March 2, 1937. A. B. MONTGOMERY 2,072,122

ROLLING MILL

Filed Dec. 4, 1934 6 Sheets-Sheet 1

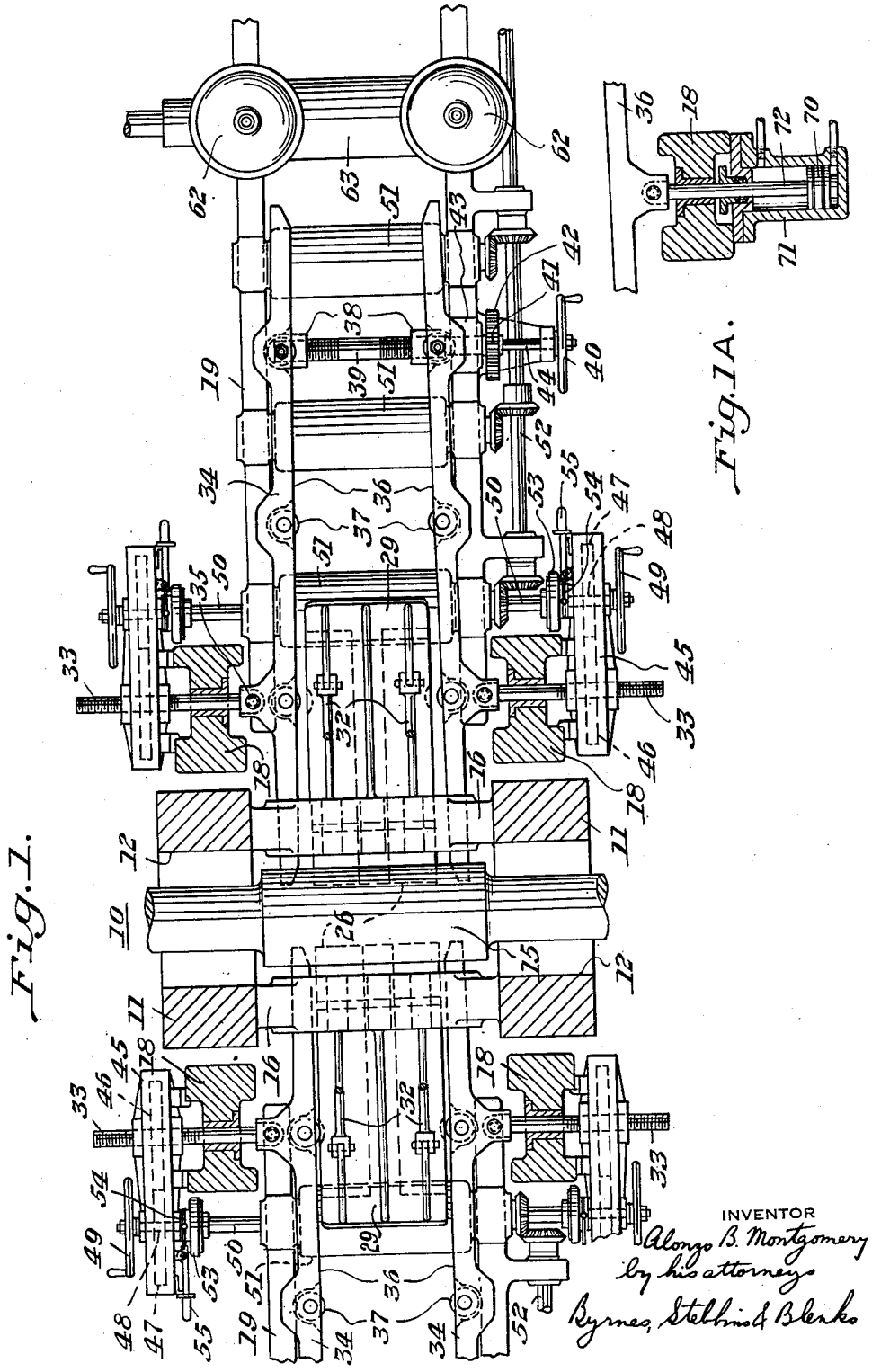

Fig. 1.

Fig. 1A.

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Fig. 3.

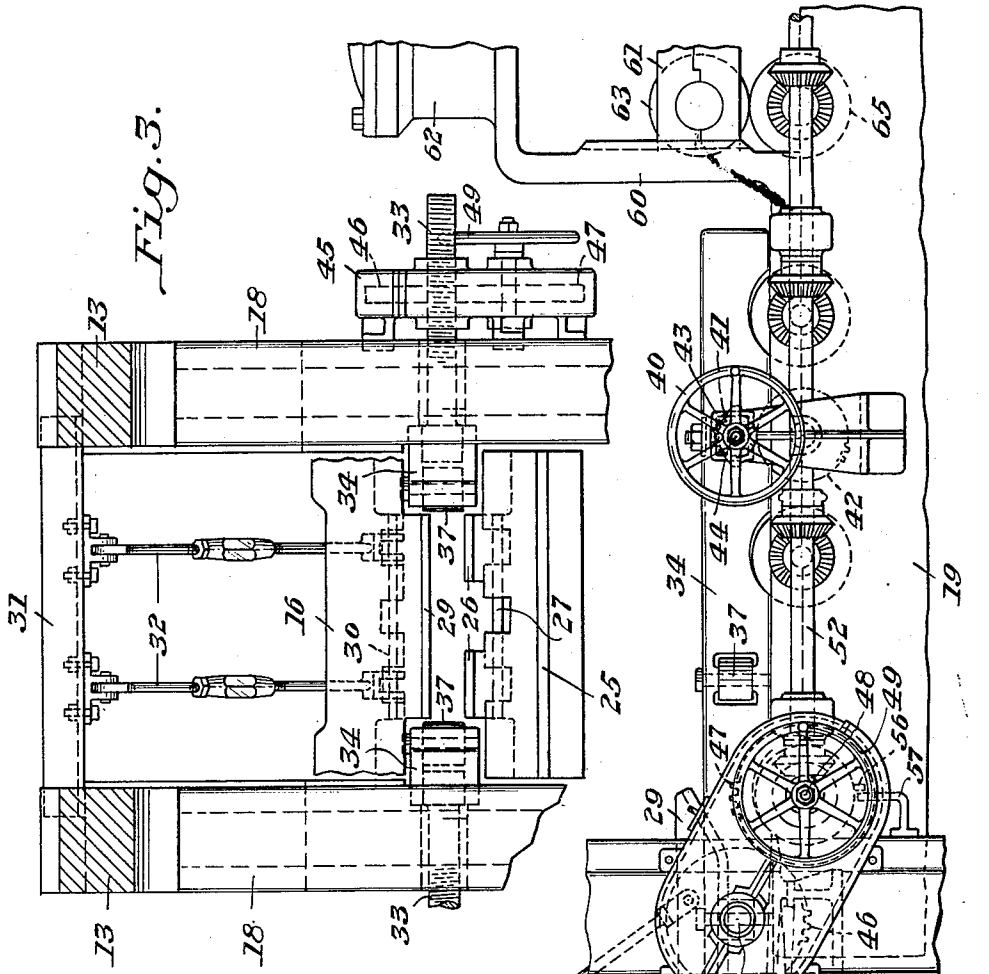
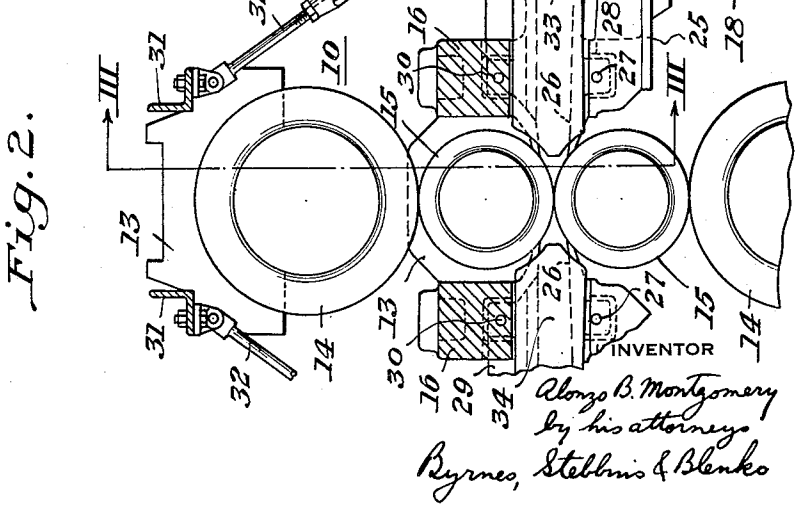


