This invention relates to improvements in metal strip uncoilers and more particularly to improved features of construction and accompanying improved methods of operation of apparatus of this character whereby metal strip may be uncoiled in a more expeditious manner, with substantially less damage occurring to the strip stock, and whereby the strip stock delivered by the apparatus is of improved physical condition, metallurgically, for passage through subsequent processing equipment or for utilization in metal working apparatus as a drawing press, for example.

One of the principal problems encountered in the uncoiling of metal strip, particularly hot rolled strip, is the avoidance of the formation in the strip of minute transverse fissures or "coil breaks" which tend to occur as the strip is paid off from the outer convolution of the coil into a tangentially extending path due to the tendency of the strip to retain its curved shape. It has heretofore been proposed to prevent the occurrence of coil breaks in the strip as it leaves the coil by mounting the coil on a mandrel, applying under pressure a fairly small-diametered working roll to the outer periphery of the coil and in parallelism with the mandrel, and by drawing off the metal strip from the coil along a path which curves snugly around the working roll. Rotation of the coil is resisted by the friction encountered in the rotation of the working roll and by the clamping pressure exerted between the mandrel and the working roll, and in this manner the metal of the strip is cold worked into a state of plasticity thereby preventing the formation of coil breaks therein. In this process the metal of the coil is securely retained only in a plane including the axes of the mandrel and the working roll and in practice the circumferential portions of the convolutions of the coil which lay outside the vicinity of this plane tend to separate due to the working or kneading action of the coil and in fact the convolutions of the coil often separate quite widely at a point diametrically opposite the working roll. This condition tends to cause sideways slippage of the convolutions of the coil and irregular alignment of the side edges of the convolutions thus causing damage to the side edges of the strip in many cases and in all cases imparting unequal strains to the transverse increments of the strip as the strip is forcibly pulled around the working roll.

It is accordingly one of the principal objects of this invention to improve a metal strip uncoiler of the type having a coil supporting mandrel and a pressure-loaded working roll for en-
and construction of the complete assembly is simplified.

A still further object of the invention is the provision of improved means to control the operation of combined metal strip uncoiling and processing apparatus of the general character herein described.

The above and other objects and advantages of the invention will become apparent upon consideration of the following detailed specification and the accompanying drawings wherein there is disclosed a preferred embodiment of the invention.

In the drawing:

Figure 1 is a front elevation of a metal strip uncoiler constructed in accordance with this invention;

Figure 2 is a transverse section through the apparatus of Figure 1;

Figures 3 and 4 are fragmentary sectional views showing certain parts of the uncoiler in loading and operating positions, respectively;

Figures 5 and 6 are elevation and plan views, respectively, of one of the flexing roll assemblies of the apparatus of Figures 1 and 2;

Figure 7 is a longitudinal section through an expanding mandrel of a type which may be utilized in the assembly of Figures 1 and 2;

Figures 8 and 9 are transverse sectional views of the mandrel of Figure 7, the views being taken along the lines VIII—VIII and IX—IX, respectively, of Figure 7; and

Figure 10 is a schematic showing of a combined hydraulic and electrical control system which is utilized for the assembly of Figures 1 and 2.

The principal frame of the uncoiler illustrated consists of a pair of housings 10 and 11 in which is rotatably supported the various rolls of the apparatus. Housings 10 and 11 are suitably inter-connected by various transverse members as the top strut 12 and the beams 13 and 14, for example.

As shown in Figure 1 the housings 10 and 11 are supported on a structural steel framework 15 over a pit 16 which in practice is elongated in the direction normal to the plane of the view of Figure 1 to accommodate a coil transfer car 17 which is movably mounted on the rails 18.

Extending outwardly from the plane of the housing 11 is a base 19 on which is slideably mounted a table 20 for movement toward and away from the housing 11, suitable ways being formed on the base and table to guide this rectilinear movement. The inner end of the table 20 moves into and out of a window formed in the housing 11 and carries a bearing housing 21 which rotatably supports the center portion of a spindle 22. The outer end of the spindle 22 is journaled in a speed-reducer housing 23 and is keyed to the large gear, not shown, in said housing while the pinion gear, not shown, of the speed reducing assembly is coupled with a dyna

