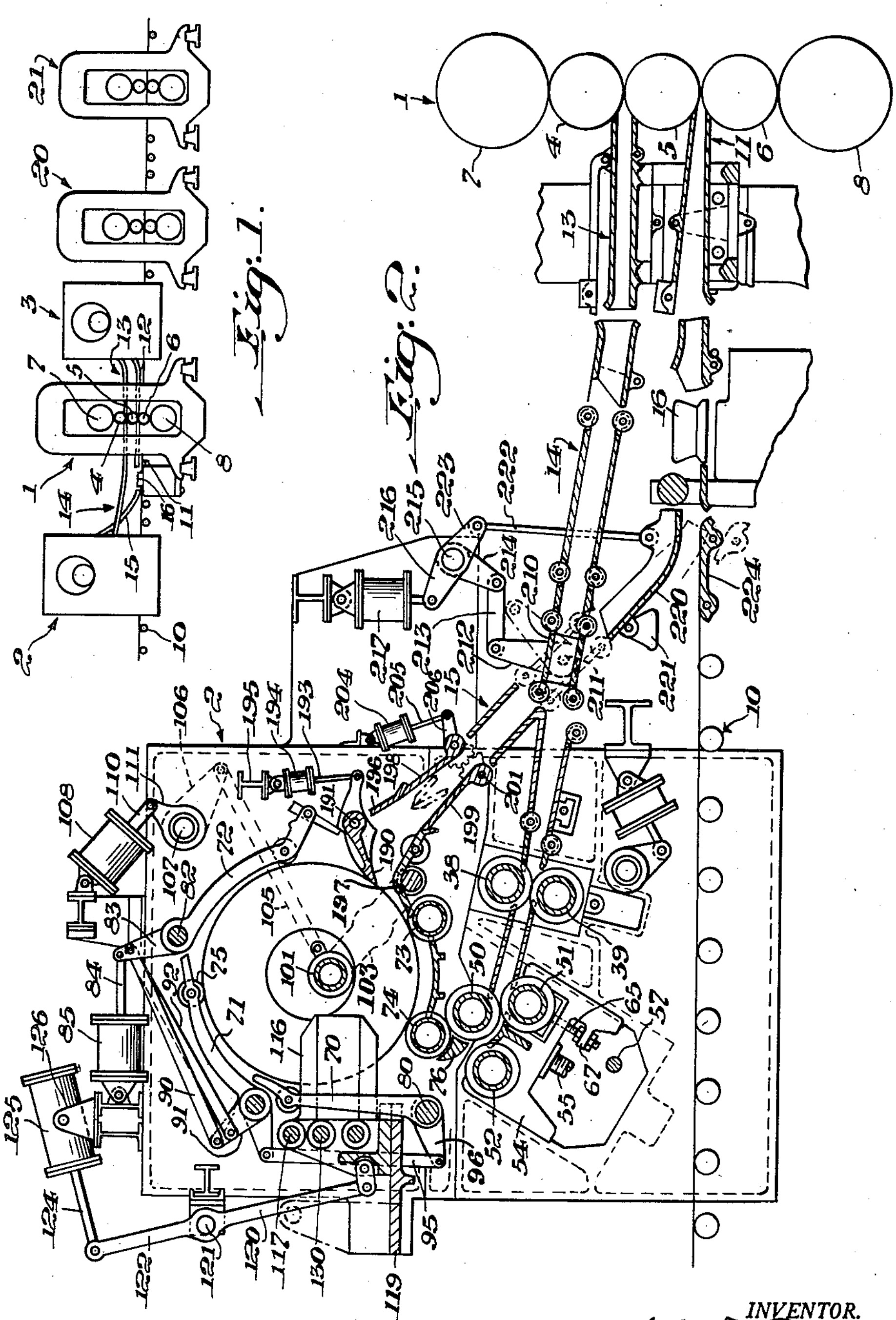
July 13, 1954 J. F. FERM 2,683,570

MILL FOR THE HOT ROLLING OF STRIP METAL

Filed Sept. 28, 1949 6 Sheets-Sheet 1



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MILL FOR THE HOT ROLLING OF STRIP METAL

