The present invention relates to cold forming mills in general where annular or ring-like workpieces are reduced or formed to a particular shape and more particularly to a new and novel rim rolling mill where various shaped rims are formed on annular workpieces between cylindrical dies mounted on internally and externally-acting mandrels. As an example, tubeless tire rims for automotive vehicles and the like may be formed in this manner.

In vertical cold forming mills of this type, it is necessary to provide means for loading the annular workpieces into position between the dies in preparation for further working, and in the prior art, this has been accomplished by sliding the workpieces over an end of an internal roll shaft (hereafter called the “outboard end”) into die engagement position. In general, it has been necessary to move the rings transversely to the direction of rolling or forming for loading and unloading, and this has seriously limited the speed of operations and the realization of inherent efficiencies which are associated with such machines. This is particularly true, as in rim rolling, where it is compulsory to subject the rings to a series of progressive dies to obtain the desired final product as the prior art mechanisms are not adapted for use in continuous process lines because of the limitation encountered in loading the workpieces over the outboard end of the internal roll shaft.

To facilitate the loading and unloading operations in many instances, the outboard end of the internal roll shaft has been left completely unsupported and it is therefore necessary to restrict the heavy working pressures employed to prevent excessive deflections and internal stresses in the cantilevered shaft upon full rolling pressure being applied. This objection has been somewhat alleviated by the use of a retractable bearing carrier to support the outboard end of the internal roll shaft during rolling, such as shown in U.S. Patent No. 1,661,024 issued to C. C. Venable, but the problem of properly supporting the internal roll shaft is still of paramount importance since the carriers are usually unable to impart the required rigidity to the roll shaft. Further, the movable bearing carrier complicates the loading and unloading of the workpieces as it must be moved into and out of position before and after each rolling.

It is therefore the primary object of the invention to provide an improved rim rolling mill embodying improved means to journal the rotatable internal die whereby several of these machines may be more advantageously used to form a continuous process line and can be operated in a fast and expedient manner to obtain substantially higher rates of production. This type of operation is desirable where the workpieces must be subjected to a series of progressive dies or rolling operations as in the making of tubeless tire rims for automotive vehicles, for example.

Yet another object of the invention is to provide cold roll forming apparatus of new and novel design wherein loading and unloading operations are easily completed. In carrying out this object, I provide apparatus whereby it is not necessary to move or transfer the rings or workpieces transversely for loading and unloading operations but, in fact, they are at all times substantially in line with the dies and/or forming rolls thereby allowing high speed operations.

A more specific object of the present invention is the provision of a new and novel supporting and retracting arrangement for the lower or internal roll shaft so that sufficient strength and rigidity is imparted thereto thus allowing optimum rolling or forming pressures to be applied. As indicated previously, some means must be provided to allow the loading and unloading of annular workpieces and yet impart the required strength to the rolls shafts. This is accomplished in the present instance by retracting the entire lower roll shaft and die assembly to one side of the pass line by means which insures die alignment including a stationary spring-loaded receptacle for the outboard end of the roll shaft.

Yet another object of the present invention is to provide means for retracting the upper roll shaft and die associated therewith from ring engaging and pressure applying position to facilitate insertion and removal of the workpiece. In connection with the above object, it is a further object of the invention to provide means for adjusting the final position of the upper roll shaft whereby the pressure desired for any given type of workpiece is readily obtained.

A still further object of the invention is the provision of new and novel means for initially positioning the workpiece prior to the movement of the upper die into pressure engaging relation with the internal die and workpiece, thereby insuring that the resulting rim will be exactly at the place desired on the annular workpiece. This preparatory alignment is especially critical when progressive dies are used, as improper registry with any one pair of dies will usually result in a completely unacceptable final product. The contemplated arrangement of the rim rolling mill utilizes both side and center guiding means each actuated by the movement of the upper roll shaft and die thus eliminating the need of further expensive control and/or synchronizing apparatus. Another auxiliary object of the invention is to provide guide means which are operative to move into and out of ring engaging position at a higher rate of speed than the movement of the upper roll thereby effecting proper alignment of the ring and allowing access for loading and unloading operations.

A further object of the invention is to provide conveying and feeding apparatus for use in combination with the rim rolling mill and forming an integral part thereof in which a substantially continuous and automatic feeding of the rings is obtained thereby allowing higher rates of production than have hitherto been found practical or obtainable. The loading and unloading of the workpieces has been the greatest single limiting factor in prohibiting the maximum utilization of rim rolling mills and the various problems encountered in providing a practical feeding device are substantially mitigated in my apparatus.

In connection with the above object it is yet another object of the invention to provide feeding and conveying apparatus which allows any number of the vertical ring rolling and/or forming mills to be used in a continuous process line where progressive operations are required. My new and novel apparatus, when used in conjunction with a rim rolling mill, is operative to feed the rings into position and then, after forming operations, to free the annular workpieces from the dies and transfer the ring to a like device associated with another mill having a different set of dies for further working. It is contemplated that the movement and operation of the feeding and conveying device will be dependent upon the position of the upper external roll shaft and the guiding means which further precludes the need of extra controlling...
equipment. By providing feeding and conveying apparatus for use with my rim rolling mill, continuous process lines and higher rates of production are completely practical and feasible.

