPARATUS FOR ROLLING METALLIC STRIP

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4 Sheets-Sheet 1

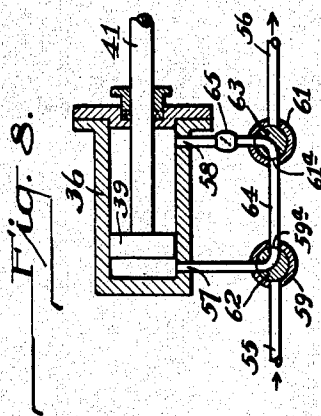
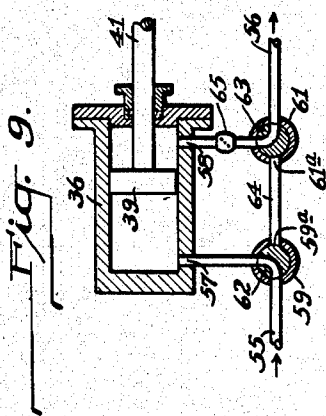
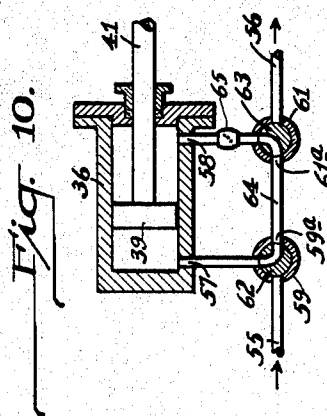
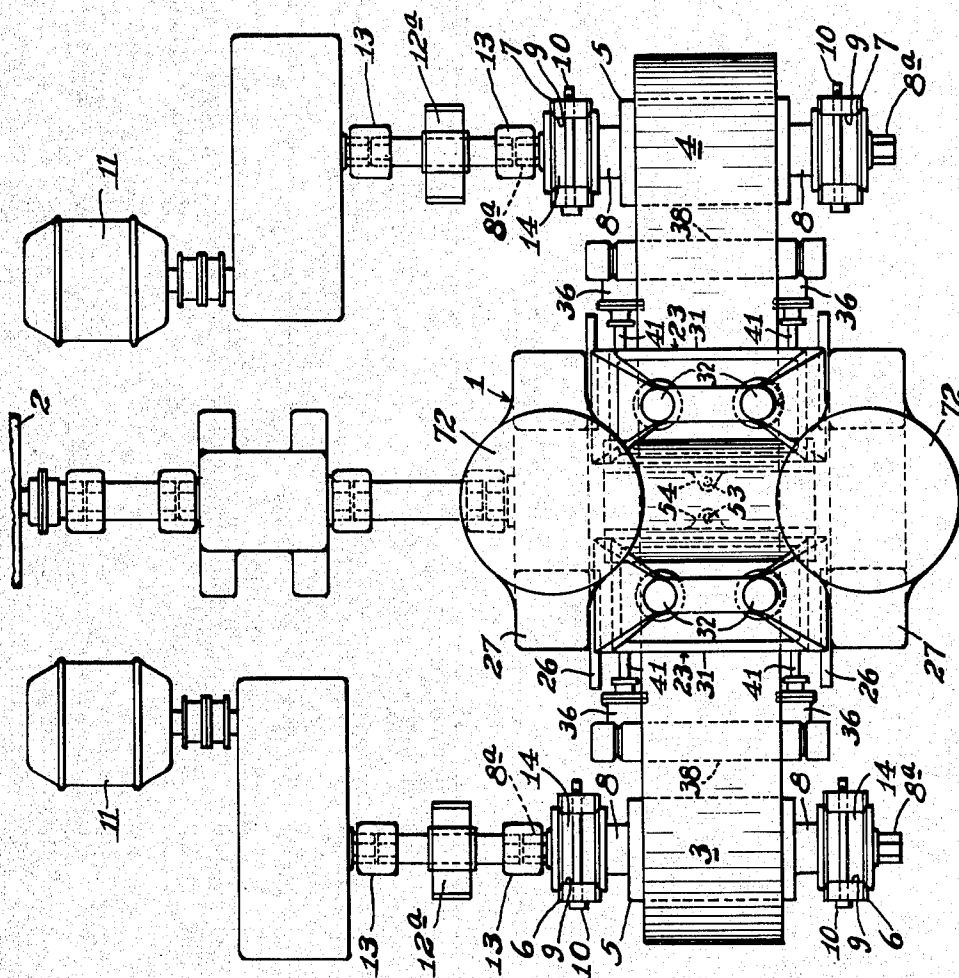


Fig. 1.

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Fig. 3.