Fig. 2.



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ROLLING MILL

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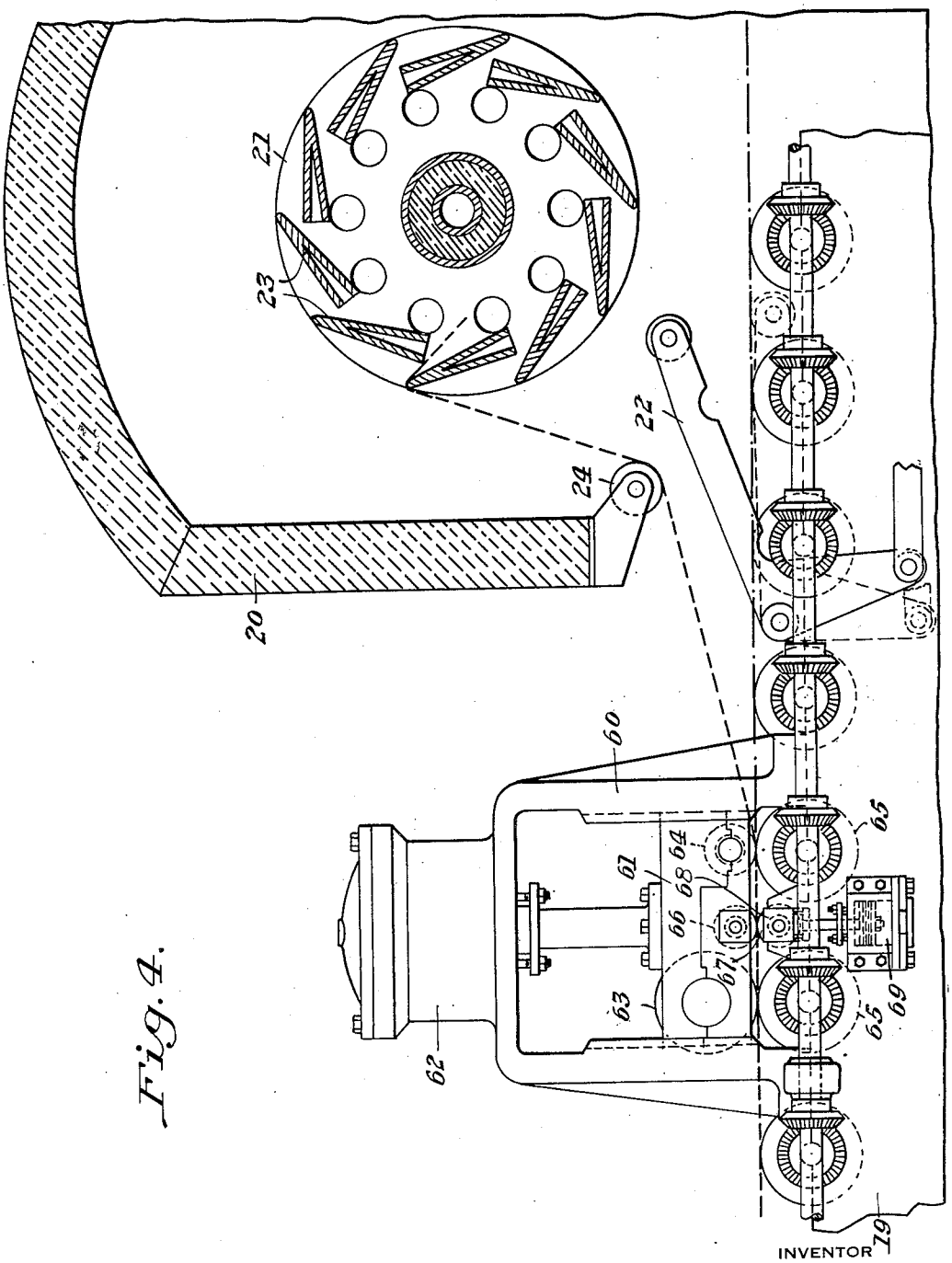

Fig. 4.

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ROLLING MILL

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Fig. 7.

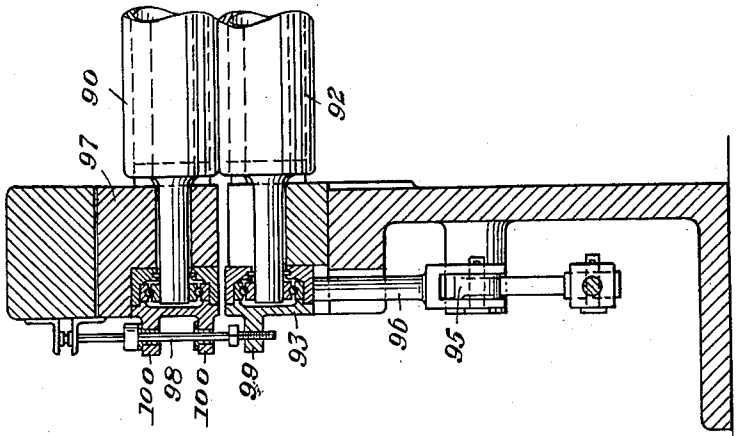

Fig. 5.