At the outset, it is noted that the various and complicated problems solved by my apparatus have often dictated complex and unwieldy machines and mechanisms in the prior art. It is therefore a primary consideration of the invention to provide apparatus having the characteristics specified above which is of the utmost simplicity in construction and operation as will be apparent to persons familiar with and skilled in this particular art.

For a better understanding of my invention, as well as the disclosure of other objects and advantages of the invention, reference should now be had to the following detailed specification and accompanying drawing wherein is disclosed a preferred and illustrated embodiment of the invention.

In the drawing:

FIGURE 1, composed of parts 1A and 1B, is a front end elevation of the rim rolling mill constructed in accordance with the teachings of my invention;

FIGURE 2 is a side view of the rim rolling mill shown in FIGURE 1;

FIGURE 3, composed of parts 3A and 3B, is a partial end view taken along the section line III—III of FIGURE 2;

FIGURE 4 is a side elevation as seen from the section line IV—IV in FIGURE 1;

FIGURE 5 is a side view of the center guide utilized for aligning the annular workpieces between the dies;

FIGURE 6 is an end view of the apparatus depicted in FIGURE 5;

FIGURE 7 is a top plan of the center guide shown in either FIGURES 5 or 6;

FIGURES 8, 9, and 10, are side, end, and top views, respectively, of the side guide used in my rolling mill;

FIGURE 11 is a side elevation of the conveying and feeding mechanism shown in an upper drawing wherein is disclosed a preferred and illustrated embodiment of the invention.

FIGURE 12 is a top plan of the feeding and conveying apparatus shown in FIGURE 11;

FIGURE 13 is an end view of the mechanism embodied in either FIGURES 11 or 12; and

FIGURE 14 is a schematic side elevation showing a number of rim rolling mills as situated in a continuous process line where the workpieces must be subjected to a series of progressive dies and/or rolling operations.

Referring now to the drawing, wherein like numerals designate like parts, and initially to FIGURES 1—3 thereof, the rim rolling mill 10 is of the vertical type and rests on the base or foundation 11 of a plant, for example, and consists of a structural framework including heavy upright housings 12 and 13 having a large opening 14 therebetween and which are separated by various and suitable structural beams 15 and 16 to provide both vertical and lateral support to the apparatus. Journaled in the housings 12 and 13 are the roll shafts 18 and 20 having threaded die retarding collars 17 and 19, respectively. It should be understood that the blanks for the tire rims are usually fabricated prior to reaching the rolling mill by joining the ends of metal strips having predetermined lengths and widths by some expedient means, such as flash welding, thereby to form the desired sized rings. The rings are then moved one at a time between the dies (not shown) mounted on shafts 18 and 20 for formation of the appropriate rim as will be hereinafter more fully explained.

The inner end of the shaft 18 is rotatably received in the housing assembly 21 consisting primarily of the generally cylindrical bearing housing 22 which is an integral part of a crosshead framework 23, and two annular end plates 25 and 26 which are secured to the bearing housing 22 by bolts 28. The roll shaft 18 decreases abruptly in diameter to form a series of shoulders that cooperate with the various circular bearings 27. The roll shaft 18 provides through the housing assembly 21 thereby exposing an end which is adapted to be connected to suitable driving means as will be hereinafter more fully explained.

The outboard end of the external roll shaft 18 is similarly supported and is journaled in the housing assembly 23 of a cylindrical housing 32. Because it is necessary to be able to remove the die from roll shaft 18, and yet tie the outboard end of this roll shaft securely to the cross-head framework 23, the outboard block 32 is rigidly attached to a support 35 having a threaded aperture 34 therein that threadably receives rod 33 and which is relatively mounted in the window of housing 12. The rod 35 is journaled in the lower end of depending brackets 36 which are in turn rigidly secured to the cross-head framework 23, and has means, such as shoulder 37 and nut 38, to firmly lock the outboard block 32 in any desired position to support and hold the external roll shaft 18. When it becomes necessary to remove or expose the die, the rod 35 is turned in a direction to retract the outboard block 32 outwardly toward the brackets 36. At this point, it is pertinent to note that both the inner and outboard ends of the roll shaft 18 are supported directly or indirectly from the cross-head framework 23 for vertical movement as will be hereinafter more fully explained.