Spindle 22 carries an expanding mandrel of any suitable construction on its overhanging portion, that is, on its portion which projects to the side of the housing 11 which is opposite the housing 23. The expanding mandrel may comprise a plurality of segments 25 and reference is now made to Figures 7, 8 and 9 which show in detail a type of mandrel which may be utilized in the machine of Figures 1 and 2. As shown, the spindle 22 is provided with an axial bore extending from end to end thereof in which is slideably received an actuating rod 26. Slideably mounted on an elongated portion 27 of uniform diameter of the spindle 22 is a sleeve 28 having four circumferentially spaced faces to which is pivotally connected the inner ends of a multiplicity of toggle links 29. One of the mandrel segments is spaced radially outward from each of the four faces of the sleeve 28 and is carried by the toggle links, the outer ends of the toggle links being pivotally connected to the housing 23. Segments 25 are held against rotative and axial movement with respect to the spindle by a spider 30 which is rigidly keyed and clamped on a shoulder 31 formed on the spindle 22 and which has four radially outward projecting studs 32, each adapted to be slideably received in a bore 33 formed in each of the mandrel segments 25.

It will be observed that this construction allows the mandrel segment 25 to move radially inward and outward while preventing axial or rotative movement of the segment with respect to the axis of rotation of the spindle 22. Segments 25 are moved radially inward and outward by varying the angularity of the toggle links 29 with respect to planes normal to the axis of rotation of the spindle 22 and this is accomplished by shifting the sleeve 28 axially on the portion 30 of the spindle 22. To do this, a key 34 is extended through the outer end portion of rod 26 and has its outer end portions received in apertures 35 formed in the diametrically opposite walls of the sleeve 28. Spindle portion 27 is diametrically notched at points 36 and 37 of the key 34 and consequently of the sleeve 28. It should therefore be observed that upon axial movement of the rod 26 in an outward direction with respect to the spindle 22, 27 the sleeve 28 will also be moved in an outward direction to draw in the segments 25 through the action of the toggle links 29.

Secured to the outer free end of the spindle 22 is a tapered but blunted nose member 37 which is arranged to be received in a complementary sleeve 38 which is journaled in housing member 10 upon the expansible mandrel being moved into operative position shown in Figure 1. To move the mandrel into and out of operating position I provide a hydraulic cylinder 39 which is supported in the base 19 and has its piston rod connected with the table 20. To move the rod 26 axially in the spindle and mandrel the rod is moved out through the driven gear in housing 23 and has its outer end connected to the piston in a cylinder 40 which may be conveniently mounted on a bracket 41 extending upwardly from the table 20 and positioned beside the dyna

Spindle 22 is mounted on a pedestal 42 in such a position that it projects upwardly from the housings 10 and 14 which is inverted U-shaped carrier 42 journaling a small-diameter driving or working roll 43 and an accompanying back-up roll 44. This assembly is arranged to be raised and lowered by a cylinder 45 which is connected to the frame from the strut 12. As shown, the lower end of the piston rod of the cylinder 45 is connected with the carrier 42 at the point 46. Roll 43 is positioned directly above and parallel with the axis of rotation of the coil supporting mandrel
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25 and is arranged to be brought down into pressure engagement with the outer periphery of the coil during the uncoupling operation as will be hereinafter more fully described.

A second carrier 47 is slideably mounted for vertical movement in suitable guideways or windows formed in the housings 10 and 11 rearwardly of the first carrier 42. Carrier 47, which is shown in detail in Figures 5 and 6, is in general similar to the carrier 42 but is arranged to rotate through a backing roll 48 below a smaller diametered flexing roll 49. Carrier 47 comprises a horizontally disposed beam 50 having attached to its ends downwardly depending journal blocks 51 which is journaled the rolls 48 and 49. As shown in Figure 5 the flexing roll 49 is spaced downwardly from the beam 50 to allow passage of the strip which is shown in broken lines at 52. Carrier 47 is arranged to be raised and lowered by a cylinder 53 the piston rod of which is connected with the carrier at 54.

To draw the strip off the coil and over the flexing rolls 48 and 49, I provide a pair of “pull-out” or pinch rolls, each pair having a lower roll 54 which is journaled in bearing blocks 55 normally fixed in windows formed in the housings 10 and 11 and an upper roll 56 which is journaled in bearing blocks 57 slideably mounted for vertical movement in the windows. Blocks 57 are each carried by an upwardly extending rod 58 which is connected at its upper end to the piston in a cylinder 59 and to adjust the position of the range of movement applied to the roll 56 by the cylinders 59, I provide worm gear arrangement 60 to raise and lower the roll when cylinders 59 are not actuated but which allow limited vertical travel of the roll upon actuation of the cylinder 59 in any position of adjustment. Thus, the cylinders 59 are primarily pressure-applying devices although being operative to raise the top pinch rolls 56 slightly to facilitate the threading through of the leading end of a piece of strip. Also journaled in the housings 10 and 11 is a small roller leveler comprised of the lower rolls 60 and the retractable upper offset rolls 61.