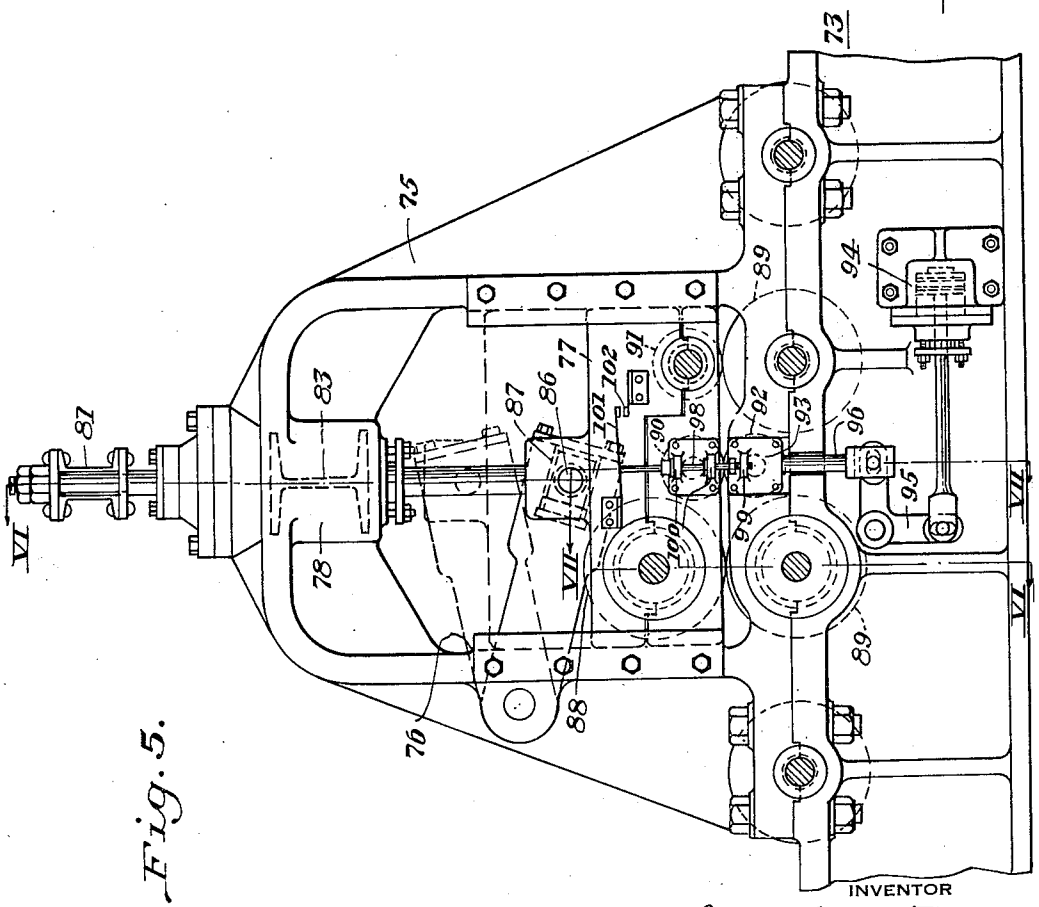

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Fig. 6.

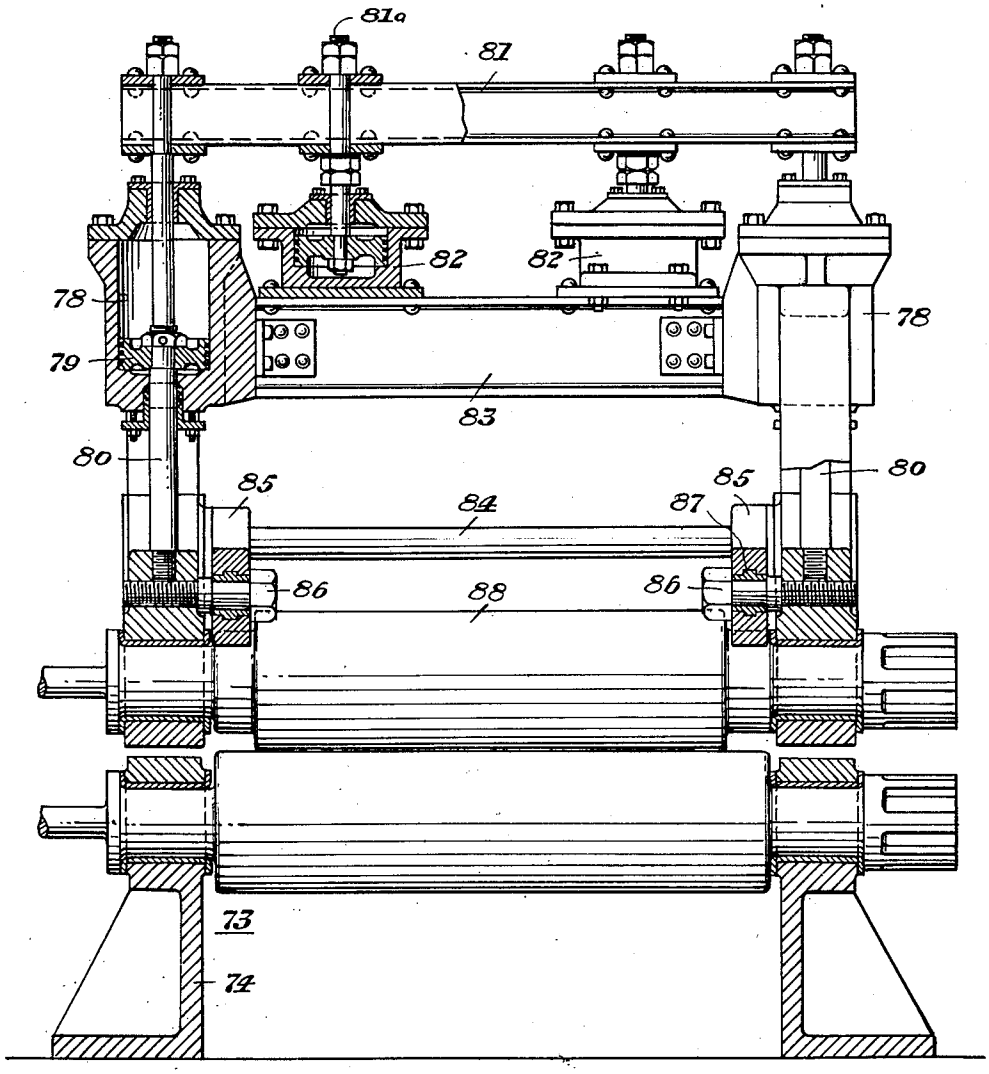

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Fig. 8.