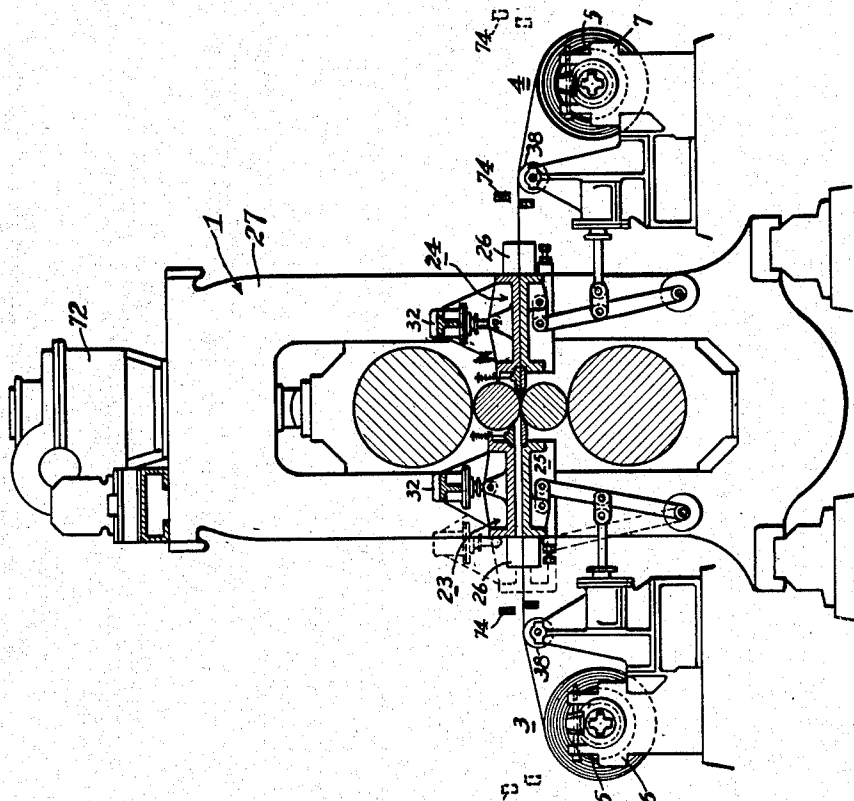
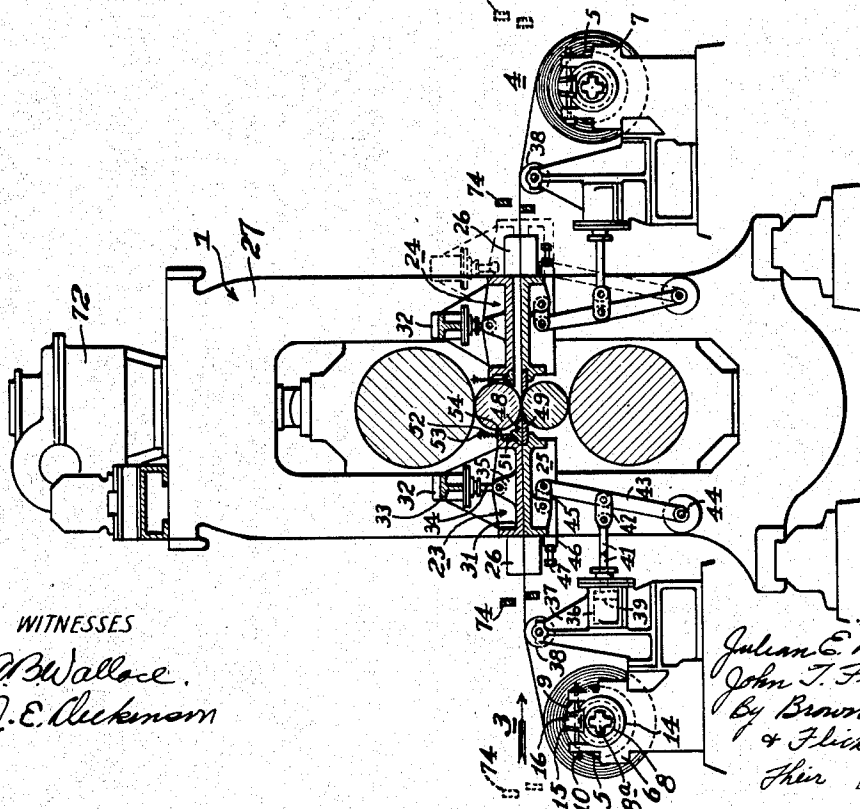


Fig. 2.