Filed Sept. 28, 1949 6 Sheets-Sheet 2

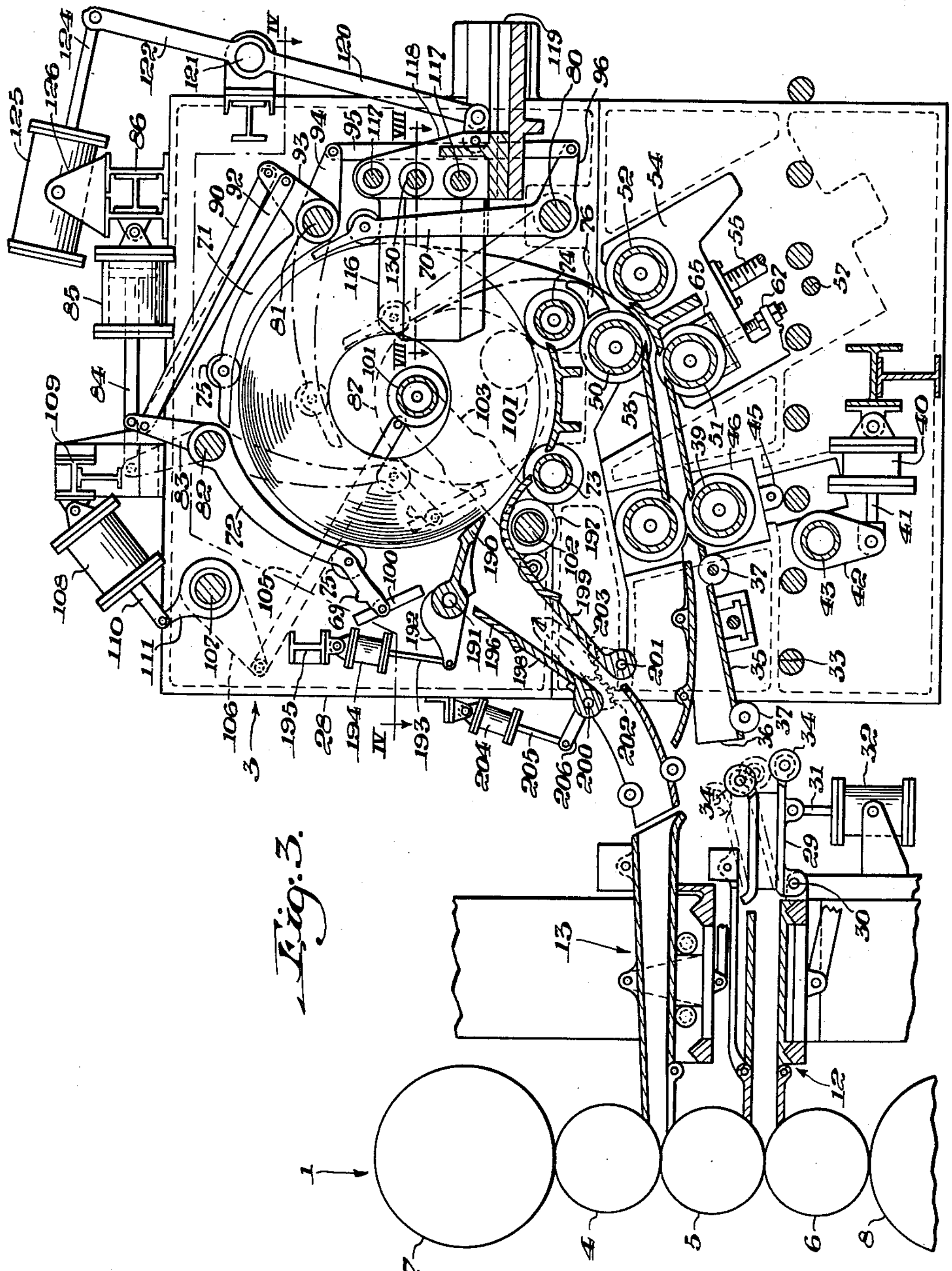

Fig. 3.

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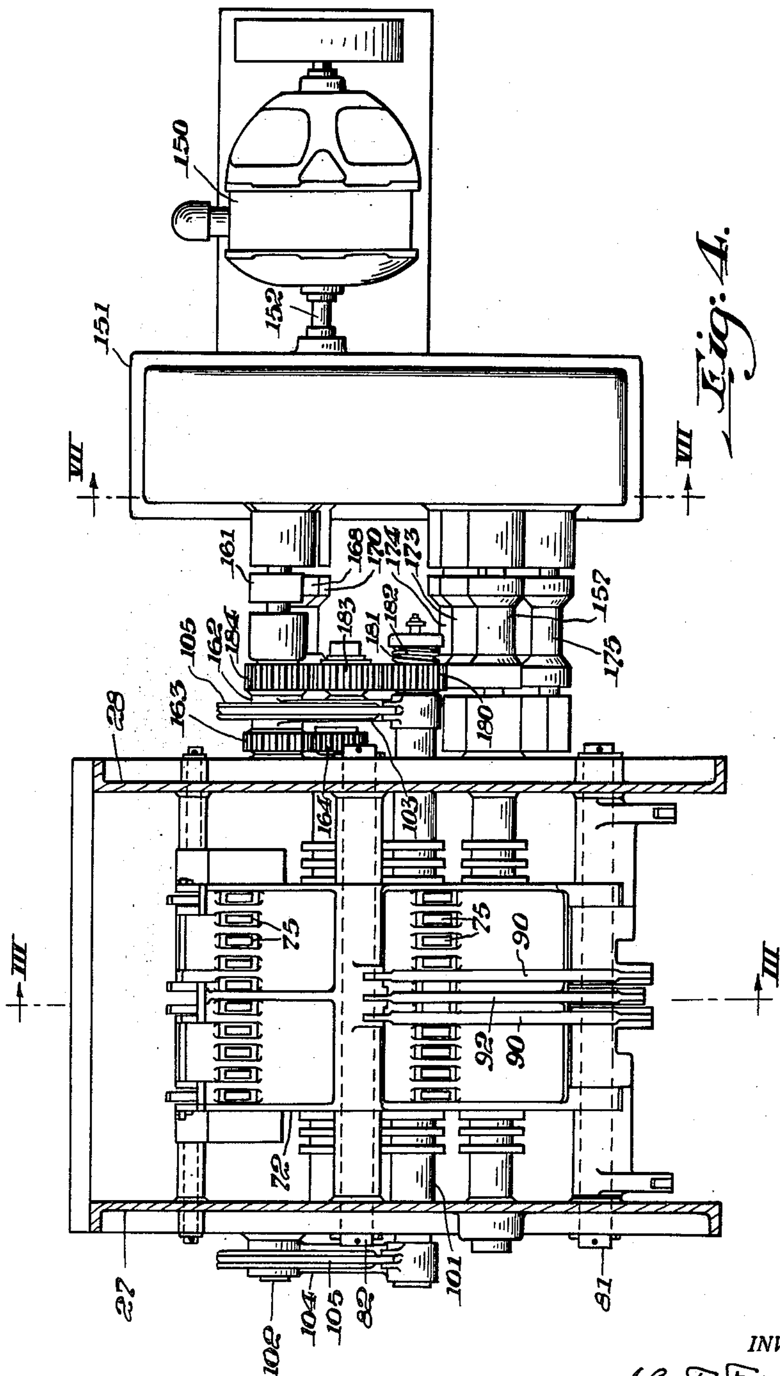

Fig. 4.