Considering now the suspension and support of the internally-acting roll shaft 20 and the die associated therewith, the inner end of the roll shaft 20 is supported in a generally cylindrical housing 21 of the bearing housing 49 having a flat top surface 47 and two annular end members 42 and 43. Roll shaft 20 is journaled in bearings 44, in the same manner as the inner roll shaft 18, and the two flat surfaces 24 and 41 are contiguously to each for sliding contact. Similar shoulder portions and a retaining nut are provided in order that any movement of the housing assembly 39 commands a corresponding movement on the part of the roll shaft 20 and the die mounted thereon. An end portion of the roll shaft 20 extends through the housing assembly 39 and is contiguously to suitable driving means. The outboard end of this roll shaft terminates in a tapered cylindrical plug 46 adapted to be slidably received in a cooperating recessed depression 47 in the end of a shaft 48. The shaft 48 is journaled in a housing assembly 49 by bearings 50 in the same manner as the inner ends of the roll shafts 18 and 20. Rigidly attached to the housing assembly 49 are a pair of transversely disposed and longitudinally spaced blocks 52 which carry a pin 53 therebetween. Keyed to the pin 53 is in an enlarged head 54 of a rod 55 which extends parallel to the shaft 48 and is slidably receivable in a tubular support 56 that is in turn suspended by angles and other means from the housing assembly 49 and the blocks 52. The outer end of the rod 55 extends through the tubular support 56 and is threaded at 57 to receive the limiting nut 58. A heavy duty coil spring 59 encircles the rod 55 and extends between the head 54 and the tubular member 56 as is readily apparent in FIGURE 3 of the drawing. The blocks 52 are adapted to slide on the transversely extending L-shaped slides 60 which in turn are attached to the housing 12. It is thus apparent that the entire outboard end assembly, including the housing assembly 49, shaft 48 and blocks 52, is spring-loaded for movement toward and away from the pass line of the workpieces subject, of course, to the restraining action imparted by the limiting nut 58. When the roll shaft 20 is moved into position for rolling, as will hereinafter be explained, the tapered recessed depression 47 is forced into pressure contact with the frustoconical shaped plug of the roll shaft 20 by the pressure exerted upon contraction of the spring 59. This manner of supporting the outboard end of the internal roll shaft is especially useful since the same is positively and very rigidly supported from both ends as is readily apparent.

To drive the upper and lower roll shafts 18 and 20, I contemplate providing a large electrical motor 61 mounted on a suitable base 62 situated to one side of the rim rolling
The motor 51 is adapted to turn a large worm gear 63 through suitable power transfer mechanism, such as the sprocket 64 and the chain drive 65. The worm gear 63, as well as another gearing mechanism to be recited, is contained in a gear casing 66 also positioned on and supported by the base 62. The body of the circular worm gear 63 is keyed to the hollow shaft 76 which in turn is journaled for rotation in the gear casing 66 by the bearings 68 on both ends thereof, the arrangement being such that upon actuation of the motor 61 the shaft 67 is caused to rotate. Also keyed to the shaft 67 is a gear 70 that meshes with another gear 71 to drive a shaft 72 which is also journaled for rotation by bearing 73 in the gear casing 66. Attached to the protruding end of the shaft 72 by means of a connector 74 is a large double universal coupling 75 that is adjustable in the transverse direction by means of the sliding interconnection between the parts 76 and 77 thereof. The far end of the universal coupling 75 is directly attached to the end of the upper roll shaft 18 by means of a suitable connector, such as the one shown at 78.

Referring again to the shaft 67, it is adapted to slidably receive an elongated shaft 79 and impart rotary motion thereto through the link 86 for pivotal movement of the roll 12. It has ways 80 extending substantially the length thereof which engage a spline coupling 81 attached to the end of the shaft 76 with the length of the ways 80 determining the distance the shaft 79 may be retracted. The outer end of the shaft 79 is directly connected to the end of the internally-acting roll shaft 20 by a coupling 82 so that rotary motion is imparted through it. It is therefore seen that upon actuation of the motor 61, the roll shafts 18 and 20 and the dies associated therewith will be caused to rotate, thus reducing or forming an annular workpiece.

As discussed previously, some means must be provided for retracting the lower roll shaft 20 to one side of the pass line of the rings. In the present instance, this is accomplished by a new and novel crank and lever connection secured to the lower housing assembly 39 on one end, and a means for imparting rotary motion through a predetermined angular displacement on the other. Rigidly attached to and depending from the housing assembly 39 are longitudinally spaced and transversely extending blocks 33 having outwardly angled end portions fitted with abrasion-resistant wear-plates 34 as shown in FIGURE 4 of the drawing. The blocks 33 carry a pin 35 which in turn shafts 30 pivotally mounted on the same. The wear-plates 34 slide on the transversely extending guides 37 which, as is apparent, are long enough to accommodate any movement of the link 86 in retracting the inner roll shaft and are rigidly supported by the housing 13. The link 86 has an integral projecting threaded end portion 89 which is coupled through the connection 90 to a link 91 which is pivoted to a crank arm 92 by a pin 93. Crank arm 92 is keyed to a drive shaft 94 of a conventional hydromotor 95. The arrangement is such that a toggle link is formed having a first rigid lever consisting of the link 86, coupling 90 and the link 91 pivotally connected to the blocks 33 and a second lever (crank 92) terminating at the hydromotor 95. When the hydromotor 95 is energized to rotate the crank 92 downwardly, the link 86, and as a consequence, the housing assembly 39 carrying the lower roll shaft 20 is retracted a predetermined distance, depending upon the angular positioning of the crank arm 92. At the same time, it is necessary to make some correction in the length of the driving connection to the inner roll shaft 26, and this is accomplished by the shaft 26 being rotated on the base 62 to a position shown by the broken lines indicating the extreme retracted position of the shaft 79 and the coupling 82. It is preferred that when the roll shaft 20 is in proper position for rolling, the toggle link connecting the housing assembly and the hydromotor will be in dead center position, thus being able to better resist any movement of the roll in the transverse direction during rolling operations.