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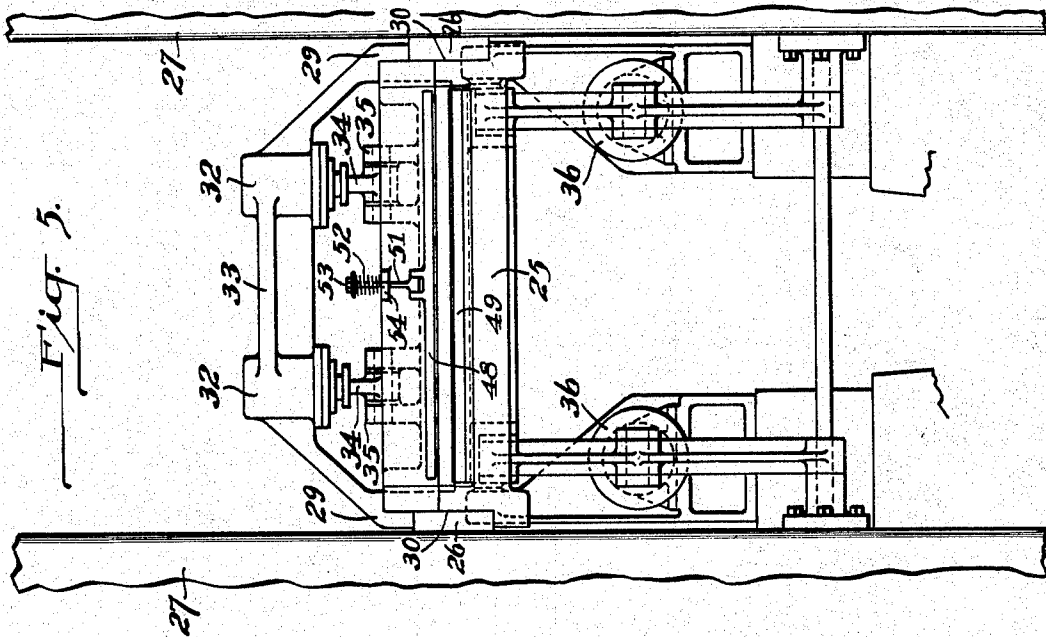


Fig. 5.

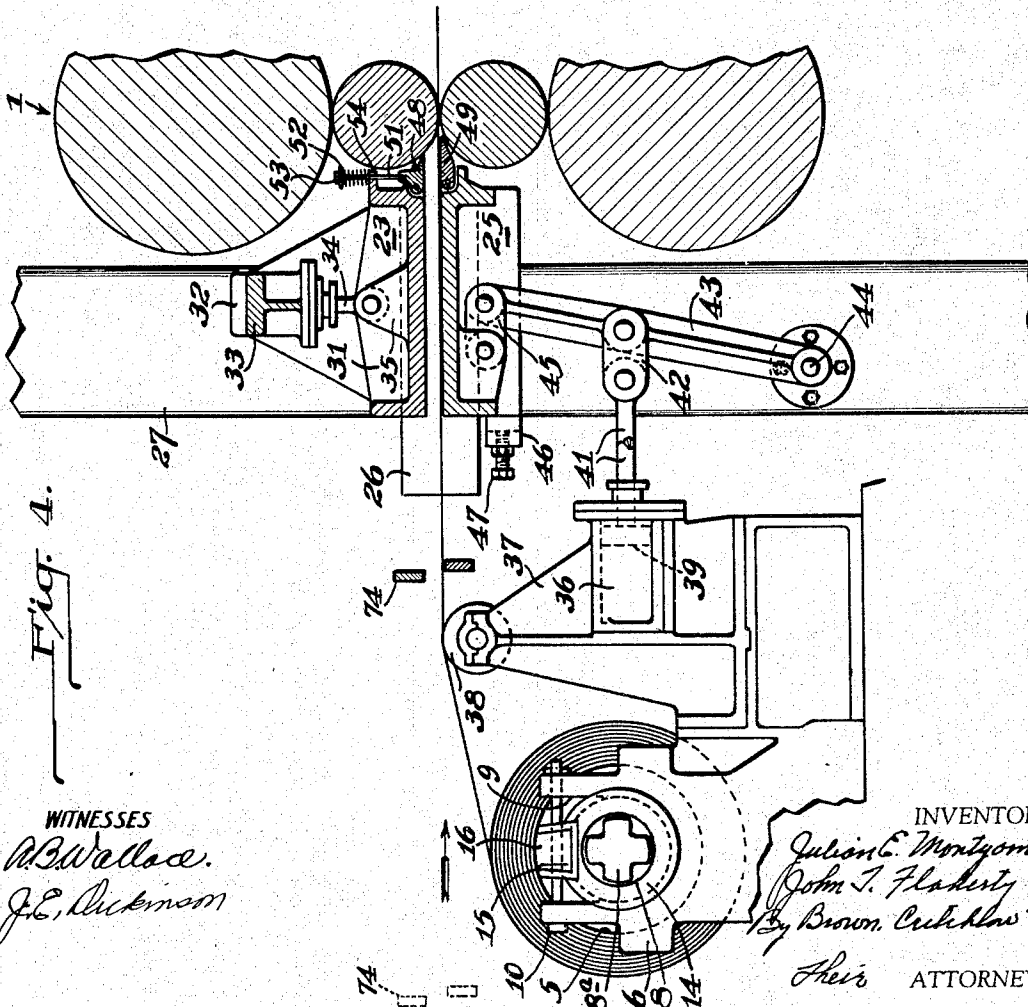


Fig. 4.