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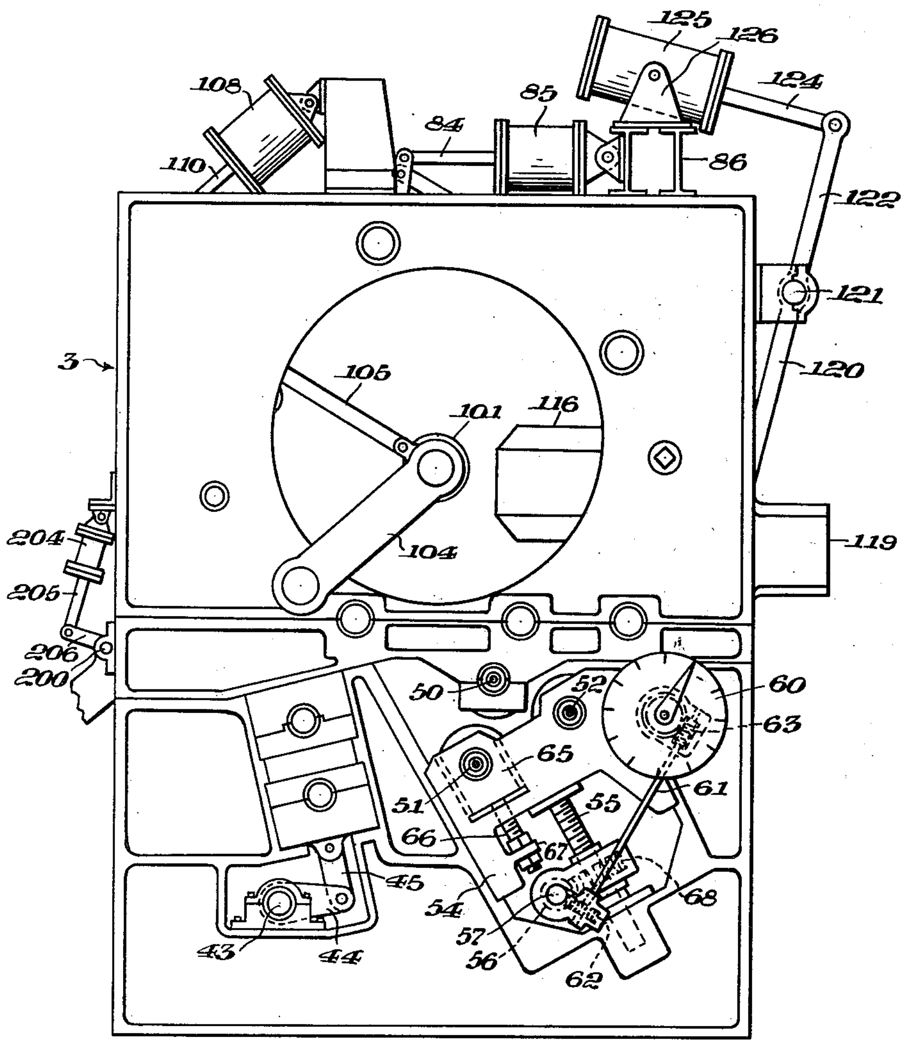

Fig. 5.

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MILL FOR THE HOT ROLLING OF STRIP METAL

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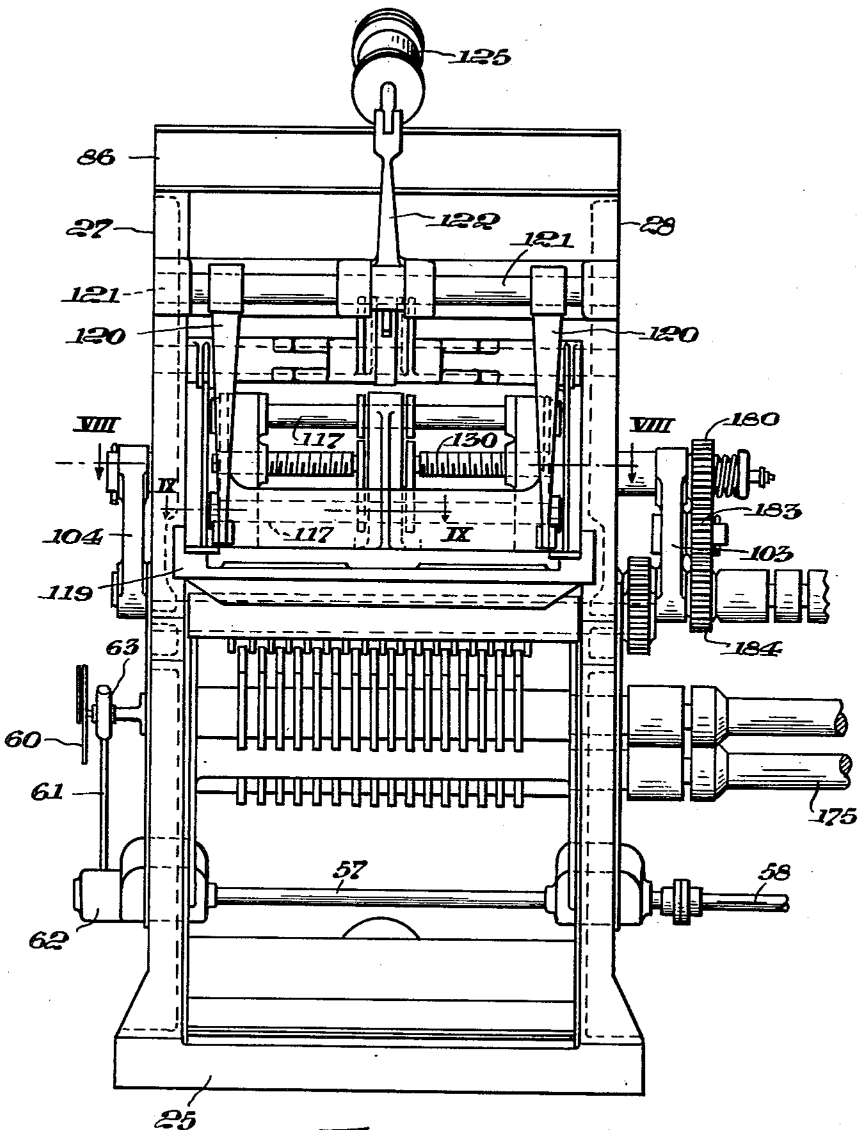

Fig. 6.

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MILL FOR THE HOT ROLLING OF STRIP METAL

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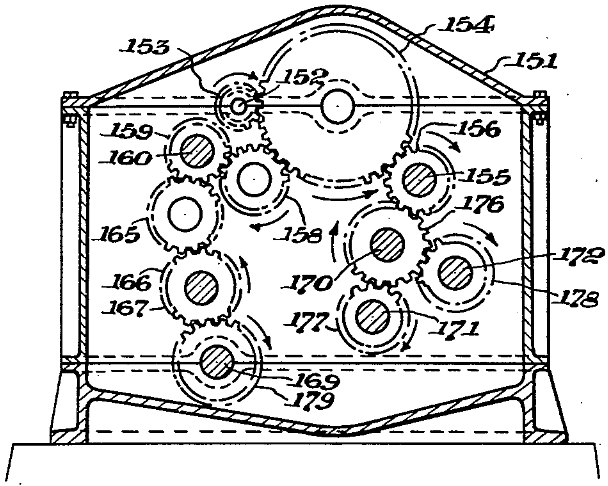


Fig. 7.