It is desirable to be able to change the rolling position of the internal roll shaft 26 and yet keep the drive link 100 at a dead center position for variations in different types of rolling operations. This can be accomplished by adjusting the coupling 90 to either separate or bring together the links 86 and 91 but this is a difficult and time consuming procedure as the links and coupling are of very large size and the adjustment must be one of the highest precision. Accordingly, I have provided a novel means of setting the inward travel of the roll shaft 20 by mounting the hydromotor 95 slidably in a cage assembly 96 which is supported from the base 62 (see FIGURE 1). Rigidly secured to the hydromotor 95 and extending toward the rim rolling mill 19 is a threaded rod 97 which fits through an aperture in a limiting plate 98 and is adapted to receive nuts 99 and 100 so that upon proper manipulation of these nuts the hydromotor 95 will be caused to slide either toward or away from the rim rolling mill and thus adjust the position of the internal roll shaft 20 when the toggle is in extended position. This means of adjusting is characterized by its simplicity and ease of operation, thereby allowing great flexibility in the operation of the vertical cold forming mill.

In retrospect, it is seen that I have provided for the mounting of the externally and internally-acting roll shafts 18 and 20, respectively, with the lower roll shaft 20 being suspended on the outward end by a novel spring-loaded bearing carrier while this roll shaft itself may be retracted for loading and unloading operation to one side of the path of rolling by means of a toggle link and variable drive connection. This system is especially adapted for rolling operations where heavy work pressures are required because the inner roll is inherently stable when in the rolling position, being positively supported on both ends and the linkage mechanism coming to a dead center position.

For loading and unloading of the workpieces prior to rolling and/or forming operations, it is necessary to further open the machine and this is accomplished in the present instance by providing means for vertically retracting the upper or outer roll shaft 18 and die associated therewith from pressure applying position. The outboard and inner housing assemblies 32 and 21, respectively, are directly or indirectly attached to the cross-head framework 23. This framework 23 is vertically movable on the housings 12—13. Attached by means of bolts 101 to the cross-head framework 23 are a pair of hollow supports 102 that slidably receive a pair of members 103 which are threadably attached to engage screwed shafts 104, each of which has a portion extending through an opening in the supports 102 and is journaled therein by a bushing 105. Rigidly attached to the lower ends of the shafts 104 are a pair of sprockets 106, with the sprocket on the shaft on the right as viewed in FIGURE 3 being double, to accommodate the chain or belt drives 107. To drive the sprockets 106, a motor 108, secured to one side of the cross-head framework 23 by a brace 109, may be energized to rotate the sprocket 110 thus causing the sprockets 106 to be rotated through the belt drives 107. The arrangement is such that the members 103 are slidably moved up or down inside the hollow supports 102 by proper rotation of the threaded shafts 104 to determine the final down position of the upper roll shaft 18 as will be apparent upon further consideration of the specification.

Each of the members 103 is pivoted on the upper end thereof by a pin 111 to a shaft 112 as shown in FIGURE 2 of the drawing. The link 112 is pivoted at its opposite end by a pin 113 to a crank 114 forming an integral part of shaft 115 which is journaled in and extends between the upper portions of the housings 12 and 13. Also keyed to the shaft 115 intermediate the crank 114 is a large crank arm 116 that is pivotally connected by a pin
When it is desired to vertically retract the upper roller shaft 18, the fluid cylinder 120 is actuated to pull the crank arm 116 to the right, thus causing the shaft 115 to rotate and forcing the various linkages from their dead center position to raise the cross-head framework 23, the roller shaft 18, and the apparatus connected therewith. Attention is drawn to the fact that when the roller shaft is in position ready for rolling or forming operations, the various linkages connecting the members 103 and the shaft 115 are in a dead center position in order that all the axial thrust encountered during rolling is taken by the threaded portions of the shafts 104 engaging the members 103, while any and all side thrust is taken, as fitted to the housing assemblies 21 and 32. It is therefore advantageous to keep the linkages in substantially dead center position when the roll is ready for rolling and yet be able to adjust the distance between the upper and lower roller shafts 18 and 20, respectively, to accommodate various workpieces of different thickness, and this is accomplished by rotating the threaded shafts 104 in the proper direction as hereinafore explained. Further, the double universal connection 75 in the drive connection for the upper roller shaft 18 permits freedom of vertical movement thereof without any effect on the lower roller shaft 20.