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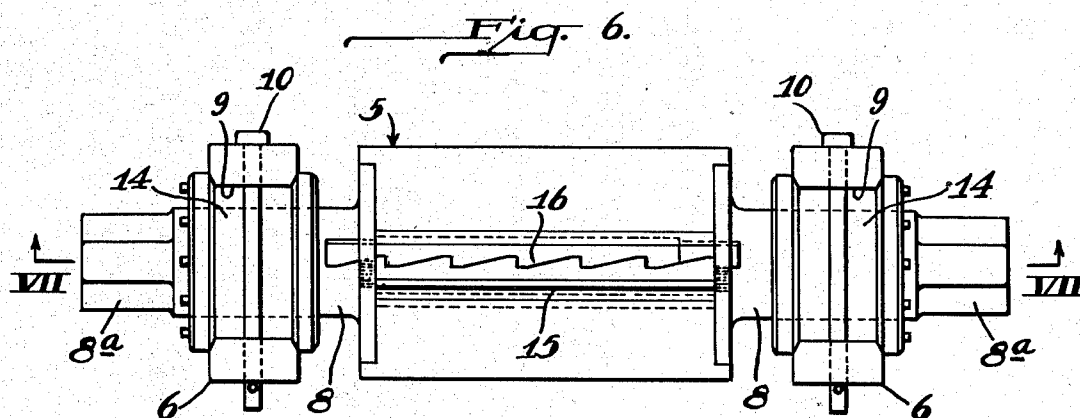
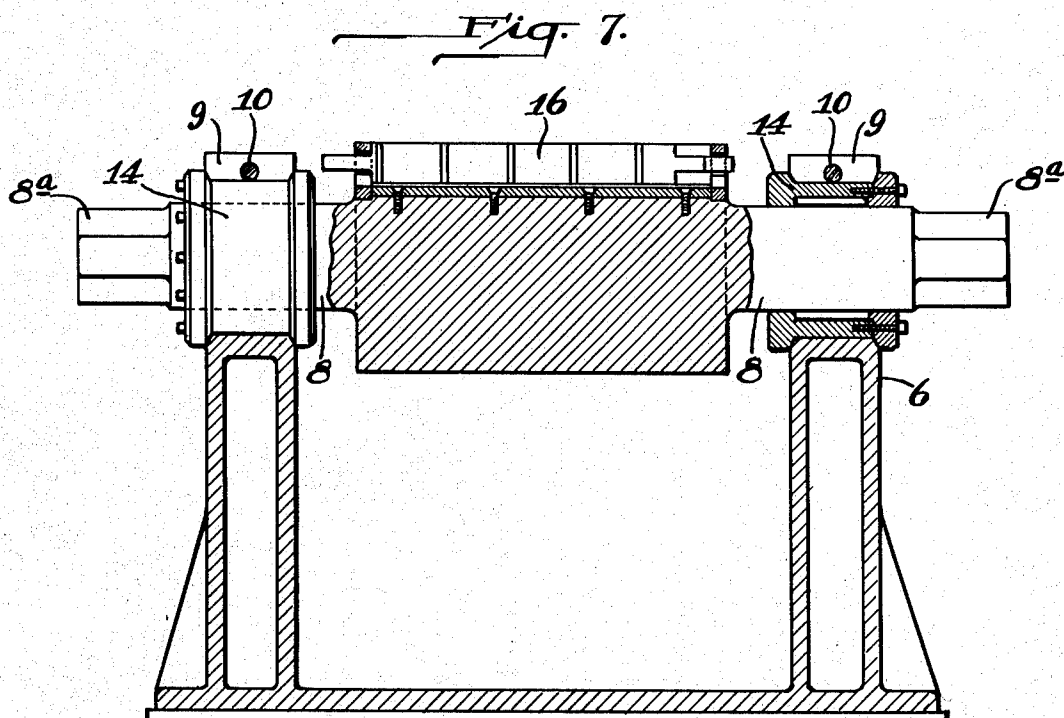
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METHOD AND APPARATUS FOR ROLLING
METALLIC STRIP

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This invention pertains to the cold rolling of metallic strip, and while not necessarily so limited relates more particularly to an improvement in method and apparatus for the cold rolling of strip steel.

Strip steel and the like is customarily made by rolling a hot slab to strip form in a continuous hot strip mill and then reducing it to the finished dimensions in a cold finishing mill. While there are a number of different kinds of cold mills used for this purpose, they may be classified generally as of three different types. These are the continuous type of mill in which a plurality of tandemly arranged roll stands is used and through which the strip is passed in succession, the single roll stand mill which is operated in one direction only and through which the strip is re-passed as many times as may be required, and the single reversible stand mill in which the strip is passed back and forth until finished.