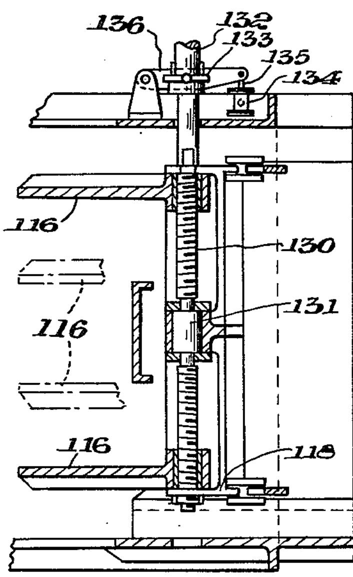
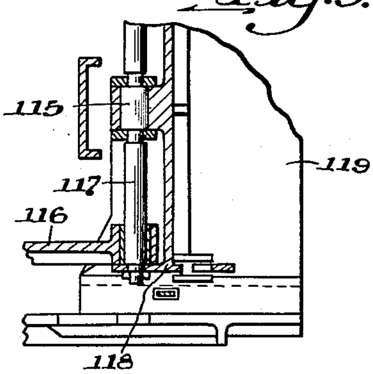


Fig. 8.

Fig. 9.



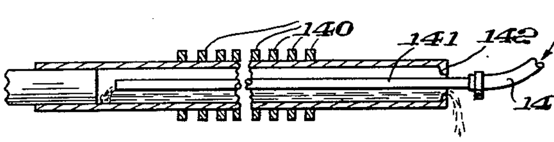


Fig. 10.

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Patented July 13, 1954 **2,683,570**

UNITED STATES PATENT OFFICE

2,683,570

MILL FOR THE HOT ROLLING OF STRIP METAL

John F. Ferm, Midland, Pa.

Application September 28, 1949, Serial No. 118,277

7 Claims. (Cl. 242—78)

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The invention relates to the hot rolling of metal in strip form, and particularly to the hot rolling of strip steel.

In steel mills having high tonnage requirements of strip, the prevailing practice is to do the hot finish rolling on a conventional or standard continuous mill that customarily has six four-high stands. The cost of building and operating such a mill is much too high for a plant that has materially lower tonnage requirements of strip than the capacity of such standard continuous finishing mills. In some plants that have lower tonnage requirements there have been installed single-stand hot reversing mills having coilers at each side arranged in heating chambers, such mills being of the type disclosed in United States Patent 1,918,968, which issued to Robert W. Keeney and me.

Hot strip reversing mills of the type just stated have been found to be unsatisfactory in some respects, among other reasons because their tonnage capacity is too low, and also because the surface finish of the strip does not meet the requirements of many uses of it. In their operation all of the reducing passes are between a single pair of rolls whose direction of rotation is changed between each pass, which materially decreases the rate of rolling and consequently the tonnage capacity of the mills. As to the surface finish of the strip, the high temperature of the blanks that are rolled in the initial passes so impairs the working faces of the rolls that in the final passes of the strip the rolls cannot impart to it the surface finish required for many uses of the strip.

Due to their construction, the operation of the coilers used on hot reversing mills of the type just stated is unsatisfactory. In such coilers, strips are wound upon drums or cores which are so constructed that desired uniformity of heat in the strip cannot be maintained, and, for engaging the leading ends of the strip, the drums or cores are equipped with various instrumentalities that retard the operation of the mill and fail properly to function with uniformity. Also, the build-up of the diameter of coils upon drums or cores results in lack of uniformity of the tension applied to the strip between the mill and coiler.

An object is to provide a five-high mill for the hot rolling of strip metal having working rolls that are continuously driven in one direction and are arranged to form two oppositely-moving roll passes in vertically spaced horizontal planes, the mill having a coiler at each side associated with guides for receiving strip from one of the mill passes and delivering it to the other.

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A further object is to provide a mill of the type just stated with coiling mechanism whereby the strip is progressively bent to coil form without the use of a central core or of end-grippers, and whereby the tension of the strip between the bite of the rolls and the coiler may be maintained uniform from one to the other of the end portions of the strip.

The invention will be further explained with reference to the accompanying drawings, of which Fig. 1 is a quite diagrammatic elevation of a five-high strip-rolling stand with a coiler at the entry and delivery sides of it, guides between the stand and coiler, and two four-high stands beyond the coiler at the delivery side of the mill; Fig. 2 a vertical central sectional view of the coiler at the entry side of the five-high stand, and of guides between the stand and coiler; Fig. 3 a view similar to Fig. 2 of the coiler and guides at the delivery side of the five-high stand, the plane of view being indicated by the line III—III on Fig. 4; Fig. 4 a sectional plan view of the coiler and the drive for it at the delivery side of the five-high stand, the plane of view being indicated by the line IV—IV, Fig. 3; Fig. 5 an elevation of the coiler shown in Figs. 3 and 4, the elevation being of the left side as viewed in Fig. 4, and some of the mechanism on the side of the coiler being shown in section; Fig. 6 a rear elevation of the coiler of Figs. 3, 4 and 5, viewed from the right as seen n Fig. 5; Fig. 7 a sectional view of the gear drive taken on a plane indicated by the line VII—VII, Fig. 4; Fig. 8 a horizontal sectional view of coil guard mechanism taken on the plane indicated by the lines VIII—VIII on Figs. 3 and 6; Fig. 9 a horizontal sectional view of the coil guard mechanism taken on the plane indicated by the line IX—IX, Fig. 6; and Fig. 10 a central longitudinal sectional view of rollers in the coilers, showing details of their construction.

Having reference now to the illustrative embodiment of the invention, the preferred form of the several mill units are quite diagrammatically illustrated in Fig. 1, which shows a five-high mill 1, a coiler 2 on the entry side of the mill and a coiler 3 on its delivery side. The five-high mill has three working rolls, an upper roll 4, a middle roll 5 and a lower roll 6, and has a large diameter backing roll 7 above the top working roll and a simiar backing roll 8 below the bottom working roll, the backing rolls being mounted in roller or other anti-friction bearings. Although not illustrated, the mill is equipped with the customary appurtenances such as roll chocks, roll balances, screw-downs, etc. The mill is driven by an adjustable speed motor with a suitable gear drive extending from it to the three working rolls.

A break-down in the form of a thin slab or plate is delivered to mill 1 by a conveyor table 10 and a strip-directing guide 11 to the lower pass of mill 1 between middle working roll 5 and lower working roll 6, and at the delivery side of the mill it is carried by a strip-directing guide 12 to coiler 3. When the blank has been rolled in this pass, and coiled, the coiler is reversed to feed the blank through a strip-directing guide 13 to the upper pass of mill 1 between top working roll 4 and middle working roll 5, the delivered blank then passing through a strip-directing guide 14 into coiler 2. For a third pass through mill 1, coiler 2 is reversed to feed the blank through a strip-directing guide 15 that crosses guide 14 to the lower pass of mill 1. This back and forth rolling of the blank is done as many times as are necessary to reduce the blank to its intended thickness in mill 1. At the entrance side of mill 1 there are a pair of vertical edging rolls 16, which may be of conventional or of any desired form, for edge rolling the blank prior to each entry of it in the lower roll pass, thereby maintaining its desired width.