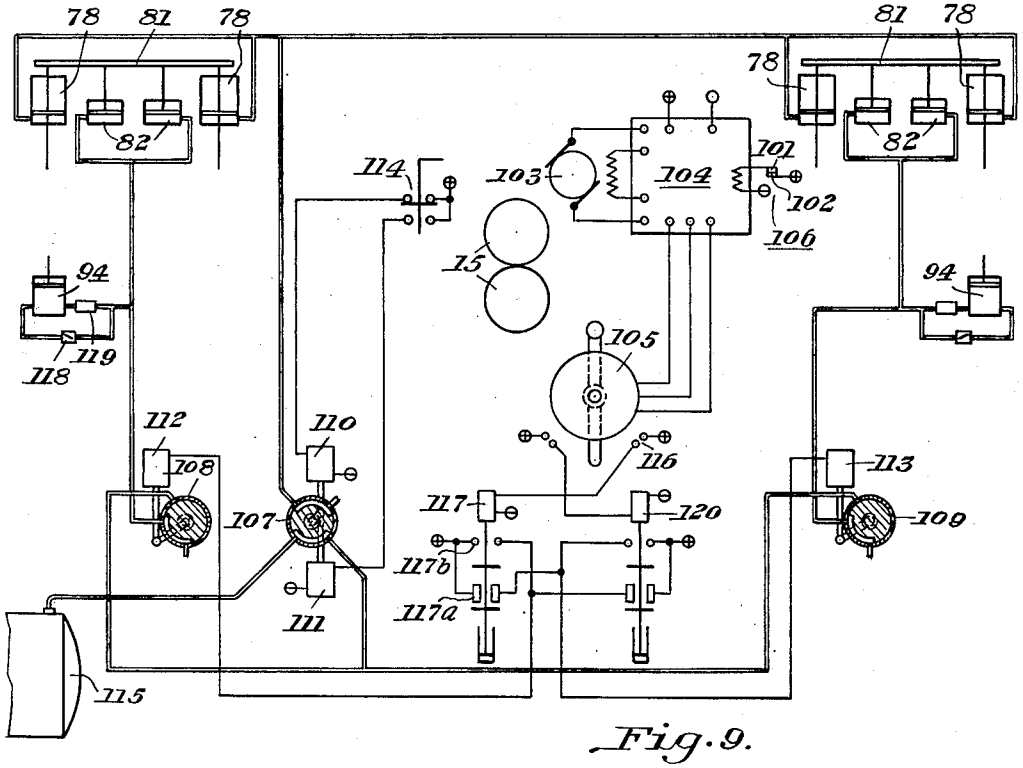
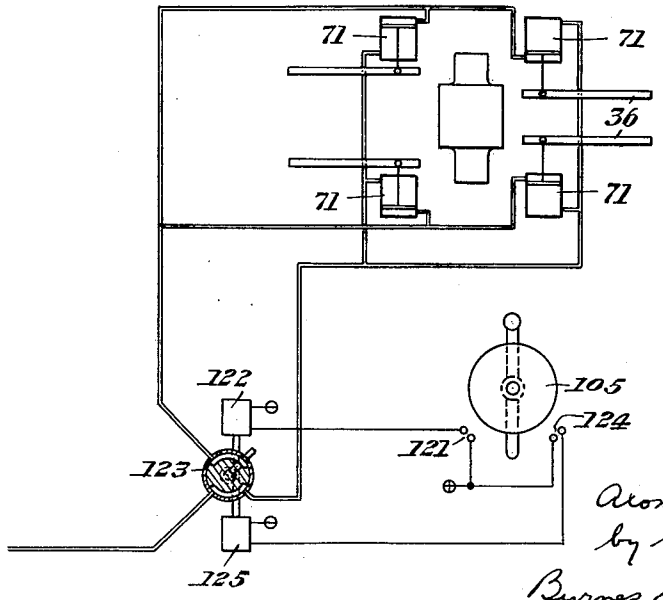


Fig. 9.



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Patented Mar. 2, 1937 2,072,122

UNITED STATES PATENT OFFICE

2,072,122

ROLLING MILL

Alonzo B. Montgomery, Youngstown, Ohio, assignor to The Cold Metal Process Company, Youngstown, Ohio, a corporation of Ohio

Application December 4, 1934, Serial No. 755,886

20 Claims (Cl. 80—32)

My invention relates to the rolling of metal and, particularly, to the hot rolling of strip and a mill therefor.

In the patents to Keeney et al. No. 1,918,968, and Steckel No. 1,977,214, there are disclosed four-high reversing mills with coiling furnaces on opposite sides thereof for hot rolling strip. My invention is concerned generally with improvements in mills of this type.

Commercial use of mills of the Keeney and Steckel type has disclosed the fact that it is sometimes difficult to cause the material being rolled to enter the rolls properly, namely, at precisely right angles to the plane containing the roll axes. The hot strip, being of comparatively small thickness in the later stages of rolling, has little or no rigidity and it has been found that the strip or the slab from which it is rolled, may become cambered or elongated more along one diagonal than the other if great care is not exercised in directing the piece properly into the mill.

Further difficulty has been experienced in causing the leading end of the material properly to engage the coilers within the furnaces on opposite sides of the mill. It frequently happens that the leading end of the piece becomes bent at a slight angle to the main body thereof and this condition, if not corrected, makes it difficult or impossible to cause the material properly to engage the coiler.

I have invented a rolling mill which overcomes the above-mentioned disadvantages of the known mill construction. In accordance with my invention, I provide side guides on both sides of the mill and operate the guides successively to provide a parallel guiding throat on the entering side of the mill and a tapered guiding throat on the other side of the mill. The conditions of the guides on the two sides of the mills are reversed automatically by a change in the direction of the movement of the piece. Means are provided for adjusting the guides initially to cooperate with material of any desired width within the range of a particular construction.

My invention also includes means for flattening or leveling the leading end of the piece prior to engagement with the furnace coiler. This means takes the form of a series of flattening rolls adjacent the furnace mouth. In passing through the rolls, the end of the strip is straightened or flattened so that proper engagement with the furnace coiler is insured practically without exception.

I also provide pinch rolls for feeding the material toward the mill and, after passing through the mill, toward the coilers, between passes, whereby the strip is properly started on the latter. These pinch rolls are automatically raised when the strip has been properly started. They are also withdrawn when the material being rolled is handled back and forth through the mill in the flat without coiling between passes.

For a complete understanding of the invention, reference should be made to the accompanying drawings illustrating a present preferred embodiment thereof. It is to be understood, however, that other embodiments of the invention may be constructed within the scope of my broader claims. Referring to the drawings:

Figure 1 is a horizontal section through a mill having my invention incorporated therein showing parts in plan;

Figure 1A is a partial, sectional view similar to Figure 1 showing a slightly modified form of construction;

Figure 2 is a partial side elevation with the mill housings removed for the sake of clearness;

Figure 3 is a partial sectional view along the line III—III of Figure 2, showing parts in elevation;

Figure 4 is a partial, vertical section through the coiling furnace showing other parts in elevation to a slightly enlarged scale;

Figure 5 is a side elevation similar to Figure 4 showing a modified form of construction embodying pinch rolls particularly adapted for automatic operation, as well as flattening rolls;

Figure 6 is a vertical, sectional view along the line VI—VI of Figure 5 showing parts in elevation;

Figure 7 is a partial, sectional view along the line VII—VII of Figure 5;

Figure 8 is a schematic diagram of the automatic control system for the apparatus of Figures 5 through 7; and

Figure 9 is a similar view of the system for controlling the guides of Figures 1 through 3.