In a rim rolling mill of this type, it is also necessary to provide guides which are operative to insure proper positioning of the annular workpiece prior to the downward movement of the upper roller shaft 18 into pressure engagement, in order to obtain a satisfactory final product, and in my mill, I provide side guides and side guides designated by the numerals 123 and 124, respectively, with the side guide operative to engage the edges of the workpiece and the center guide operative to align the ring properly with respect to the path of rolling. The construction of the carriers and actuating means for both the center and side guides is primarily the same, and for the sake of brevity, only one of these will be described. Referring now to FIGURES 5 through 10, both of the guides 123 and 124 are shown as being movable in vertical direction in tracks 125 that are secured to the housings 12 and 13 of the rollers 12, an angle 126 and a plurality of aligned bolts 127. Riding in the tracks 125 are vertically oriented and transversely spaced runners 128 that carry the side guide assembly 124 in a manner to be further described. Bolted to the inner face of each of the runners 128 by the bolts 129 and 130, adapted to cooperate with a pinion gear 131 in moving the guide in the vertical direction. The pinions 131 are carried on both ends of a shaft 132 which is journaled in brackets 133 rigidly attached to the cross-head framework 23 by welding or other expedient means. Diagonally opposed to the racks 134 are another set of racks 134 secured by means, such as the bolts 135, to the main housings 12 and 13. The utility of this arrangement is quite apparent when it is remembered that the brackets 133 are movable in the vertical direction with the movement of the roller shaft 18 while the racks 134 are stationary, and thus the runners 128 and anything supported thereon will move with the speed, but in the same direction as the movement of the upper roller shaft 18 or the cross-head framework 23. In this manner, the front and side guides 123 and 124, respectively, are adapted to move into ring engaging position before the upper roller, thereby insuring proper workpiece positioning when the dies moved on the roller shafts 18 and 20.

The side guide 124 consists of a pair of transversely spaced conical rollers 136 journaled by bearings 137 on the end of shafts 138 which are bolted to a transverse cross-arm 139. The cross-arm 139 has a pair of elongated apertures 140 therein, in order that the distance between the rollers 136 may be adjusted as necessary. Welded to the cross-arm 139 intermediate the ends thereof, are a pair of spaced brackets 141 having central apertures and a plurality of radially disposed and circularly spaced ports therein, the arrangement being such that a bar 142 is pivotally received between the brackets 141 by a pin 143 and the angle of tilt of the rollers 136 from the plane of the bar 142 is controlled by means, such as pins, inserted between coincident pairs of the circumferentially spaced apertures as is readily apparent. Spaced 143 is a large fluid cylinder 120, having an enlarged head portion 145 which extends through the top cover of a rectangular housing 146 surrounding the bar 142 so that the relative vertical inward and outward position of the rollers 136 is easily adjustable. Part of the inner side of the rectangular housing 146 is formed by an angled foot portion 147 of a transverse plate 148 which is centrally located and extends primarily across the opening between the runners 128. Rigidly attached to the plate 148 intermediate the ends thereof is a rectangular piece 149 which is bored to threadedly receive a large bolt 150 having its head resting on the support 69 which in turn is attached to a cross-piece 151. The cross-piece 151 is joined on both ends to the runners 128, as shown in FIGURE 10 of the drawing, in order that any motion thereof is directly imparted to the side guide 124. In the drive connection, the side guide 124 will be adjustable laterally by sliding the same along the foot portion 147 of the plate 148, and to hold the side guide in any given position, I have provided a bracket 152 attached to either side of the foot portion 147 of the plate 148 having an aperture therein to hold a rod 153. Brevity does not permit a detailed description of this arrangement. The brackets 133 are movable in the vertical direction by means of supporting nuts 154, for example. It is seen that the guide 124 is thus adjustable in a plurality of directions to meet the requirements of different size and shaped workpieces that may be used in a cold rolling forming mill of this type.

Referring now to FIGURES 6 and 7 of the drawing wherein is shown the construction of the center guide 123, the arrangement for carrying the center guide is almost exactly the same as that utilized with the side guides. The only exceptions are that, instead of the runners and other apparatus connected therewith, there is provided a guide roll on a transverse shaft 156 which is journaled in brackets 157 extending from and directly attached to the bar 142. Of course, the side guide 124 is carried on one side of the rolling mill 10 while the center guide 123 is carried on the other side of the workpieces are supported and guided on both sides of the roller shafts 18 and 20 during forming operations.