As has been stated, coilers 2 and 3 are preferably of like construction. Coiler 3 at the delivery side of mill 1 is illustrated in Figs. 3–6, to which reference will now be made. The mechanism of the coiler is mounted in and supported by a housing having a base 25 (Fig. 6) and side frames 27 and 28. The strip-directing guide 11 leading from the lower pass of mill 1 may be of conventional or of any desired construction. At its right end as seen in Fig. 3, there is a trough 29 whose left end is pivotally supported at 30 and whose outer end is connected to the piston rod 31 of a pressure fluid cylinder mechanism 32 for moving the trough upwardly to its dotted line position to deliver a blank to the coiling mechanism roll, and to move it downwardly to the position shown in Fig. 3 for delivering a blank to a conveyor table 33 which passes between the side frames of the coiler below the coiling mechanism to carry the blank to the entry side of finishing-pass stand 20, when coiler 3 is followed by such a stand or stands. The right end of trough 29 is provided with idle rollers 34, between which, when the trough is elevated, a blank is delivered to an upwardly inclined guide 35 at the entrance of the coiler, such guide being provided with laterally adjustable side guards 36, and also with idle rollers 37.

When directed into the coiler, the forward end of a blank is engaged by a pair of driven pinch rolls 38 and 39, the roll 39 being adjustable with relation to the upper roll 38 by fluid pressure mechanism including a cylinder 40, Fig. 3, position in the central bottom portion of the coiler. The piston 41 of this mechanism is pivotally connected to the lower end of an arm 42 borne by a rock shaft 43 to which an arm 44, Fig. 5, is connected at each side of the coiler in a window in a side frame. These arms are connected by links 45 to housings or chocks 46 in the side frame windows, that support the ends of pinch roll 39. Pinch roll 39 is vertically adjusted by the mechanism just explained to cause the pinch rolls to grip blanks of different thicknesses, and, in a manner presently to be explained, the pinch rolls are driven at the proper peripheral speed to hold a blank taut as it is delivered from the lower pass of mill 1.

Beyond the pinch rolls 38 and 39, the coiler is provided with a bender for continuously curving the blank delivered from the pinch rolls to facilitate the coiling of the blank. The bender preferably comprises an upper roll 50 and two laterally spaced lower rolls 51 and 52 (Figs. 3 and 5), all of which are driven in a manner presently to be explained so that a blank delivered from pinch rolls 38 and 39 through a guide 53 is continuously bent upwardly. Provision is made for adjusting the lower pinch rolls 51 and 52 with relation to upper pinch roll 50 properly to bend blanks of different thicknesses. For this purpose, the ends of the lower pinch rolls are borne by blocks 54 (Figs. 3 and 5) mounted in windows of the side frames of the coiler for movements in an upwardly inclined direction. A screw 55 is attached to the lower side of each block 54, and threadably engaging the screw in the usual manner there is a worm gear 68 driven by a worm 56 formed on a shaft 57 connected at one end to a drive shaft 58 (Fig. 6) that may be rotated by a suitable motor. Proper adjustment of the lower bending rolls may be shown by an indicator 60 (Fig. 5) which is actuated by a shaft 61 having a worm gear 62 at its lower end adapted to be driven by a worm on shaft 57 and also having a worm 63 at its upper end for rotating the indicator hand. Minor adjustments of lower bending roll 51 with relation to bending roll 52 are effected by mounting the ends of bending roll 51 in chocks 65 which are engaged by screws 66 that are adjustably supported by brackets 67 on blocks 54.

As a blank is fed upwardly in curved form by the bender, its outer surface is engaged by a series of arms that are arranged in an arc to coil the blank, and are mounted for outward movement as the diameter of the coil increases. As the blank is being coiled the coil is supported by cradle rolls which are driven to rotate the coil. As shown in Fig. 3, there are three coil-forming arms 70, 71 and 72, and there are two cradle rolls 73 and 74, and each of the arms is provided near its outer end with a series of blank-engaging rollers 75 as shown in Figs. 3 and 4. Between the bender and cradle roll 74 there is a guide 76 to prevent the leading end of the blank issuing from the bender from striking cradle roll 74.

Preferably the coil-forming arms are pivotally mounted, and provision is made for simultaneously swinging their blank-engaging outer ends outwardly as the diameter of the coil increases. As shown in Fig. 3, arm 72 is pivotally mounted on a rock shaft 82, arm 71 on a rock shaft 81, and arm 70 on a rock shaft 80, the ends of which shafts are borne by side frames 27 and 28. Rock shaft 82 is connected by an arm 83 to the piston rod 84 of a pressure fluid cylinder 85 that is pivotally connected at its end to a beam 86 attached to the top of the side frames of the coiler. In Fig. 3, coil-forming arm 72 is shown in full lines in its outer position at the completion of a coiling operation, and in dotted lines at the beginning of a coiling operation at which time the inner convolution of the coil is shown by the dotted line 87. Arm 83 is connected by links 90 (Figs. 3 and 4) to an arm 91 that is attached to rock shaft 81 for moving arm 71, and arm 83 is also connected to a link 92 that is connected to the outer end of an arm 93 which forms a part of a bell crank lever attached to shaft 81. The other arm 94 of this lever is connected by a link 95 to an arm 96 attached to rock shaft 80 for moving arm 70. Thus by actuating pressure cylinder 85 to move its piston inwardly, each of rock shafts 80, 81 and 82 are turned in a clockwise direction as viewed in Fig. 3 simultaneously to move the outer ends of arms 70, 71 and 72 outwardly as a coil is built up within the arms and upon cradle rolls 73 and 74. At the outer end of arm 72, there is pivotally supported a tilting auxiliary guide 100 to facilitate the initial forming of a coil when such arm is moved to its innermost position. The upper end of guide 100 then engages a projection 69 formed on arm 72 to hold the lower end of the guide firmly against the leading end of the strip.