Referring in detail to the drawings, a mill 10 comprises housings 11 having windows 12 for receiving bearing chucks adjustably positioned therein. Backing rolls 14 and working rolls 15 are journaled in the chucks, the rolls preferably having anti-friction bearings, not shown. The housings 11 are connected by transoms 16.

Auxiliary housings 18 are positioned on opposite sides of the mill. Roll tables 19 extend between the housings 18 for conveying material to and from the mill rolls. Furnaces 20 having coilers 21 therein are positioned at a convenient distance from the mill. Tilting guides 22 are provided on the roll tables 19 for diverting material advancing through the mill from a hori-

zontal path of travel into the coilers 21. These coilers are simply spools of convenient size with suitable driving and control equipment, each spool having blades 23 positioned therein, as shown in Figure 4, so that when the leading end of the strip enters one of the coilers between adjacent blades 23, the rotation of the coiler bends the strip around the leading edge of one of the blades. As shown in Fig. 4, the coiling reel is driven in such direction that the blades on the lower side move in a direction opposite that in which the strip moves. The remainder of the strip is then drawn around a scale-breaking roll 24 at the edge of the furnace mouth and wound up on the coiler.

A base 25 is carried between each of the auxiliary housings 18. Bottom guides 26 are pivotally supported on the bases 25 at 27. The guides 26 are also supported by flat seats 28.

Top guides 29 are pivoted at 30 to the transoms 16 and are suspended from angle bars 31 extending across the mill between the chucks 13 for the top backing rolls, by links 32. The inner ends of the guides 26 and 29 are shaped to conform closely to and are actually in contact with the work rolls to effect a stripping action in case the piece tends to follow around the periphery of one or the other of the rolls.

In the subsequent description of the invention, I shall refer specifically to the equipment on the right-hand side of the mill only, as shown in Figures 1, 2 and 4, but it will be understood that duplicate equipment is employed on the opposite side of the mill.

Screw shafts 33 are slidably mounted in the housing 18 parallel to the axes of the mill rolls. Side guides 34 are supported on the screw shafts 33 by hinged joints 35. The guides 34 have a plane inner surface 36 with recesses into which anti-friction rolls 37 are let. The mill ends of the guides extend to a point closely adjacent the rolls, as shown in Figures 1 and 2. The outer ends of the guides are pivotally supported on nuts 38 traveling on a screw shaft 39 journaled in the side frames of the table 19. The ends of the screw shaft 39 are oppositely threaded so that on rotation of the shaft, the outer ends of the guides are moved toward or away from the center line of the table 19.

From what has been said, it will be apparent that my invention provides side guides which may be disposed in parallel relation, as shown on the left-hand side of the mill in Figure 1, or in angular relation, as shown on the right-hand side of the mill in Figure 1, for the purposes, respectively, of definitely and positively guiding the leading end of an advancing strip into the rolls at the proper angle thereto, and providing a tapering throat for receiving the end of the piece as it emerges from the mill. I shall now describe the mechanism for operating the guide supports to bring about the proper relation of the guides at the proper time.

The outer ends of the guides may be adjusted toward or away from each other through the shaft 39, as already described. This adjustment is effected by a hand wheel 40 having a pinion 41 meshing with a gear 42 along the screw shaft 39. A suitable pedestal bearing 43 is provided for the hand wheel shaft 44. The outer ends of the guides 34 are adjusted manually to the proper spacing before commencing the rolling.

The adjustment of the inner ends of the guides 34 is effected through the screw shafts 33. Gear cases 45 attached to the housings 18 enclose gear wheels 46 having their bores threaded for engagement with the shafts 33, and pinions 47 keyed to shafts 48. Hand wheels 49 permit manual adjustment of the screw shafts 33. These shafts are normally driven from extensions 50 of the shaft of one of the rolls 51 of the table 19. The rolls of the table are driven from a line shaft 52 through the usual bevel gears by a reversing motor, not shown. Between the shaft extensions 50 and the shafts 48 are positioned friction clutches 53 and jaw clutches 54 having operating levers 55. The purpose of the friction clutches is to permit the rotation of the shaft 48 to be arrested after a predetermined movement thereof without stopping the operation of the roll 51. The jaw clutches 54 permit the shafts 33 to be freed from the table drive while being manually adjusted.

The friction clutches 53 have detents 56 thereon cooperating with stops 57 on the housings 18 to limit rotation of the shaft 48 to the desired extent. After the detents engage the stops, the adjustment of the shafts 33 ceases but the roll 51 continues rotating with accompanying slippage of the clutches 53.

It will now be apparent that once the outer ends of the guides 34 have been adjusted, the inner ends of the guides will be spread to form a tapering throat or moved together to parallel position with the reversal of the drive for the rolls of table 19. The detents and stops controlling the amount of rotation of the friction clutches will determine the amount of movement imparted to the inner ends of the guides and may, if desired, be made adjustable. It will be understood, of course, that the guide-operating mechanism is designed so that the guides will be spread at the mill end when the table rolls are driven in such a direction as to move material away from the mill. At the same time, the guides on the opposite side of the mill will be actuated to parallel position. In this way, the material advancing toward the mill is definitely and positively alined at right angles to the plane containing the axes of the mill rolls. The emerging material is in no wise obstructed but is gently received within a slightly tapering guiding throat. In both cases, the anti-friction rolls 37 prevent binding and insure continuous, steady forward movement of the material without grabbing or slipping. As before stated, the extreme positions of the inner ends of the guides may be adjusted initially by hand after disengaging the clutches 54. Thereafter, the range of movement of the inner ends of the guides is determined by the location of the detents 56 and stops 57. In the construction illustrated, I have assumed that one complete revolution of the shaft 50 will produce the necessary movement of the inner ends of the guides.

Referring now particularly to Figure 4 for a disclosure of the flattening rolls, housings 60 supported on side members of the roll table 19 have bearing chucks 61 movable vertically therein by means of a pneumatic cylinder 62. Rolls 63 and 64 journaled in the chucks 61 cooperate with adjacent rolls 65 of the table 19. A roll 66 also journaled in the chuck 61 cooperates with a roll 67 journaled in adjustable chucks 68. The chucks 68 are actuated by pneumatic cylinders 69.