A fault common to all of these prior mills where they are provided with means for tensioning the strip, in accordance with a well-known practice as it is passed through them, is that they are incapable of tensioning and working a considerable length of the end portions thereof in the same way that the rest of the strip is worked. Due to this these end portions have to be scrapped, and not infrequently the loss which they represent exceeds in value the entire labor cost of the finished strip.

Another disadvantage of the tandem type mill is that it involves a tremendously large investment, and all of the roll stands thereof have to be shut down whenever any part of the mill goes wrong. In the prior single stand mills in which the strip is rolled one or more times in the same direction there is also the further disadvantage that considerable time is lost in transferring the strip around the mill between passes as well as the fact that considerable transfer apparatus is required for such purpose. In the reversing type mills it is the usual practice to engage the ends of the strip in reels or winding devices, on which the strip is coiled, at the two sides of the mill and to never release them during the rolling operation. This results in such portions of the strip not being worked at all.

With the foregoing in mind, it is the primary object of this invention to provide an improved method and apparatus for the cold rolling of strip material under tension, which is efficient and economical to both install and operate, and which greatly reduces the amount of waste material ordinarily produced at the ends of the strip.

A more specific object is to provide for the cold rolling of strip steel, or the like, in a single reversing roll stand and for passing the entire strip through the mill each time it is worked while at the same time maintaining it under tension from end to end during the entire rolling operation.

Another object is to provide a reversible cold mill which is equipped to pass the strip all the way through the mill each time it is rolled and to reenter it in the mill without releasing the tension in the coil on either side of the mill.

These and various other objects as well as various other novel features and advantages of the invention will be apparent when the following detailed description is read in conjunction with the accompanying drawings, of which Fig. 1 is a plan view of a mill layout designed to practice the invention; Figs. 2 and 3 sectional views taken through the center of the mill illustrated in Fig. 1 showing it operating in opposite directions; Fig. 4 a sectional view to enlarged scale of the strip-handling mechanism at one side of the mill showing the sticker in position to enter the strip into the mill rolls; Fig. 5 an elevational view looking into the mill end of one of the combination strip-tensioning and feeding stickers; Fig. 6 a plan view of one of the reel drums together with its support and drive; Fig. 7 a section taken on the line VII—VII of Fig. 6; Fig. 8 a sectional view of one of the hydraulic motors used for actuating the feeding and tensioning stickers together with its operating controls showing the position of the plunger of the motor and its control valves when the sticker is idle and in its outermost position; Fig. 9 a view similar to Fig. 8 but showing the position of the control valves and the motor plunger when the sticker is being moved toward the mill; and Fig. 10 another view similar to Fig. 8 showing the position of the control valves when the plunger is being operated as a dash-pot or brake to resist the movement of the sticker away from the mill.

In accordance with the invention a single reversing roll stand 1 of the 4-high type, as illustrated in the drawings, is preferably all of the rolling apparatus that is used to perform the cold rolling operations. For driving such stand it is equipped with a reversible motor 2, while for handling the strip passed through it, suitable coil-supporting and strip-rewinding apparatus, designated generally by the reference characters 3 and 4, is provided.

This latter apparatus may obviously take various forms, but as shown it comprises a pair of portable winding drums 5 which are detachably

supported in a pair of coil boxes 6 and 7 suitably spaced from the roll stand. Preferably the strip is wound on one of these drums after it leaves the hot mill and is delivered thereon to one of the coil boxes 6 or 7, an empty drum 5 being provided in the other coil box. Referring more particularly to Figs. 1, 6, and 7, the drums 5 are provided at their ends with supporting and driving necks or trunnions 8 and the coil boxes 6 and 7 with recesses 9 in their side walls wherein such necks are detachably held in place by suitable retainers 10. For driving them suitable driving motors 11 are provided adjacent one end of each of the coil boxes, being connected to the drive shafts 12 equipped with suitable couplings 13 which are adapted to be detachably connected to the ends 8a of the drum necks 8, such ends being properly developed for this purpose. To also facilitate the rotation of the drums the necks 8 are equipped with roller bearing sleeves 14 which are in turn provided with flanges adapted to straddle the wall structure of the coil boxes and hold them against axial displacement.

In their details of construction the winding drums 5 may be widely varied so long as they are adapted to effectively engage the end of the strip to permit a tension being applied to it and to also readily release the strip when such is desired. In addition, they may be either automatically or manually operable, and those shown are of the latter type in which the end of the strip is inserted in a slot 15 and releasably locked in place by an axially adjusted wedge acting type of clamping bar 16.