To aid in forming a coil, and also to uncoil a blank that has been coiled, a driven coil roll 101 of materially smaller diameter than the inside diameter of coils that are formed, is positioned within the confines of arms 70, 71 and 72, and above cradle rolls 73 and 74 so that it will be in the central portion of a coil. This coil roll is supported at its ends by a yoke comprising a shaft 102 whose ends are supported by side frames 27 and 28, and arms 103 and 104 that engage the coil roll. The lower end of arm 103 is pivotally supported by a sleeve 162 (presently to be explained), and the lower end of arm 104 is pivotally supported by shaft 102. Provision is made for swinging this yoke (shaft 102 and arms 103 and 104, or merely the arms) upwardly at the beginning of a coiling operation to position coil roll 101 adjacent to the coil arms as shown in dotted lines in Fig. 3, and particularly adjacent to the idle rollers 75 on coil-forming arm 72. For thus swinging the yoke, arms 103 and 104 are connected by links 105 (Figs. 3 and 4) to the outer ends of lever arms 106 that are attached to a rock shaft 107 whose ends are supported by the side frames 27 and 28. This shaft is rocked by a pressure fluid mechanism including a cylinder 108 whose upper end is pivotally supported by a beam 109 supported by the tops of the side frames. The piston rod 110 of cylinder 108 is pivotally connected at its outer end to an arm 111 borne by shaft 107. By causing piston rod 110 to move outwardly of cylinder 108, rock shaft 107 is rotated in a counterclockwise direction to move coil roll 101 downwardly, so that it can cooperate with cradle roll 74 to form a pair of pinch rolls for rotating the coil after the first few inner convolutions of it have been formed.

The coiler includes a pair of guards which are positioned at the opposite ends of a coil as it is being formed to maintain the coil in cylindrical form, or in other words to prevent the successive convolutions to be formed in a spiral or telescopic manner. These guards preferably comprise plates 116 (Figs. 3, 8 and 9) that are slidably supported at their outer ends by rods 117 whose outer ends and enlarged central portions 115 are supported by a sliding frame or support 118, Fig. 9. The base of frame 118 is slidably mounted in a bracket 119, and provision is made for moving the frame and guard plates 116 supported by it outwardly (to the right as shown in Fig. 3) as the diameter of a coil is built up, and also for removing a coil as a whole if that should become necessary due to a breakdown of the mill or coiler. For this purpose, frame 118 is pivotally connected by short links to the lower ends of arms 120 which are attached to a rock shaft 121 borne by the side frames (Figs. 3 and 6). An arm 122 is attached at its lower end to the central portion of shaft 121 and at its upper end is connected to the outer end of the piston rod 124 of a fluid pressure cylinder 125 mounted for rocking movement within brackets 126 supported by beam 86. Thus by moving piston 124 to the left as viewed in Fig. 3, frame 118 and guards 116 supported by it are moved outwardly to the right of the position there shown.

For adjusting guard plates 116 laterally with respect to each other that is to say towards and from their dotted positions indicated in Fig. 8 they threadably engage a screw 130 in the manner shown particularly in Fig. 8. This screw is supported at its ends by frame 118, and also at the central portion where it is provided with an enlargement 131. The outer end of the screw is connected to a motor driven drive shaft 132 which includes a clutch 133 adapted to be actuated by a fluid pressure cylinder 134 whose piston 135 is connected to a pivoted lever 136 that engages a movable element of the clutch.

As shown in Figs. 4, 6 and 7, each of the several driven rolls, namely pinch rolls 38 and 39, bending rolls 50, 51 and 52, cradle rolls 73 and 74, and coil roll 101, are preferably provided with spaced rings 140 to minimize the loss of heat from a blank being coiled. Also, if desired, each of these rolls, as for example pressure roll 101 may be of tubular form, and may be centrally cooled by water. For this purpose, a tubular roll may be provided with a water supply pipe 141, Fig. 10, which extends through an opening formed in a flange 142 at an end of the roll. Pipe 141 is connected at its outer end to a flexible water supply hose 143, the arrangement being such that water flows through the pipe to the end of the roll opposite flange 142 and escapes from the roll between pipe 141 and the opening in flange 142, sufficient clearance being provided for this purpose.

As has been explained, each of the pinch rolls, bending rolls and cradle rolls, as well as the coil roll is driven, the drives being such that the peripheral speeds of all but the coil roll is the same, or substantially the same, as the delivery speed of a blank from the lower pass of mill 1. As shown in Figs. 4, 6 and 7, all of these rolls are preferably driven by a single adjustable speed motor 150 through a train of gears in a gear box 151. The motor is wound to provide dropping characteristics, and is set initially to drive the coiler rolls at a higher peripheral speed than the delivery of a blank, but drops to conform with the latter. Armature shaft 152 of motor 150 is provided with a pinion 153 which meshes with a speed-reducing gear 154 in gear box 151, Fig. 7. Cradle roll 74 is driven by a shaft 155 which is provided with a gear 156 that meshes with gear 154, shaft 155 being connected to roll 74 by a spindle 157. The drive of the other cradle roll 73 is through an idle gear 158 that meshes with gear 154 and also with a gear 159 borne by a shaft 160 that is connected by a spindle 161 to a sleeve 162 that is carried by shaft 102. Sleeve 162 is provided with a gear 163 (Fig. 4) which meshes with a gear 164 attached to the end of cradle roll 73.

For driving upper pinch roll 38, an idle gear 165 (Fig. 7) meshes with gear 159 and also with a gear 166 attached to a shaft 167 which is connected by a spindle 168 to the outer end of the pinch roll. For driving lower pinch roll 39, gear 166 drives a gear 179 attached to a shaft 169 which is connected by a spindle 170 to the outer end of the pinch roll. As shown in Figs. 4 and 7, the three bending rolls 50, 51 and 52, are driven by shafts 170, 171 and 172, respectively, through spindles 173, 174 and 175 which are connected to the outer ends of the bending rolls. Shaft 170 is rotated by a gear 176 which is driven by gear 156, and which meshes with gears 177 and 178 carried by shafts 171 and 172, respectively.

Coil roll 101, which bears continuously upon the inside of a coil being formed, can not, without slipping upon and marring the inner face of the inner convolution of the coil, be driven at the same peripheral speed as the pinch rolls, bending rolls and cradle rolls, in view of which the coil roll is provided with a slip drive. This roll is borne by the outer ends of arms 103 and 104, and, as seen in Fig. 4, is driven by a gear 180 through a friction clutch 181 whose movable element is urged by a spring 182 into slip engagement with the interior of gear 180. An idle gear 183, driven by a gear 184 connected to sleeve 102, meshes with and drives gear 180.