The rolls 63 and 65 may be driven and when the former is lowered into engagement with the latter, they serve as pinch rolls to feed the strip toward the mill from the coiler 21. When the

strip has been started through the mill and engages the coiler on the opposite side thereof, the chucks 61 are preferably raised and the rolls 63, 64 and 66 lifted off the strip. The chucks 68 of the rolls 67 are preferably lifted at the same time as the chucks 61. In its normal lower position, however, the roll 67 is effective to assist in flattening or leveling the leading end of the material in its passage from the mill to the coiler. The pinch rolls 63 are lowered, of course, at this time. If the leading end, after passing through the pinch rolls, is deflected downward, it will engage the roll 67 and then the roll 65. On passing between the rolls 64 and 65, the end will be flattened sufficiently to engage the coiler 21 without difficulty. Similar results occur if the leading end of the piece is deflected upward, in which case it will engage the rolls 66 and 64 successively, and after passing between the roll 64 and the roll 65 cooperating therewith, will be found to be satisfactorily flattened. The control of the fluid supplied to the cylinders 62 and 69 has not been illustrated since it may be of any desired character, automatic or manual.

Figure 1A illustrates a modified form of actuating mechanism for the guides 36. This means takes the form of pistons 70 reciprocable in cylinders 71 by means of fluid pressure, hydraulic or pneumatic, supplied thereto. The pistons 70 have piston rods 72 attached thereto corresponding to the screw shafts 33 and functioning in the same way, under the influence of fluid pressure admitted to either side of the cylinders 71 for actuating the guides.

A modified form of construction of the auxiliary rolls for feeding and flattening the strip is shown in Figures 5 through 7. A roll table 73 has side frame castings 74. Housings 75 are attached to the castings 74 and have windows 76 therein in which bearing chucks 77 are slidable. Cylinders 78 formed in the upper part of the housings 75 have pistons 79 reciprocating therein. Piston rods 80 attached to the pistons 70 are threaded into the chucks 77 whereby the latter may be lifted to the dotted line position shown in Figure 5. Piston rods 80 extend outwardly through the upper end of the cylinders 78 and are connected by cross beams 81. Cylinders 82 carried on a transom 83 extending between the housings, also have pistons and piston rods arranged as shown in Figure 6 whereby the beams 81 and, therefore, the chucks 77, may be raised through a small distance. The piston rods of the cylinders 82 have separable, abutting engagement with bolts 81*a*. It will be apparent that the cylinders 79 and 82 provide independent means for lifting the chucks 77 through a long stroke and a short stroke, respectively. The object of this arrangement will become apparent as the description proceeds.

An equalizing shaft 84 extends between the housings 75 and is journaled therein. Cranks 85 keyed to the shaft 84 carry trunnions 86 in slidable bearings blocks 87. The trunnions 86 are threaded into the chucks 77, as best shown in Figure 6. The equalizing shaft obviously serves to effect simultaneous and equal movement of both bearing chucks and prevents binding of the reciprocating mechanism.

A top pinch roll 88 is journaled in the chucks 77 for cooperation with a bottom pinch roll 89, which may conveniently be one of the rollers of the table 73. Flattening rolls 90 and 91 are also journaled in the chucks 77. The roll 91 cooperates with a roll of the table 73. A roll 92 is journaled in chucks 93 slidable vertically in the base portions of the housings 75. Cylinders and pistons 94, bell crank linkage 95 and struts 96 are provided, as shown in Figure 5 to effect vertical movement of the chucks 93 for a purpose which will appear later.

As best shown in Figure 7, the roll 90 is journaled in chucks 97 secured to the chucks 77. A contact-actuating rod 98 is threaded into a projection 99 from one of the chucks 93. The rod 98 also passes through guides 100 projecting from one of the chucks 97. The rod 98 controls the engagement of a moving contact 101 with a fixed contact 102 on one of the chucks 77 for a purpose which will presently appear.

The chucks 93 are normally lowered so that contact 101 engages contact 102. These contacts control a circuit for stopping the main mill motor in case of breakage of the strip. When the strip is being rolled, the rolls 88, 90 and 91 rest on the strip and are spaced thereby from the rolls 89 and 92. After the strip has been entered into the mill so as to separate the pinch rolls 88 and 89, fluid is admitted to the cylinders 94 to cause the chucks 93 to be raised until the roll 92 engages the lower surface of the strip. The rolling operation then proceeds. If breakage of the strip should occur, the continuing fluid pressure in the cylinders 94 causes the chucks 93 to rise until the roll 92 actually engages the roll 90. This causes the rod 98 to move upwardly and lift contact 101 out of engagement with contact 102. Separation of these contacts, through suitable auxiliary equipment, causes stoppage of the main mill motor.

The cylinders 79 and 82 are automatically controlled to cause the pinch rolls 88 and 89 to engage the material at certain times and to release it at other times.

In rolling a slab into strip on the mill 10, it is desirable that the pinch rolls 88 be withdrawn as long as the slab being reduced has sufficient rigidity to permit it to be fed back and forth to and from the mill by the friction of the table rolls. When the slab has been reduced to a gauge such that it has relatively little rigidity, or to a condition in which coiling between passes is advisable, the pinch rolls are advanced to assist in threading the strip through the mill at the beginning of each pass. While both ends of the strip actually pass through the mill, the pinch roll motors are so controlled that neither end of the strip is disengaged from the pinch rolls on both sides of the mill. At least one end of the strip is always engaged by at least one set of pinch rolls. It is by these pinch rolls that the strip is then fed back to the mill for the next pass. On the exit side of the mill, the pinch rolls assist in delivering the leading end of the strip into the coiler by pushing it up the guide 22.

The system for automatically controlling the pinch rolls will be now explained with reference to Figure 8. In Figure 8, the work rolls of the mill are indicated by the same numeral as in Figures 1 and 2. A motor 103 is provided for driving the mill and the power of the motor may be applied directly to the work rolls 15 or to the backing rolls 14. The motor 103 may be controlled by any suitable control system. For simplicity, I have only illustrated a control panel 104 having incoming power leads, outgoing motor leads, and outgoing control leads extending to a controller 105. The panel 104, of course, will be provided with suitable relays and contactors effective under the control of the controller 105 to cause starting of the motor 103.

The panel 104 also has a relay 106 effective when deenergized to cause stopping of the motor. The specific details of such an arrangement are known and need not be included here. The controller 105, obviously, is effective on being shifted manually in one direction or the other, to cause operation of the motor 103 to drive the mill rolls 15 and thus move the strip through the mill in the desired direction. The supply of fluid to the cylinders 78, 82 and 94 is controlled by a master valve 107 and auxiliary valves 108 and 109. The valve 107 has operating magnets 110 and 111 and the valve is of such character that it remains in the position to which it was last operated until positively actuated therefrom. The valves 108 and 109 have operating magnets 112 and 113. The arrangement of these valves and their operating magnets is such that they remain in the illustrated position until the magnets are energized, and return to the illustrated position when the magnets are deenergized.