For feeding the ends of the strip into the mill rolls and also tensioning it as soon as it is engaged in the mill, as well as preventing the tension in the winding reel from being relieved when the trailing end of the strip leaves the mill, a pair of strip-sticking and tensioning devices 23 and 24, referred to hereinafter as stickers, is provided at the two sides of the mill adjacent the working rolls. As shown, these devices each comprise a main frame 25 which is mounted for guided reciprocatory movement in a horizontal plane toward and from the mill rolls on a pair of guide bars 26 secured to the inner faces of the roll housings 27, the frame 25 being provided with grooves 30 in its side walls 29 for the reception of such bars. The upper surface of this frame is made flat and is disposed in the plane of the roll pass to support the strip. Above it there is arranged for vertical reciprocatory movement between its side walls 29 a shoe 31 which is disposed to clamp the strip against the frame so that together they are operable for sticking the strip into the mill rolls and tensioning it after it is engaged in the rolls.

To operate each of these clamping shoes 31 a pair of pressure-applying and lifting motors 32 is mounted on a cross member 33 secured to the side walls 29 of the frame 25. In the form shown these motors may be either of the hydraulic or electromagnetic type provided with plunger or armature-operated connecting rods 34 which are connected to brackets 35 located at the top of the shoe 31 adjacent its ends. All that is essentially required of these motors is that they have sufficient power to lift the shoes when desired and to exert the necessary pressure upon them to give the gripping action on the strip needed for feeding it into the mill and for tensioning after it is engaged in the mill.

For moving the stickers 23 and 24 toward the mill, hydraulic motors 36 are provided, being sup-

ported in the uprights 37 which comprise the supports for idler rolls 38 arranged in the plane of the roll pass between the stickers and the coil boxes to facilitate the delivery of the strip from the winding drums to the stickers and from the stickers to the winding drums. The plungers 39 of these motors, two of which are associated with each sticker, are connected by connecting rods 41 and links 42 to the mid-section of a pair of levers 43. These levers are in turn secured at their lower ends to fixed pivots 44 and pivotally connected at their upper ends by links 45 to the under side of the frames 25 adjacent the outer end of the latter. Consequently when the plungers 39 are forced outwardly the stickers are actuated toward the mill.

To limit the forward movement of the stickers, arms 46 are provided on the outer ends of the frames 25 and disposed to project over the outer face of the mill housings. In these arms suitable adjusting screws 47 are threadably mounted and adapted to engage the mill housings and determine the inward movement of the stickers as may be desired.

To also provide for insuring against the strip passing otherwise than through the stickers when it issues from the mill, as well as remove foreign material from the mill rolls, a pair of wiper guides 48 and 49, which are disposed to bear against the surface of the working rolls, is pivotally mounted on the mill ends of frames 25 and shoes 31. The upper of these guides is resiliently maintained in contact with the upper mill roll by means of rods 51 secured to the mid-section thereof and springs 52 mounted on such rods below their heads 53 and above brackets 54 on the shoes through which the rods project. The lower of these wipers, 49, is held in contact with the lower working roll by gravity.

As schematically illustrated in Figs. 8, 9, and 10, the pressure supply for the sticker-actuating motors 36, which may be of any suitable form, is furnished by a supply line 55 and the exhaust of the motors disposed of by an outlet pipe 56. In these pipes, which are connected respectively to the inlet and outlet ports 57 and 58 at the ends of the motor cylinders, there is provided a pair of two-way valve casings 59 and 61 equipped with valves 62 and 63 and cooperating ports 59a and 61a which are connected together by a pipe 64. With this arrangement when the valves 62 and 63 are adjusted as shown in Fig. 8, the pressure supply for the motors is shut off, and when adjusted as shown in Fig. 9, it is communicated to the rear end of the motor cylinders to force the piston 39 outwardly and the associated stickers toward the roll stand.

For a purpose which will be presently more fully described, one-way check valves 65 are provided in the exhaust lines 56 between the motor cylinders and control valve casings 61. These check valves, which may be of any well-known construction, are adapted to permit free flow of the motor pressures out of the motor cylinders by way of the exhaust outlet, but only restricted flow in the reverse direction. Hence when the valves 62 and 63 are adjusted to the positions shown in Figs. 8 and 10 movement of the pistons 39 toward the rear of the motor cylinders is determined by the pressure on the pistons and the setting of the check valves 65. Thus the motors are adapted to resist the rearward or outward movement of the stickers.

In practicing the invention a loaded drum 5 is mounted in one of the coil boxes, say the coil

box 6, in a position for the strip to be unwound from the top of the coil. It is then connected by the coupling 13 to the drive shaft 12 associated therewith. The motor 11 connected to such shaft, which is of the reversible type, is then excited to operate in a direction to unwind the strip from the drum until the free end of the coil is passed over the associated idler roll 38 and through the adjacent sticker 23 previously actuated to its outer position. When the forward end of the strip projects beyond the forward end of the sticker 23 far enough for the sticker to force such end into the mill rolls when it is moved to its forward position, the shoe 31 is then clamped against the strip by the motors 32. The sticker is then moved to its feeding position by its actuating motors 36, the mill, of course, being previously set in motion in the proper direction by its driving motor 2.