For compacting the coil in an axial direction when the mandrel is first inserted into it and to position the coil centrally on the mandrel relative of the length of the coil, I provide on each housing 10, 11 a pair of plates movable in unison toward and away from the center of the machine. Thus, slideably mounted on the housing 10 are the plates 62 and 63, each carried by a pair of vertically spaced but parallel rods 64 and 65 which are slideably received in suitable grinding apertures formed in the housing 10. A similar pair of similarly carried plates are supported on the housing 11 opposite the plates carried by the housing 10. By referring more particularly to Figure 2 it will be observed that the plates will engage substantial segments of the ends of a coil which is positioned on the mandrel 25 and the parts are so dimensioned that when the mandrel is rotated the position of the plates will fit snugly and closely about its outer periphery. Further, the plates are separated circumferentially sufficient to actuate the rolls 43 and 44 so as not to interfere with the radially inward travel of these rolls upon the paying off of a coil of strip.

A rack is on the upper surface of each of the rods 65 for engagement by pinions 66. The two pinions 66 on each of the housings 10, 11 are keyed to a common shaft 67 and the shafts, in turn, are arranged to be rotated by rack and pinion assemblies 68 actuated by cylinders 69. In order that the plate 62, 63 on the opposite housings 10, 11 will move inwardly or outwardly in unison the two shafts 67 are mechanically coupled together with a cross-shaft 70 and the bevel gear set 71. Thus, upon the admission of fluid pressure to the lower ends of cylinder 69 the two shafts 67 will be simultaneously rotated in such direction as to move the four plates 62, 63 inwardly toward the center of the machine and if at this time the coil of strip is supported on the mandrel 25, the axial position of the respective convolutions of the coil will be brought into axial alignment in parallel planes normal to the axis of rotation of the mandrel and, further, the body of the coil will be moved to the exact center of the machine as will be understood. Upon reversal of fluid flow in the cylinders 69 the racks which are connected to the 64, piston rods of these cylinders will move downwardly to rotate the shafts 67 thereby moving the plate 62, 63, outwardly. In actual practice the plate 62, 63 may be moved inwardly and outwardly in a rapid manner to in effect hammer the convolutions of the coil into precise alignment.

The transfer car 17 may be moved along the rails 18 by a cylinder 72 which is shown schematically in Figures 1 and 10 and the car may support a vertically movable cradle 73 which rotatably supports a pair of cradle rolls 74. Means, not shown, may be incorporated in the cradle 73 to rotate the rolls 74 and to raise and lower the cradle 73 to provide a cylinder 75 which is mounted on the body of the car 17. The cylinder 15 is thus operative to elevate a coil of strip which is supported in the cradle rolls 74 up into the machine in alignment with the mandrel 25 so that the mandrel will enter in the coil upon inward movement of the mandrel caused by actuation of the cylinder 39.

Immediately ahead of the pass between the first pair of pull-out rolls 61 I provide a guide plate 76 which is hinged at its rear edge to the housings 10 and 11 and which extends substantially the entire width between these housings. The forward edge of the plate 76 is arranged to be engaged by fingers 77 which are carried by the depending portions 81 of the slideable carrier 47. As the carrier 47 moves downwardly to inoperative or loading position the guide plate 76 will tilt downwardly to horizontal position so as not to interfere with the threading through of the leading end of a piece of strip. It should be observed, moreover, that when the flexing roll 49 is in lowestorm or inoperative position the upper curved surface thereof acts as a guide to facilitate the passage of the leading edge of the strip to a position immediately above the plate 16 and thus into a position immediately ahead of the first set of rolls 54, 56 whereby the edge may readily enter in between these rolls. Upon actuation of cylinder 54 to raise the flexing roll 49 and its backing-up roll 48 the fingers 77 tilt the plate 16 upwardly to the position shown in Figure 2.