In the previous discussion, particular attention has been drawn to the fact that the cold roll forming mechanism have heretofore not been adapted for use in continuous process lines at high speeds of operation, due to the trouble encountered in loading and unloading workpieces and to the lack of suitable transferring equipment and apparatus. In the illustrated embodiment of the invention, as shown in FIGURES 11, 12, 13 and 14 in particular, there is shown a new and novel feeder and conveyor 161 consisting of a large flat plate 161 disposed below the lower roller shaft 20 and between the housings 12 and 13. Extending vertically upward from the plate 161 near the corners thereof are four upright rods 162 being threaded on their upper ends and received in the couplings 163. The couplings 163 carry four normally extending bolts 193 which are adapted to fit through apertures 164 (see FIGURES 6 and 9) in the runners 128 whereby the base plate 161 experiences the same up or down movement as imparted to the side and center guides when the upper roller shaft 18 is raised or lowered. In order to control the relative height of the base plate 161, a sprocket 165 is attached to each upright 162 near the base plate, and these sprockets are...
connected by a chain 166 and sprockets 167, or other suitable means, so that upon rotation of one upright rod, a corresponding movement takes place in the others. This is accomplished by providing a driven speed reducer 166 bolted to the plate 161 and driving its driving parts connected to one of the upright rods 162.

Positioned near the back of the plate 161 is a basket 168 constructed from suitable plates and structural member which is large enough to accommodate the largest sized annular workpiece to be rolled or formed. The basket is mounted from the bottom face thereof on the basket rod 195 which is journaled on a center rod 170 rigidly supported from both side by side housings 171 welded to the base plate 161. Depending from the tubular rod 169 are two pairs of spaced brackets 172 that serve to pivotally connect the piston rods 173, by means of the pins 174, to the basket 168. The piston rods 173 protrude from a pair of spaced air cylinders 195 that are pivotally mounted to the base plate 161, the arrangement being such that when a workpiece is loaded into the basket 168, the air cylinders 195 may be actuated to tip the basket and transfer the workpiece to the kiccker mechanism now to be described.

Positioned forwardly of the basket 168 is a shaft 175 that is journaled by bearings 176 on both ends thereof in slides 177 which move in windows formed in the housings 171, and shaft 175 carries a pinion gear 178 intermediate its ends. A rack 179 is provided on the base plate 161 to cooperate with the pinion gear 178 when the shaft 175 is moved as the slides 177 move in the housings 171. To move the shaft forward and to the rear, the slides 177 are bolted to bars 196 (FIGURE 12) and these are spanned by a transversely extending plate 180 which is apertured to receive the piston rod 181 of a large air cylinder 182. Welded or otherwise rigidly attached to the shaft 175 inwardly of the side housings 171 are a pair of rearwardly and upwardly angled roller supporting plates 183 having a downwardly angled end portion adapted to support a roller 184 somewhere along the edge thereof, the roller being adapted for rotary motion about its own axis as is readily apparent. The roller supporting plates extend forwardly beyond the central shaft 175 and are formed to have hook-like portions which are joined by a transverse bar 185 to form an over-taking device, the use of which will become fully apparent upon further consideration of the specific embodiment. Journeyed at 178 around the shaft 175 intermediate the slides 177 and the roller supporting plates 183 are a pair of upwardly angled and forwardly projecting roller supporting plates 189, having a flat end portion adapted to support a roller 190 along the edge thereof. Also attached to the roller supporting plates 189 on the inner faces thereof are small stop plates 191 which cooperate with the bar 185 in the operation of the kiccker mechanism. It is noted that the assembled apparatus of the kiccker provides a trough-like receptacle for the annular workpieces.

In operation, the annular workpiece is first rolled into the basket 168 after which the same is tilted by cylinder 193 to deposit the workpiece onto the cradle rolls 184, 190 as shown by the broken lines of FIGURE 11. The assembly on the base 161 is then raised to properly position the workpiece in rolling position and after completion of the working the same is again lowered to the position shown in FIGURE 11. If now the cylinder 182 is energized the slides 177 and consequently the shaft 175 moves forwardly (or to the left as viewed in FIGURE 11) and the shaft rotates by reason of the interconnection between gear 178 and rack 179 to move arms 183 and consequently roll 184 upwardly and forwardly. At the same time, the arms 189 move lower and the lower the roll 190 as indicated. Since the bar 185 merely abuts the stop plates 191 the assembly of the arms 183 and roll 184 can override the assembly comprised of the arms 189 and the roll 190 so that roll 184 can move far to the left, as viewed in FIGURE 11, to move the workpiece over the roll 190 and onto the next succeeding basket 168 or other conveyer or support as will be understood. Upon reversal of fluid pressure to cylinder 182 the parts are returned to their initial positions shown in full lines in FIGURE 11.

In the operation of the cold roll forming machine disclosed herein it is assumed that initially an annular workpiece has been positioned in the basket 168. In preparation for the rolling and/or forming operations, the upper roll shaft 18 and the die associated therewith are supported along with the center axis side guides 123 and 124, respectively, in a vertical direction, thereby causing the conveying and feeding mechanism 160 to be moved vertically also. Prior to this operation, the lower or internal working roll shaft 20 and die mounted thereon have been retracted so as not to impede or interfere with the workpiece and feeding and conveying assembly 160 when they are raised. It is thus apparent that the entire space usually occupied by the upper and lower working roll, plus the appurtenant equipment associated therewith, has been moved substantially out of the way to permit loading of the workpiece.

With the machine thus prepared, the basket 168 is tilted by the air cylinder 195 to roll the ring into the trough defined by the rollers 184 and 190 and it is contemplated that at this position, the workpiece will have its center axis substantially aligned with the axis of the lower roll shaft 20 which is then in the retracted position.