When a blank has been coiled in coiler 3 in the manner explained, coiler motor 150 is reversed to drive cradle rolls 73 and 74 in a counterclockwise direction as seen in Fig. 3, and to drive coil roll 101 in a clockwise direction as there seen. By fluid pressure cylinder 108 (Fig. 3) and the connections from it to arms 103 and 104 that support the coil roll, such roll is pressed downwardly against the interior of the coil to press the coil against cradle rolls 73 and 74. In effect, the cradle rolls and coil roll then act as pinch rolls to rotate the coil in a clockwise direction as viewed in Fig. 3. The outer end of the blank is stripped from the coil by a stripper 190 which is pivotally mounted on a shaft 191 and is connected by an arm 192 to the outer end of the piston rod 193 of a pressure fluid cylinder 194 supported by a beam 195 extending between the side frames of the coiler. Pressure fluid cylinder 194 being actuated to cause the stripper 190 to bear against the outside of the coil, the stripper engages the outer end of the coil and directs it into a guide or chute 196. An idle roller 197 borne by shaft 102 prevents the bottom of guide 196 from scratching the blank as it is uncoiled. At the outer end of guide 196 there is a guide section formed of upper and lower plates 198 and 199 which are attached to rock shafts 200 and 201, respectively, geared together by segmental gears 202 and 203. Shaft 200 is rocked by a pressure fluid cylinder 204 whose piston rod 205 is connected at its outer end to an arm 206 attached to shaft 200. Near the end of an uncoiling operation, cylinder 204 is actuated to cause guide plates 198 and 199 to move from their solid to their dotted line position shown in Fig. 3 so that if the inner end of the coil blank is lapped upon itself, the lap will be straightened out by being engaged by the outer end of one of these plates. This prevents a lapped or doubled end of a blank from passing through mill 1 and marring the faces of its working rolls.

Beyond guide plates 198 and 199, the uncoiled blank passes through strip directing guide 13, which may be of conventional or of any desired construction, to the upper roll pass between upper working roll 4 and middle working roll 5 of mill 1, from which it passes into guide 14 leading to coiler 2, shown in detail in Fig. 2. This coiler is the same as coiler 3 shown in and described with reference to Figs. 3–10, in view of which coiler 2 will not be described in detail. Its principal elements are indicated by the same numerals that are used to designate the corresponding parts of coiler 3 shown in Fig. 3.

As shown in Figs. 1 and 2, strip-directing guide 15 for carrying a blank unwound from a coil formed in coiler 2, crosses guide 14 which directs a blank to coiler 2 for coiling it. By thus causing these guides to cross each other, both coilers may, as illustrated and described, be of like construction. At the crossing of these guides, a guide section 210 is pivotally supported at 211 to swing to and from its full to its dotted line positions shown in Fig. 2. Guide section 210 is connected to an arm 212, which in turn is connected by a link 213 to the outer end of an arm 214 mounted on a rock shaft 215. Attached to this shaft there is an arm 216 which is connected to the piston rod of a fluid pressure cylinder 217, the arrangement being such that when the piston rod is moved downwardly guide section 210 will be swung from its full to its dotted line position.

The continuation of guide 15 to the right of tilting section 210 includes a guide section 220 which is pivotally mounted at its upper end on a block 221. The lower end of guide section 220 is suspended by a rod 222 whose upper end is pivotally connected to an arm 223 attached to rock shaft 215. When guide section 210 is swung to its dotted line position, the lower end of guide section 220 is dropped to the level of an apron 224, over which blanks pass from conveyor 10 to the lower pass of mill 1. When a blank is moved over conveyor 10 to mill 1, guide section 220 is moved upwardly to its full line position shown in Fig. 2 to permit the blank to pass under it, and in such position of guide section 220, swinging guide section 210 is in its full line position for directing a blank from the upper roll pass of mill 1 to coiler 2.

The operation of the mill provided according to this invention has been explained in connection with the foregoing description of the mill. Summarizing the operation, a thin slab or plate heated to a hot-working temperature is delivered by conveyor 10 to the lower pass of five-high mill 1 (Fig. 2), and from that pass is delivered through strip-directing guides 12, 29 and 35 to pinch rolls 38 and 39 (Fig. 3) at the entrance of coiler 3. When the blank is so delivered to the coiler, pivoted guide section 29 is moved by pressure cylinder 32 to an upwardly inclined position in registration with guide 35. The pinch rolls are driven at a peripheral speed substantially the same as the speed of delivery of the blank from mill 1, but nevertheless at such peripheral speed that the blank is held taut between the pinch rolls and the bite of working rolls 5 and 6. The pinch rolls deliver the blank to bending rolls 50, 51 and 52, which curve it upwardly to facilitate its coiling around coil roll 101 and within arms 70, 71 and 72 which initially are moved to their inner dotted-line position shown in Fig. 3. The coil is supported and rotated by cradle rolls 73 and 74, and, during the initial stage of coiling, coil roll 101 is moved adjacent to arm 71. After a few of the inner convolutions of the coil have been formed, the coil roll is lowered to cause it and cradle rolls 73 and 74 to act as pinch rolls to rotate the coil. To maintain the coil in cylindrical form, or in other words to prevent it from coiling in telescopic fashion, coil side guards 115 are initially moved to the position at the sides of the coil shown in Fig. 3, and, as the coil builds up, these side guards may be gradually moved outwardly by the action of fluid pressure cylinder 125 and the connections from it to frame 118 that supports the side guards. Bending rolls 51 and 52 may be adjusted as a unit for every pass, if desired.

At the completion of a coiling operation, coil motor 150 (Fig. 4) is reversed to drive cradle rolls 73 and 74 and coil roll 101 in the opposite direction to rotate the coil for unwinding it. The outer end of the coil blank is stripped from it by stripper 190 which directs the blank into and through guides 196, 198, 199 and 13 to the upper pass of mill 1 between working rolls 4 and 5, and the blank is delivered by that pass through guide 14 to coiler 2 shown in Fig. 2, in which the the coiling operation just explained with reference to coiler 3 is repeated. During the coiling by coiler 2, pivoted guide section 210 is in its position shown in full lines in Fig. 2 to make guide 14 continuous. At the conclusion of a coiling operation in coiler 2, the blank is uncoiled in the manner explain with reference to coiler 3 and passes through guide 15 to the lower pass of the mill between working rolls 5 and 6. When the blank is thus uncoiled, pivoted guide section 210 is moved to its dotted line position shown in Fig. 2 by fluid pressure cylinder 217 and the connections extending from it to guide section 210, in which position guide 15 is continuous from coiler 2 to mill 1. When guide 210 is thus tilted to its dotted line position, lower guide section 220 is lowered to its dotted line position to deliver the blank between edging rolls 16 to the lower pass of mill 1.