The valve 107 is controlled by a limit switch 114 operated by any convenient means, in accordance with the position of the mill screwdowns which determine the thickness of the pass between the rolls and the material itself after passing through the mill. When the space between the mill rolls 15 is greater than a predetermined value, say ¾", the limit switch 114 closes its lower contacts to energize the magnet 111 and move the valve 107 so that fluid under pressure is supplied from a reservoir 115 through suitable piping, to the cylinders 78 on both sides of the mill. The pistons 79 are thereby actuated full stroke to withdraw the upper pinch roll 88 and provide ample free space for the passage back and forth to and from the mill of the slab in the initial stages of its reduction to strip.

When the thickness of the slab has been reduced to a point such that, on the next pass, the mill rolls are spaced apart only ¾" or less, the partially reduced material is sufficiently thinned and elongated to permit of coiling and, at the same time, its rigidity is such that the assistance of the pinch rolls is required to manipulate it through the mill and into the coilers. The limit switch 114 then closes its upper contacts to energize the magnet 110 and operate the valve 107 to the illustrated position. This vents the cylinder 78 and the pistons 79 immediately drop to lower the pinch rolls 88 onto the material. The pinch rolls are driven by any convenient means, at the same peripheral speed as the rolls 15, so as to cooperate therewith in moving the material back and forth.

If it is assumed for the sake of explanation that the breakdown formed from flat rolling the slab was reduced on a pass from left to right, to a gauge such that after the next reduction, it would be less than ¾" thick, as soon as the top roll 15 is lowered to within less than ¾" of the bottom roll, the described operation of the valve 107 will take place and the pinch rolls will seize the breakdown for the next pass from right to left. When all is ready for this pass, the roller operates the handle of the controller 105 to the left, as shown in Figure 8, whereupon the motor 103 is operated so as to drive the rolls 15 and roll the strip from right to left. The pinch roll drive is so coordinated with that of the mill that the pinch rolls 88 are simultaneously operated so as to assist in the feeding of the breakdown.

The movement of the controller 105 bridges contacts 116 to energize a relay 117. The relay 117 has a time delay in its operation, indicated by a dashpot, and after a certain time bridges contacts 117*a* to energize the magnet 113. The relay is adjusted so that the contacts 117*a* will be bridged just after the leading end of the breakdown being rolled passes between the rolls 15. The magnet 113 operates the valve 109 to admit fluid supplied through the valve 107 to the cylinders 82 on the entering side of the mill. The pinch roll 88 on that side is thus lifted from the material.

After a slightly longer time, the relay 117 operates to bridge its contacts 117*b*, maintaining the circuit for the magnet 113 by reason of the fact that the bridging contact slides along the contacts 117*a*. The relay is adjusted so that the contacts 117*b* are bridged after the material has emerged from the mill on the exit side, passed through the pinch rolls, and made one turn about the coiler. The bridging of the contacts 117*b* causes the operation of magnet 113 to shift the valve 108. The cylinders 82 on the exit side of the mill thus operate to raise the associated pinch roll from the strip. The strip is thus free between the winding and unwinding coilers, except where engaged by the mill.

The operation of the valves 109 and 108 described above, also causes the operation of the cylinders 94 on opposite sides of the mill. The roll 92 is thus raised into engagement with the material but is sufficiently spaced thereby from the roll 90 that the contact 101 remains in engagement with the contact 102. The fluid pressure is continuously applied to the cylinders 94 as long as the rolling continues but, unless the strip breaks during rolling, the rolls 90 and 92 are maintained separated and the contacts 101 and 102 remain in engagement. If the strip is broken, the roll 92 is immediately lifted into engagement with the roll 90, whereupon the rod 98 lifts the contact 101 to open the circuit for the relay 106 and thereby stop the motor 103.

When the pass is completed, the controller 105 is restored to neutral position so that the trailing end of the strip stops between the mill and the pinch rolls on the exit side thereof. The relay 117 is thus deenergized and substantially immediately opens its contacts to deenergize magnets 112 and 113. The cylinders 82 are thus exhausted to the atmosphere and the pinch rolls dropped. At the same time, the cylinders 94 are exhausted through check valves 118, the weight of the roll 92 and chucks 93 serving to force the accumulated fluid out of the cylinders. The operating fluid for the cylinders 94 passes initially through expansion valves 119 which slightly delays the lifting of the chucks 93 on starting a pass.

The next pass is accomplished in exactly the same manner. Reversal of the controller 105 energizes the relay 120 and this, in turn, causes sequential lifting of the pinch rolls 88 on the entering and exit sides of the mill. This cycle is repeated until the strip has been reduced to the desired gauge, when it is wound on a coiler beyond the furnace on the exit side of the mill. The top work roll is then lifted by reversal of the screwdowns. The switch 114 closes its lower contacts and operates the valve 107 to admit fluid under pressure again to the cylinders 78, whereby the pinch rolls 88 on both sides of the mill are lifted out of the way for the next flat rolling operation.

Figure 9 shows how the side guide actuators of Figure 1A are controlled. When the controller **105** is shifted so as to cause the material to be fed from left to right, it closes contacts **121**. It will be understood that operation of the controller also, through appropriate relays, causes the starting of the motor **103** in the proper direction. The closing of the contacts **121** energizes an operating magnet **122** for a valve **123**. This valve is similar to that shown at **107** of Figure 8. The energization of the magnet **122** operates the valve to the position illustrated in Figure 9, in which it delivers fluid under pressure to the inner ends of the cylinders **71** on the exit (left-hand) side of the mill, and to the outer ends of the cylinders on the entering (right-hand) side of the mill. The guides **36** on the entering side are thus closed in, as indicated in Figure 9, while the guides on the exit side are opened to permit free passage of the material as it emerges from the mill.

On the reversal of the direction of rolling, for the next pass, the controller **105** bridges contacts **124** and energizes a magnet **125** to shift the valve **123** to the other position. The reverse operation of the cylinder **71** then takes place to close the guides on the left-hand side and open the guides on the right-hand side.

It will be understood that only a single controller **105** is employed and that it controls contacts **116** and **124**, for example, simultaneously, in addition to the other contacts necessary to bring the motor **103** up to operating speed. The system of Figure 9 is shown separately from that of Figure 8 simply because it is a diagrammatic plan, whereas the latter is a diagrammatic elevation, but it will be understood that the two systems are combined and under the common control of the controller **105**.

It will be apparent from the foregoing description that my invention provides a rolling mill having numerous advantages over known apparatus of the same kind. In the first place, the slab or strip is definitely guided into the mill along the pass line or longitudinal axis of the mill. There is thus no possibility for the strip to move into the rolls crabwise at a slight angle to the pass line. Cambering of the strip or slab is thus prevented. Free movement of the highly flexible, thin strip from the mill is permitted without obstruction since the guides on the exit side of the mill are automatically retracted to form a tapering guiding throat. The positions of the guides on opposite sides of the mill are reversed automatically with the reversal of the roll tables and the mill so that once the guides have been adjusted, they require no further attention until a different width of material has to be rolled.

The flattening rolls insure that the leading end of the strip will always be sufficiently flat to enter and engage the coiler properly to wind the strip thereon. This avoids the delays experienced heretofore incident to the backing up of the strip and repeating the entry thereof into the coiler after a first unsuccessful attempt.