As soon as the working rolls begin to pull the strip through the mill it is placed under tension by the sticker, and the sticker, being stationary, functions as a drag. To maintain this tension after the rolling gets under way, and without the aid of the sticker, which for many purposes may be desirable, a brake 12a is provided on each of the drive shafts 12 to resist the rotation of the unwinding drum 5. This may, of course, also be accomplished by dynamically or regeneratively braking the rotation of the motor associated with such drum.

On issuing from the mill the leading end of the strip is passed through the sticker 24, which is previously actuated to a point adjacent the mill, and engaged in the clamping means of the drum 5 comprising the winding reel. Once it is so engaged the motor 11 for the latter drum is excited to cause the drum to wind the strip thereon and also tension the forward end to the extent desired. When the last turn of the strip unwinds from the unwinding drum 5 at the front of the mill, the entering sticker 23, if previously released, is reclamped upon the strip to maintain the tension in the strip until the trailing end thereof is pulled from the sticker. Hence all of the strip except the very small length between the sticker and mill is maintained under tension while it is being rolled.

Slightly before the tail-end of the strip leaves the mill rolls the shoe 31 of the sticker 24 at the discharge side of the mill is actuated to engage the strip and, as the valves 62 and 63 of the sticker motors 36 are previously adjusted to the positions shown in Figs. 9 and 11, the sticker 24 is now pulled back with the strip and against the resistance offered by the enclosed fluid in the cylinder. This resistance serves to maintain the tension in the strip while the tail-end is out of the mill. The sticker is then operated in the reverse direction to reinsert the tail-end of the strip back into the mill for reverse rolling. To prevent the winding motor 11 from drawing the strip through the sticker 24, its associated brake may be applied and its current supply reversed when it is stopped.

Before repassing the strip through the mill, its working rolls are adjusted by the screw-down mechanism 72 provided for such purpose and the driving motor 2 of the mill reversed. When this is done the sticker 24 is actuated to stick the end of the strip back into the mill and the previously described operations repeated in the reverse direction. These operations, are, of course, repeated as many times as may be desired and the finished coil removed from the coil box in which it

is supported when the rolling operations are completed.

As a further feature of the invention, shears 74 either of the stationary or of the flying type may be arranged adjacent the reel drums 5 and utilized to remove the fish-tails which form on the ends of strip to facilitate the entry of the strip in the gripping elements of the winding drums. Such shear, as shown in full and dotted lines, may be arranged on either side of the drums.

The controls for the different motors, which have not been shown in detail as such is deemed unnecessary, may, as will be readily appreciated by those skilled in the art, be made in various ways so long as they are capable of providing the proper control for such motor, and if desired may also be made to operate automatically wherever practical.

According to the provisions of the patent statutes, we have explained the principle and mode of operation of our invention, and have illustrated and described what we now consider to be its best embodiment. However, we 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.

We claim:

1. A strip mill comprising a roll stand, means for driving said roll stand in opposite directions, means at opposite sides of said stand for handling the strip and tensioning it while it is engaged in the roll stand, means interposed between said handling means and the roll stand and operative adjacent the roll pass thereof for gripping the strip and positively feeding it into the mill rolls and tensioning it as soon as it is engaged therein, and means for moving said gripping and tensioning means toward and from the roll stand.

2. The method of rolling metal strip which comprises passing the strip completely through the working rolls of a rolling mill in first one direction and then the other and maintaining it under tension from the instant its leading end enters the mill until the rolling is completed.

3. A strip mill comprising a roll stand, means for driving the rolls thereof in opposite directions, means at opposite sides of the mill for delivering the strip to the mill rolls and also tensioning it, and strip engaging means interposed between said strip-delivering and strip-tensioning means at both sides of the mill and movable to and from the mill for positively feeding the leading end of the strip into the rolls and applying a back tension thereto as soon as the strip is engaged in the rolls.

4. The method of rolling metal strip which comprises passing the strip all the way through the working rolls of the mill in opposite directions, applying a back tension to it as soon as the first end is entered in the mill and constantly maintaining said tension in both directions of rolling from the instant the strip is first entered in the mill until the rolling is completed, and also applying a front tension to the strip as it issues from the mill in each direction.

5. A strip mill comprising a roll stand, means for driving the rolls of said stand in opposite directions, a coil-supporting reel at each side of said stand, means for driving and braking said reels to wind and tension the strip when passing through the roll stand in either direction, and strip-engaging means interposed between said reels and the roll stand which is adapted to posi-

tively feed the ends of the strip into the mill rolls and tension it as soon as it is engaged between the rolls and to also grip the trailing ends as they leave the mill and also feed them back into the mill rolls without releasing the tension exerted therein by the reels.