The apparatus thus far described may be controlled by the combined electrical and hydraulic system shown schematically in Figure 10 which will now be described. A hydraulic fluid pump 80 driven by a motor 81 deriving energy from a suitable alternating current source 82 is employed to supply hydraulic fluid pressure to a manifold 82 which, in practice, may be a control pump with a common control pump 83 to a sump 84 to which
the inlet of pump 88 is connected. Actuation of cylinders 83 is manually controlled by a manual four-way valve 85 which interconnects the manifolds 82, 83 and the cylinders 69. The mandrel travel cylinder 35, the mandrel expanding cylinder 40, and the coil transfer-car moving cylinder 72 are likewise under manual control, being interconnected with the corresponding fluid manifolds through manual valves 86, 87 and 88 respectively. Fluid pressure is supplied to the hold-down cylinders 59 by the manually controlled three-way valve 89 and normally fluid pressure is continuously supplied to the cylinders 56. Fluid pressure is furnished the lift cylinder 79 by a valve 90 equipped with a servo-actuator 91 the operating port of which is connected with the conduit leading to the tail end of cylinder 49 by means of a conduit 92. The operation of valve 89 is such that upon its initial manual actuation the cradle 73 is elevated to proper position after which the valve lever is moved to a neutral position to hold the fluid in cylinders 75 thereby retaining the cradle in proper elevated position. However, following the insertion of the mandrel in the coil and the subsequent energization of cylinder 40 in a direction tending to expand the mandrel, fluid pressure is developed in conduit 92 to operate actuator 91 whereupon the valve 90 is actuated to connect cylinders 75 with the return manifold 93 to allow the cradle 73 to drop preparatory to being loaded with the next succeeding coil.

While the dynamo-electric machine 24 may be of any suitable and known character, I have illustrated the same as being a simple shunt wound direct current machine adapted to be connected to a suitable direct current line 33 by means of a switch 94. A field winding 95 of this machine may be connected directly to the line 33 by a switch 96 and when so connected the machine will serve as an effective dynamic brake at all speeds above a predetermined minimum. When switch 96 is open a resistance 97 is connected in series with the winding 95 and the machine will then act as a conventional motor. However, for more effective dynamic braking when required means, not shown, may be provided to disconnect the machine from the line while simultaneously connecting it to a suitable load as a large resistor, for example.

Fluid pressure is supplied to the flexing roll moving cylinders 45 and 55 under the control of the four-way valves 98 and 99, respectively, and these valves are arranged to be actuated in a direction to furnish fluid pressure to the upper end of cylinder 45 and to the lower end of cylinder 55 by solenoids 100 and 101 respectively. Solenoids 100 and 101 are arranged to be simultaneously energized by a circuit deriving energy from source 82 through a transformer 102 under the control of a switch 103. Switch 103 is positioned between the two pairs of pinch rolls 54, 57 and is arranged to be closed, during the passage of a coil of strip, when the leading edge of the strip piece enters between the pinch rolls. These rolls as well as the rolls 60, 61 and roller leveler are normally continuously driven by a motor 104 acting through suitable gears, not shown, housed in casings 105 and 106.

Normally, the pinch rolls 54, 56 and the rolls 60, 61 of the roller leveler are continuously driven and at the start of an uncoiling operation the pressure and flexing roll 43 is lowered while the flexing roll 48 is raised, as shown in Figure 3, and the mandrel 25 is retracted and collapsed. A coil of stock is now moved into the uncoiler (into the space between the coil proper either manually or by the use of suitable peeling equipment, not shown, and after the end is so moved outwardly the coil is again rotated to cause the strip end to pass under the roll 43 and over the roll 49 into the bite between the first pair of pinch rolls, all as suggested in Figure 3. As the strip stock passes between the pinch rolls 54, 57 the valves 98 and 99 are actuated to energize cylinders 45 and 53 whereupon the pressure and flexing roll 43 is brought down into pressure engagement with the outer periphery of the coil while the flexing roll 49 is drawn upwardly, all as shown in Figure 4. The strip stock now levels off through the pinch rolls and the roller leveler and while doing so is severely flexed over the rolls 43 and 49 while under tension to thereby cold-work the stock to relieve any existent stresses therein and to bring the stock to a desired state of plasticity thus facilitating the subsequent processing of the stock.

During the uncoiling of the strip stock the rotation of the coil may be resisted by means of a mechanical or dynamic brake as the dynamo-electric machine 24, for example, to keep the coil in a tight condition thereby preventing creeping of the convolutions of the coil and to increase the back tension in the strip whereby the strip will be forced to follow more closely the flexing curvatures provided by the rolls 43 and 45. As the coil decreases in diameter the roll 43 follows its periphery continuously and under pressure to insure the strip stock being subjected to severe reverse flexure under tension immediately upon the stock being peeled off the coil which is known to be highly beneficial in the avoidance of "coil breaks." Further, the combination of the radially inward pressure and braking effect provided by the roll 43 with the radially outward force provided by the expansible mandrel as well as the braking effect on the rotation of the coil results in the maintenance of an exceedingly tight coil which makes impossible any shifting of the respective convolutions of the coil and which is found to impart a better and more uniform physical condition to the uncoiled strip.

The above specifically described embodiment of the invention should be considered as illustrative only as obviously many variations may be made therein without departing from the spirit or scope of the invention. Reference should therefore be had to the appended claims in determining the scope of the invention.