The top and bottom guides **29** and **26** respectively, with the side guides **34**, form a complete guide box and prevent any departure of the strip from the pass level or the horizontal plane through the roll pass. With the guides of my invention, improper entry of the material into the mill is rendered almost impossible. The top guide may be adjusted by a turnbuckle in the links **32**. The bottom guide may be similarly adjusted by shimming up the outer end thereof which rests on the seat **28**.

The automatic control of the pinch rolls on both sides of the mill insures that the strip will be advanced properly into the mill and, on emerging therefrom, into the coiler, whereupon the pinch rolls will be lifted out of the way when there is no further need for them. The automatic stop mechanism prevents loss, damage or injury in case the strip breaks during a pass.

The positive actuation of the side guides under the control of the main controller causes the strip to be properly started toward the mill and correctly positioned with respect thereto before it actually enters between the mill rolls, after which no effort is sufficient to correct an improper starting of the strip, because of the great force exerted on the strip by the rolls.

The top guide **29** has an important function in preventing the coiling up of the leading end of the piece when rolling in the flat. If it were not for this guide, the slab, in the early stages of its reduction, might bend up sufficiently to escape the side guides altogether, whereupon it might be improperly entered into the mill pass on the next reversal.

Although I have illustrated and described only one embodiment of my invention, it will be apparent that numerous changes therein may be made without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. In a rolling mill, side guides extending therefrom, pivoted supports for the outer ends of the guides, means for adjusting said supports toward or away from each other, a roll table for feeding material to and from the mill, and means driven from a roll of said table for moving the inner ends of the guides toward and away from each other.

2. In a rolling mill, a pair of side guides pivotally supported adjacent their outer ends, axially movable screw shafts hinged to the guides adjacent their inner ends, a roll table for moving material to or from the mill, means for shifting said screw shafts including nuts thereon, means for driving the roll table, and means including a friction clutch whereby said drive also actuates said nuts.

3. The combination with a hot strip mill and a coiler adapted to receive strip from the mill and wind it into a coil, of means between the mill and the coiler for flattening the leading end of the strip passing from the mill to the coiler.

4. The apparatus defined by claim 3 wherein said flattening means comprises a plurality of leveling rolls.

5. In a method of making strip, the steps including rolling down a hot slab into an elongated strip, coiling the strip between rolling passes, and flattening the leading end of the strip before coiling between passes.

6. In a rolling mill including a pair of housings and work rolls journaled therein, pinch rolls on one side of the mill, and means for raising one of the pinch rolls through a short distance, and independent means for raising the upper pinch rolls through a greater distance.

7. The combination with a rolling mill, of pinch rolls on one side of the mill, one of said rolls being retractible, a motor for driving the mill, a controller for the motor, and means operated by said controller for causing retracting movement of said one of said pinch rolls at a

predetermined time after the starting of the mill motor.

8. The combination with a rolling mill, of pinch rolls on at least one side of the mill for feeding material thereto, one of said pinch rolls being retractible, and means actuated by the setting of the mill for passes of various thickness, whereby to operate said retracting means.

9. The combination with a rolling mill having an adjustable upper roll, of pinch rolls for feeding material to the mill, one of said rolls being retractible, and means operated in accordance with the adjustment of the upper mill roll for controlling retraction of said pinch roll.

10. The combination with a rolling mill having a driving motor and a controller for the motor, of adjustable side guides on both sides of the mill, and means operated by said controller for shifting the guides inwardly on the entrance side of the mill and outwardly on the exit side of the mill.

11. The combination with a rolling mill and a roll table for feeding material thereto, a motor for driving the mill, of a pair of pinch rolls adapted to engage material on the table, at least one of said pinch rolls being movable, means for constantly urging said movable roll into engagement with the material, and means actuated by movement of said movable roll toward the other of said pinch rolls for stopping said motor.

12. The combination with a rolling mill having a driving motor, of a pair of pinch rolls adapted to engage the material moving to or from the mill, one of said rolls being movable, means for normally holding said movable roll in engagement with the material, and means actuated by movement of said one of said rolls into engagement with the other of said rolls for stopping said motor.

13. The combination with a rolling mill, a driving motor therefor and a controller for the motor, of pinch rolls on one side thereof, one of said rolls being movable, means tending to hold said movable roll against the material being rolled, and means responsive to movement of the roll on breakage of the material for stopping the mill motor.

14. The combination with a rolling mill, a driving motor therefor and a controller for the motor, of pinch rolls on one side thereof, one of said rolls being movable, means tending to hold said movable roll against the material being rolled, means responsive to movement of the roll on breakage of the material for stopping the mill motor, and means operated by movement of the controller to start the motor, for rendering said first-mentioned means effective.

15. The combination with a reversing strip mill, and pinch rolls on opposite sides thereof for feeding material to and from the mill, of a pair of side guides on each side of the mill between the mill and the pinch rolls, means pivotally supporting the outer ends of said guides for swinging movement in a horizontal plane, and means for so moving the inner ends thereof as to dispose the guides on the entry side of the mill in parallel relation and those on the exit side of the mill at an angular relation, depending upon the direction of movement of the material through the mill, said first mentioned means being so spaced as to permit the strip to pass freely between the ends of the guides on the exit side and enter the pinch rolls.

16. In a strip mill, a controller for reversing the direction of rotation of the mill, side guides pivoted adjacent their outer end, and means operated by said controller for adjusting the inner ends of the guides toward or away from each other, according to the direction of rotation of the mill.

17. In a strip mill, a pair of side guides on each side of the mill, pinch rolls adjacent the outer ends of the guides and means controlled by the direction of movement of material passing through the mill effective to cause the guides on the entering side to move to parallel relation, and those on the exit side to move to an angular relation forming a tapering throat with its narrowest portion adjacent the pinch rolls whereby accurately to center the material entering the pinch rolls and preventing cambering of the material.

18. In a rolling mill, a pair of housings having work rolls journaled therein, pinch rolls on at least one side of the mill for engaging material being worked in the mill, means for retracting one of said pinch rolls when unused for a substantial period, and independent means for temporarily retracting one of said rolls.

19. The combination with a rolling mill and a roll table for advancing work thereto, of pinch rolls on one side of the mill, one of said pinch rolls being retractible, and means for retracting said roll including fluid pressure-operated cylinders and pistons, one of which has a short stroke for temporarily retracting the roll and the other having a longer stroke for retracting the roll when unused for substantial periods.

20. Strip rolling apparatus comprising a mill, pinch rolls on opposite sides thereof for feeding material to and from the mill, guides between the mill and the pinch rolls, and means for positioning the guides on the entering side of the mill parallel to the pass line whereby to guide positively the material advancing to the mill, said means being also effective to set the guides on the exit side at a slight angle to the pass line forming a converging throat to receive material issuing from the mill and guide it into the pinch rolls while maintaining it centered relative to the pass line.

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