The lower roll is then moved into rolling position by the actuation of the hydromotor 95 to force the toggle linkage into dead-center position. With the linkage in the dead-center position, the outboard end of the internal roll shaft 20 is positively supported by the spring-loaded outboard bearing carrier assembly 49 in the manner heretofore described. After this operation is completed, the large hydraulic cylinder 120 is actuated to move the crosshead frame 23 toward the line of strip travel which in turn causes the lowering of the feeding and conveying mechanism 160 so that the annular workpiece is supported by, and resting on, the internal roll shaft 18. At the same time, the center and side guides 123 and 124 are also being lowered, but these reach workpiece engaging position sometime before the pressure roll because of the double rack and pinion arrangement which moves the guides at twice the speed of the crosshead framework 23. It is noted that the feeding and conveying mechanism also moves into and out of position at double the speed of the upper roll because it is carried by the center and side guides. By the time the guides are operative to properly position the workpiece the feeder and conveyor have moved out of the way so as not to interfere when the side guides engage the side edges of the workpiece and the center guide rests against the center of the ring on the opposite sides of the rolls. With the workpiece thus properly positioned the upper roll shaft 18 continues to move downwardly until finally it is in pressure applying position so that when the motor 61 is energized, the roller dies on shafts 18 and 20 operate to properly form the workpiece.

After the rolling and/or forming operation has been completed, it is necessary to free the ring from between the rolls and dies and to move or transfer the same out of the mill. The cylinder 120 is again actuated to withdraw the roll shaft 18 and the center and side guides because of the double rack and pinion, are retracted at twice the speed of said roll to be out of interfering relation with the workpiece. At the same time, the platform 161 carrying the feeding and conveying mechanism 160 is moved upwardly to free the workpiece from the lower die and position the same so its axis is substantially aligned with the axis of the lower roll. Then the lower roll is retracted to the right (looking at FIGURE 2) by the linkage mechanism and the hydromotor 95 so that the working area of the mill is again completely open and there is nothing to impede the longitudinal
movement of the workpiece. The next operation is the utilization of the kicker with the overtaking device to push the formed ring from the mill as has been previously explained.

A rim rolling mill of the type disclosed herein is readily adaptable for use in a continuous process line where progressive forming of the workpiece is desirable, as in the making of tire rims for automotive vehicles and the like, and in FIGURE 14 I show a schematic arrangement for a continuous process line using a number of the rim rolling machines each having a separate set of dies. The process line is made up of the machines 10', 10'', and 10'''', all being constructed in accordance with the teachings of the present invention, with the direction of workpiece travel being designated by the arrows. A ring is loaded into the basket of the machine 10' by means, not specifically shown, but it should be understood that any conventional feeding device may be utilized, and the first rim forming operations is performed in the manner indicated in the above description. After the first rolling operation, the kicker is operative to move the ring to the basket of the second rim rolling mill 10'' which performs another rolling operation and moves the same to the basket of the mill 10''' for the final forming. The mill 10''' then discharges the ring having the desired rim thereon to any conventional conveying device, not specifically shown, which may carry the same to other stations for further working and inspection. In the carrying out of such a process line it is contemplated that the mills will be synchronized to obtain the highest rates of production by adjusting the various components of the mills so that when one workpiece is being rolled in a mill, another workpiece will be loaded in the basket of the mill in order that there will be no break in the continuous operation thereof. In other words, while one machine is rolling and has the feeding and conveying device in the down position, the next proceeding machine will have completed rolling and with the kicker associated therewith in the up position, will kick the next workpiece into the basket of the lowered feeding and conveying apparatus. In FIGURE 14 there are shown three machines used to form a continuous process line but any number may be connected in a like manner to obtain the desired degree of rolling and/or forming of a particular type workpiece.

It should thus be apparent that I have accomplished the objects initially set forth by providing improved cold roll forming apparatus that allows substantially higher rates of production than have heretofore been known in the prior art and the utilization of a number of the machines to form a continuous process line.

An important aspect of the present invention is the novel support of the outboard end of the internal roll and the means for retracting said roll from the pass line of the workpieces. A spring biased outboard bearing carrier is provided so that the lower roll is positively supported from both ends thereof thereby imparting to it the necessary strength and rigidity to prevent deflection and internal stresses in the roll. The hydromotor and dead center linkage is operative to completely retract the internal roll to one side of the pass line of the workpieces in a minimum time without breaking the drive connection to the rolls.

Yet another aspect of the invention is the provision of a greatly improved arrangement for mounting and moving the pressure applying external roll. The utilization of the dead center crank means that all axial thrust is taken by the threaded shafts while all side thrust is dissipated in the bearing housing holding the upper roll. The upper roll may be retracted to the desired position without breaking the drive connection in a fast and expedient manner.