6. The method of rolling metal strip which comprises winding the strip to be rolled in the form of a coil, passing it from the coil into the working rolls of a rolling mill, applying a back tension to it as soon as it enters the mill and maintaining said tension thereon until its trailing end enters the mill, winding the strip into a coil as it leaves the mill and at the same time applying a tension to it, gripping the trailing end as it leaves the mill and preventing the tension in the coil from being substantially relieved, and then repassing the strip in the same manner through the mill in the reverse direction.

7. A strip mill comprising a roll stand, means for driving the rolls of said stand in opposite directions, a coil-supporting reel at each side of said stand, means for driving said reels to wind the strip thereon as it issues from the roll stand and applying a tension thereto, means for braking said reels to exert a tension on the strip as it is being unwound from the reels, and movable means between each of said reels and the roll stand for gripping the trailing end of the strip as it leaves the roll stand to maintain the tension therein and positively feed it back into the rolls.

8. The method of rolling metal strip which comprises positively feeding the strip into the working pass of a rolling mill, applying a back tension to it as soon as it is engaged in the mill, applying a tension to it as it leaves the mill, gripping the strip adjacent the mill just before its trailing end leaves the mill, adjusting the working pass of the mill, and then reinserting the strip between the mill rolls without releasing the tension therein and repassing it through the mill in the same fashion in the reverse direction.

9. In a strip mill, a roll stand, means for driving the rolls thereof in opposite directions, a combination sticker and drag mounted for horizontal reciprocation on each side of said roll stand adjacent the working rolls thereof, means for operating said stickers to engage the strip, means for positively moving said stickers toward the stand to feed the ends of the strip into the mill rolls, and means for resisting the movement of said stickers away from the roll stand.

10. In a strip mill, a roll stand, means for driving the rolls thereof in opposite directions, a combination sticker and drag mounted for horizontal reciprocation on each side of said roll stand, hydraulic means for actuating said stickers toward said roll stand, and means for controlling said hydraulic means to resist the movement of said stickers away from said stand.

11. A strip mill comprising a roll stand, means for driving the rolls thereof in opposite directions, a coil box arranged on opposite sides of said stand, a driving motor associated with each of said coil boxes, a removable coil drum mounted in each of said coil boxes, means for releasably connecting said coil motors to said coil drums, means for braking said drums, a combination sticker and drag mounted for horizontal reciprocation adjacent each side of said roll stand between it and said coil boxes, means for engaging and disengaging said stickers, and means for

moving said stickers toward and resisting their movement from the roll stand.

12. In combination with a strip mill, an uncoiler at one side of said mill adapted to exert a restraining tension on the strip entering said mill, a coiler at the other side of said mill adapted to exert a forward tension on the strip delivered by said mill, and movable means disposed between said coiler and said mill which is adapted to engage the tail-end of the strip as it is leaving the mill rolls and both maintain the tension on the coiled strip and feed the end thereof back into the mill for reverse rolling.

13. In combination with a strip mill, means for coiling strip under tension while it is being rolled, and means disposed between said coiling means and the mill which is operative to maintain the strip under tension from the time it leaves the rolls until it is reentered in said mill and whereby the strip is constantly maintained under tension until the rolling is completed.

14. In combination with a strip mill, means for coiling strip under tension while it is being rolled, means cooperating with said coiling means for maintaining the tension in the strip after it leaves the rolls of said mill, and means for operating said last-mentioned means to feed said strip back into said mill.

15. In combination with a strip mill, means for engaging and tensioning a piece of strip leaving said mill, and means interposed between said last-mentioned means which is operative to engage the strip just before its tail-end leaves the rolls and maintain the tension therein until the end thereof is reinserted in the mill by said last-mentioned means.

16. The method of reducing metal strip which comprises rolling the strip between the working rolls of a mill, coiling said strip under tension as it leaves said mill, and gripping the trailing end of said strip as it leaves the mill without permitting the tension in the strip to be released, said gripping action being yieldable in a direction longitudinal of the strip.

17. The method of rolling strip in a reversing mill having releasable horizontally movable clamps on both sides of the mill which comprises entering the leading end of the strip through and beyond the clamp on the entering side of the mill, engaging said clamp and moving it toward the mill to feed the protruding leading end of the strip between the mill rolls and through the released clamp on the opposite side of the mill, coiling the strip under tension beyond said last-mentioned clamp, engaging said last-mentioned clamp before the trailing end of the strip leaves the mill to maintain the tension therein, and moving said last-mentioned clamp toward the mill to feed the strip back into the rolls.

18. The method of reducing coiled metal strip which comprises passing the strip from the coil into the working rolls of a rolling mill, applying a back tension to it as soon as it enters the mill and maintaining said tension thereon until its trailing end enters the mill, coiling the strip under tension as it leaves the mill, gripping the trailing end before it passes out of the mill and returning it to the mill without allowing the tension in the strip to be released, and then repassing the strip in the same manner through the mill in the reverse direction.

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