This cycle of rolling by mill 1 and the alternate coiling by coilers 3 and 2 may be repeated as many times as are necessary to reduce the blank to a desired thickness. When the blank has been thus reduced by mill 1 it is delivered to conveyor 33 (Fig. 3) which passes below the coiler mechanism between its side frames 27 and 28, pivoted connection 29 then being lowered to the position in which it is shown in Fig. 3. To impart good hot rolled surfaces to the blank thus reduced in mill 1, the blank is preferably passed through finishing pass stands 20 and 21, at which time these stands form with mill 1 a three-stand continuous or tandem mill, the drives of stands 20 and 21 being coordinated in the usual manner to thus continuously roll the blank.

According to the provisions of the patent statutes, I have explained the principle and mode of operation of my invention, and have illustrated what I now consider to be its preferred embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than specifically illustrated and described.

I claim:

1. A coiler for coiling hot strip metal delivered from a rolling mill and for unwinding it for delivery to such mill, comprising a frame having a centrally-disposed coil-forming compartment, means for feeding and for continuously curving a strip-like blank, a pair of cradle rolls at the bottom of said compartment for supporting coiled strip metal while a coil is being formed and while it is being unwound, means for driving said cradle rolls in one direction for forming a coil and in the opposite direction for unwinding it, a driven coil roll within said compartment extending transversely of it and movable in a vertically-extending direction therein, and means for holding said coil roll downwardly against the interior of a coil to press the exterior thereof against one of said cradle rolls.

2. A coiler for coiling hot strip metal delivered from a rolling mill and for unwinding it for delivery to such mill, comprising a frame having a centrally-disposed coil-forming compartment, means for feeding and for continuously curving a strip-like blank, a pair of cradle rolls at the bottom of said compartment for supporting coiled strip metal while a coil is being formed and while it is being unwound, means for driving said cradle rolls in one direction for forming a coil and in the opposite direction for unwinding it, a coil roll within said compartment extending transversely of it and movable in a vertically-extending direction therein, means for driving said coil roll in each direction at all positions thereof, and means for holding said coil roll downwardly against the interior of a coil to press the exterior thereof against one of said cradle rolls.

3. A coiler for coiling hot strip metal delivered from a rolling mill and for unwinding it for delivery to such mill, comprising a frame having a centrally-disposed coil-forming compartment, means for feeding and for continuously curving a strip-like blank, a pair of cradle rolls at the bottom of said compartment for supporting coiled strip metal while a coil is being formed and while it is being unwound, means for driving said cradle rolls in one direction for forming a coil and in the opposite direction for unwinding it, a yoke comprising a pair of laterally spaced arms and a rotatable shaft positioned at a side of said compartment and to which one end of each arm is attached, a driven coil roll borne by the other ends of said arms within said compartment extending transversely of it, and means for holding said yoke downwardly to position said driven coil roll against the interior of a coil and to press the exterior of the coil against one of said cradle rolls.

4. A coiler for coiling hot strip metal delivered from a rolling mill and for unwinding it for delivery to such mill, comprising a frame having a centrally-disposed coil-forming compartment, means for feeding and for continuously curving a strip-like blank, a pair of cradle rolls at the bottom of said compartment for supporting coiled strip metal while a coil is being formed and while it is being unwound, means for driving said cradle rolls in one direction for forming a coil and in the opposite direction for unwinding it, a coil roll within said compartment extending transversely of it and movable in a vertically-extending direction therein, means for driving said coil roll in each direction at all positions thereof, and means for holding said coil roll downwardly against the interior of a coil to press the exterior thereof against one of said cradle rolls, said last-named cradle roll and said coil roll constituting a pair of driven pinch rolls for forming a coil and for unwinding it.

5. A coiler for coiling hot strip metal delivered from a rolling mill and for unwinding it for delivery to such mill, comprising a frame having a centrally-disposed coil-forming compartment, means for feeding and for continuously curving a strip-like blank, a pair of cradle rolls at the bottom of said compartment for supporting coiled strip metal while a coil is being formed and while it is being unwound, means for driving said cradle rolls in one direction for forming a coil and in the opposite direction for unwinding it, a driven coil roll within said compartment extending transversely of it and movable in a vertically-extending direction therein, means for holding said coil roll downwardly against the interior of a coil to press the exterior thereof against one of said cradle rolls, said last-named cradle roll and said coil roll constituting a pair

of driven pinch rolls for forming a coil and for unwinding it, a chute for receiving strip metal as it is unwound from a coil, a stripper pivotally mounted adjacent to the entrance of said chute, and means for pressing the stripping end of said stripper against the exterior of a coil to remove strip metal therefrom and direct it into said chute.

6. A coiler for coiling hot strip metal delivered from a rolling mill and for unwinding it for delivery to such mill, comprising a frame having a centrally-disposed coil-forming compartment, cradle rolls in the bottom of said compartment forming the sole support for strip metal while a coil of it is being formed, a pair of guard plates at one side only of said compartment adjacent to the opposite edges of the outer convolutions of a coil being formed, a laterally movable support for said plates, means for moving said support and plates outwardly of and beyond said compartment while a coil is being formed, and means for adjusting said plates toward and from each other to accommodate strips of different widths.

7. A coiler for coiling hot strip metal delivered from a rolling mill and for unwinding it for delivery to such mill, comprising a frame having a centrally-disposed coil-forming compartment, cradle rolls in the bottom of said compartment forming the sole support for strip metal while a coil of it is being formed, a pair of guard plates at one side only of said compartment adjacent to the opposite edges of the outer convolutions of a coil being formed, a laterally movable support for said plates, means for moving said support and plates outwardly of and beyond said compartment while a coil is being formed, and means borne by said laterally movable support for adjusting said plates toward and from each other to accommodate strips of different widths.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
784,004	Kent	Feb. 28, 1905
1,213,771	Leen et al.	Jan. 23, 1917
1,809,128	Koch	June 9, 1931
1,975,756	Summey	Oct. 2, 1934
1,985,501	Hudson	Dec. 25, 1934
2,207,663	Glasner	July 9, 1940
2,267,161	Miller	Dec. 23, 1941
2,280,564	Wilson	Apr. 21, 1942
2,322,784	Klein	June 29, 1943
2,334,109	McBain	Nov. 9, 1943
2,340,646	Crosby	Feb. 1, 1944
2,363,585	Grosser et al.	Nov. 28, 1944

FOREIGN PATENTS

Number	Country	Date
509,951	Great Britain	July 25, 1939
511,279	Great Britain	Aug. 16, 1939
672,122	Germany	Feb. 2, 1939