What I claim is:

1. In a strip uncoiler the combination of a frame having a pair of spaced housings for the reception of a coil of strip, a support slideably
mounted for movement toward and away from an outer side face of one of said housings and rotatably mounting an overhanging expandable mandrel, an opening in said one of said housings for the passage therethrough of said mandrel and a bearing surface on the other of said housings to rotatably support the free end of said mandrel when the same is in operative position spanning said housings, means on said support to expand said mandrel and to restrain rotation thereof, a pair of pinch rolls journaled in said housings and defining a horizontally disposed pass positioned above and to the rear of said mandrel, a yoke carrying a flexing roll slidably mounted in said housings for movement toward and away from the axis of rotation of said mandrel whereby said flexing roll may be maintained in pressure engagement with the outer periphery of a coil of metal strip positioned on said mandrel and said housings intermediate said first yoke and said pinch rolls for movement substantially parallel with said first mentioned yoke, and means to move said yokes in opposite directions whereby said flexing roll being brought into pressure engagement with said coil said second mentioned pressure roll is moved to a position outside of the plane of said pass.

4. Apparatus according to claim 3 further characterized in that said second yoke is slideably moveable to a position sufficiently inward to place said second flexing roll inside said plane of the pass through said pinch rolls whereby the curved surface of said second flexing roll serves as a guide to facilitate the entry of the leading end of a coil strip length into said pinch rolls.

5. In a strip uncoiler the combination of a frame adapted to receive a coil of strip, a support slideably mounted with respect to said frame and rotatably mounting an overhanging expandable mandrel for insertion in said coil when positioned in said frame, a pair of pinch rolls journaled in said frame and defining a pass spaced outwardly from the axis of rotation of said mandrel, a flexing roll carried by said frame and extending parallel with the axis of rotation of said mandrel, means mounting said flexing roll for movement toward and away from the axis of rotation of said mandrel, means to apply a force to said flexing roll to maintain the same in pressure engagement with the outer periphery of the coil of metal strip supported on said mandrel, the arrangement being such that the strip is curved about said flexing roll as it leaves the coil and before it enters said pass, and means on said support to expand said mandrel and to restrain rotation thereof.

6. In a metal strip uncoiler the combination of a frame comprising a pair of spaced vertically extending housings to receive a coil of strip, a coil-supporting mandrel, means mounting said mandrel for longitudinal movement into a coil positioned between said housings of a pair of pinch rolls journaled in said housings and defining a pass positioned above and to the rear of said mandrel, a yoke rotatably supporting an upper bucking roll and a contiguous lower flexing roll slideably mounted in said frame for movement toward and away from the axis of rotation of said mandrel, a second yoke having spaced downwardly extending legs rotatably supporting a lower backing roll and a contiguous upper flexing roll slideably mounted in said frame for movement generally parallel to the plane of movement of said first mentioned yoke and being positioned between said first mentioned yoke and said pinch rolls, and means to slide said yokes in opposite directions.

7. Apparatus according to claim 6 further characterized in that said means to slide said yokes in opposite directions comprises separate and independent motive means whereby the first of said flexing rolls may continue to move inwardly toward said axis after sliding movement of said second yoke is stopped.

8. Apparatus according to claim 6 further including means engageable by the leading end of a piece of strip as the same issues from said pass to energize said means to slide said yokes whereby the first of said yokes is moved toward said axis while the second mentioned yoke is simultaneously moved in the opposite direction upon said strip and issuing said pass.

9. In a metal strip uncoiling assembly having a frame for the reception of a coil of strip and
a coil-supporting mandrel mounted for longitudinal movement into said coil when the coil is positioned in said frame, a car for moving a coil of strip into said frame, elevating means on said car to raise said coil to proper position for insertion of said mandrel, means to expand said mandrel, and means operable automatically upon energization of said means to expand to lower said elevating means.

10. In a strip uncoiler the combination of a frame adapted to receive a coil of strip, a support slideable with respect to said frame and rotatably mounting an overhanging expansible mandrel for insertion in said coil when positioned in said frame, a pair of pinch rolls journaled in said frame and defining a pass spaced outwardly from the axis of rotation of said mandrel, a flexing roll carried by said frame and extending parallel with the axis of rotation of said mandrel, means mounting said flexing roll for movement toward and away from the axis of rotation of said man-

drel, means to apply a force to said flexing roll to maintain the same in pressure engagement with the outer periphery of the coil of stock supported on said mandrel, the arrangement being such that the strip is curved about said flexing roll as it leaves the coil and before it enters said pass, and means on said support to expand said mandrel.

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