Further, by the use of a double rack and pinion arrangement, the center and side guides move at twice the speed of the upper roll into or out of ring engaging position to properly position the workpiece. This is particularly important where progressive dies are used as misalignment with any one set of dies will usually result in a completely unacceptable final product.

Another important aspect of the invention is the provision of new and novel feeding and conveying mechanism adapted to feed and convey the workpieces which allows the realization of the maximum inherent efficiencies of the cold roll forming machines. The mechanism itself comprises a novel basket and kicker arrangement mounted on a platform supported from the side and center guides which revolves at twice the speed of the upper working roll. This mechanism, in addition to feeding and transferring, is operative to load and free the workpieces prior to and after rolling operations.

An important consideration of the present invention is that all component parts thereof are readily adjustable thus providing a versatile machine adapted to be used on different size and shaped workpieces. The upper roll is adjustable from the lower roll by means of threaded shafts while the transverse travel of the lower roll is adapted to be controlled and manipulated by the proper positioning means. These adjustments are made without effecting the dead center linkages which give inherent strength to the mechanism. In addition, the side and center guides are movable and adjustable in a multiplicity of directions to accommodate different workpieces. Also, the relative height of the platform carrying the feeding and conveying device as well as the spacing between the rollers of the kicker mechanism may be readily changed.

It is apparent that many modifications and changes may be made in form, arrangement, and number of elements disclosed in the foregoing description and accompanying drawings without departing from the spirit or teachings of the invention. Accordingly, to such modifications and changes may be made as are necessitated by the prior art.

I claim:

1. In a continuous processing line including plurality of roll forming machines having progressive dies for forming annular workpieces and said dies being aligned to form a path of travel for said workpieces, each of said machines having a vertically retractable first roll-carrying spindle, a horizontal retractable second roll-carrying spindle, means to retract said spindles, and feeding and conveying means positioned below said spindles; the improvement in said feeding and conveying means comprising means to position a workpiece between said spindles, and said feeding and conveying means further comprising ejecting means for transferring a partially formed workpiece to the feeding and conveying means associated with another one of said machines whereby said workpieces move in progression along said path of travel through said machines.

2. Apparatus according to claim 1 further comprising means to vertically move said feeding and conveying means, and said means to vertically move comprising means interconnecting said feeding and conveying means with the vertical retractable first roll-carrying spindles associated therewith whereby said feeding and conveying means and said first spindles are moved vertically simultaneously.

3. In a roll forming machine for forming annular workpieces, the like, a first roll-carrying spindle, means to vertically move said first spindle, a second roll-carrying spindle, means to horizontally move said second spindle, drive means for rotating said spindles about their own axes, workpiece feeding and conveying means positioned below said spindles, means to vertically move said feeding and conveying means to insert and unload workpieces from between said spindles, said means to vertically move said feeding and conveying means comprising means interconnecting said feeding and conveying means with said means to vertically move said first spindle, guiding means
for guiding and positioning workpieces with respect to said spindles, means to vertically move said guiding means, said means to vertically move said guiding means comprising means interconnecting said guiding means and said means to vertically move said first spindle, and the arrangement being such that said spindle, feeding and conveying means and guiding means are moved vertically simultaneously.

4. Workpiece guiding means for use in a roll-forming machine of the type adapted to form annular workpieces and the like, comprising a housing and a pair of roll-carrying spindles, one of which is carried on a vertically movable framework, comprising a guide roll positioned to one side of said one spindle, a pinion gear mounted from said framework, a stationary vertical rack mounted on said housing and meshing with said pinion gear, a second rack meshing with said pinion gear, means mounting said guide roll from said second rack, and the arrangement being such that said guide roll is caused to move at twice the speed of said framework and said one spindle upon vertical movement thereof.

5. Apparatus according to claim 4 further characterized in that said means mounting said guide roll comprises a plate mounted from said second rack, a housing mounted for sliding movement on said plate, a rod received in said housing, means to adjust the position of said rod with respect to said housing, and said rod mounting said guide roll.

6. A multiple stand rim rolling plant comprising a plurality of rim rolling machines each having

(1) a horizontally disposed upper roll and a horizontally retractable lower roll to thereby permit feeding of a workpiece in a vertically upward direction,
(2) a pair of cradle supports normally positioned below said rolls and generally parallel therewith,
(3) means to raise and lower said pair of cradle supports whereby a workpiece supported thereon may be fed into and unloaded from the machine,
(4) means to tilt said pair of cradle supports bodily about an axis generally parallel with said rolls whereby the workpiece may be rolled off said cradle support,
(5) a basket positioned on the entry side of said cradle supports to receive and support in upstanding relation the workpiece in a position generally parallel with the rolling position of the workpiece,
(6) means to tilt said basket about an axis spaced outwardly of but generally parallel to the axis of tilt of said pair of cradle supports whereby a workpiece so supported in said basket may roll onto said pair of cradle supports;

said machines being arranged in closely spaced position and so aligned that the workpiece discharged from any particular machine except the last in the line by said tilting of the cradle supports of said particular machine is automatically deposited in the basket of the next succeeding machine in the line.

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