Oct. 4, 1938. H. M. HUBBARD 2,132,370

METAL ROLLING APPARATUS AND METHOD FOR ANNULAR WORK

Filed Feb. 25, 1938 4 Sheets-Sheet 1

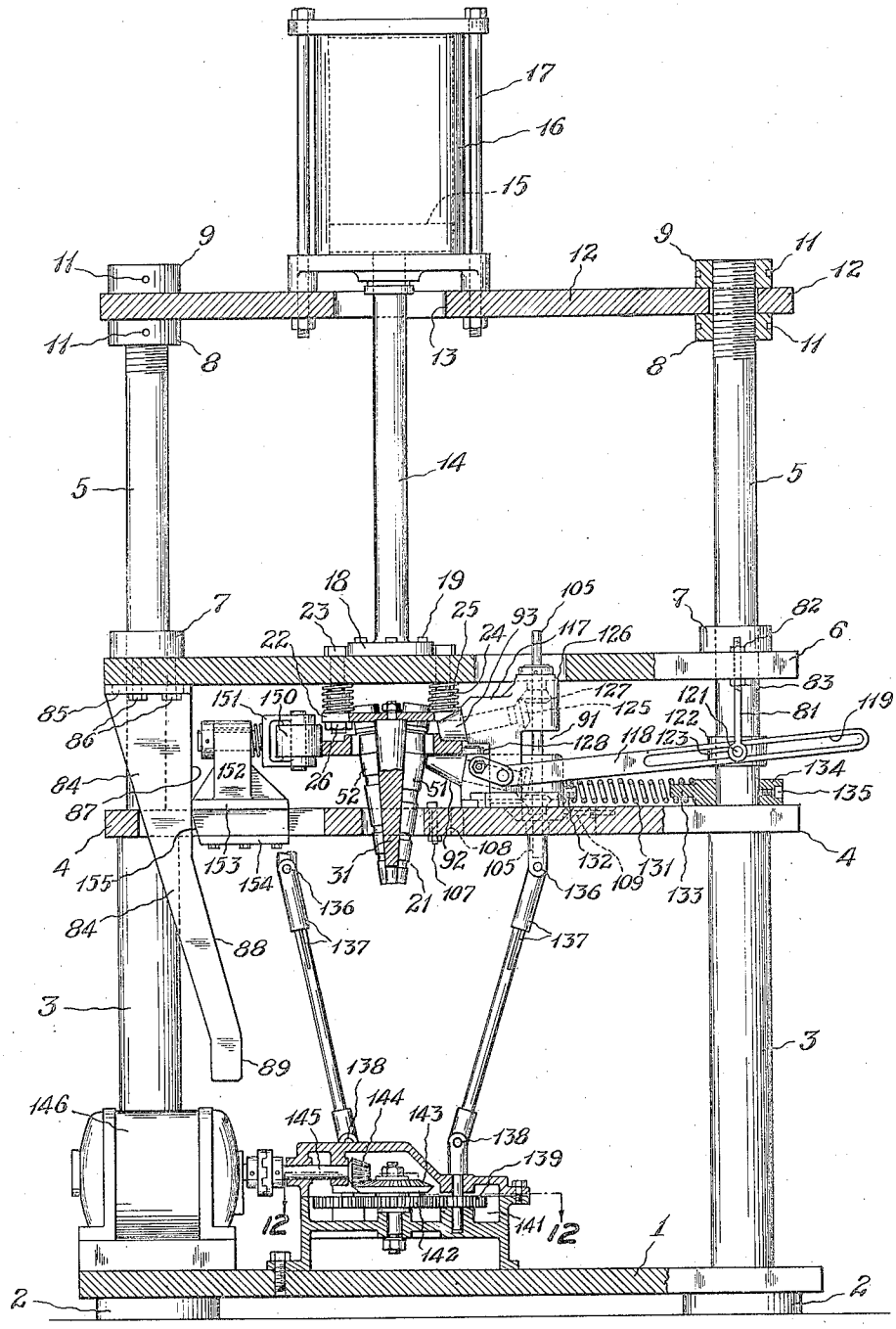


FIG. 1.

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METAL ROLLING APPARATUS AND METHOD FOR ANNULAR WORK

Filed Feb. 25, 1938 4 Sheets-Sheet 2

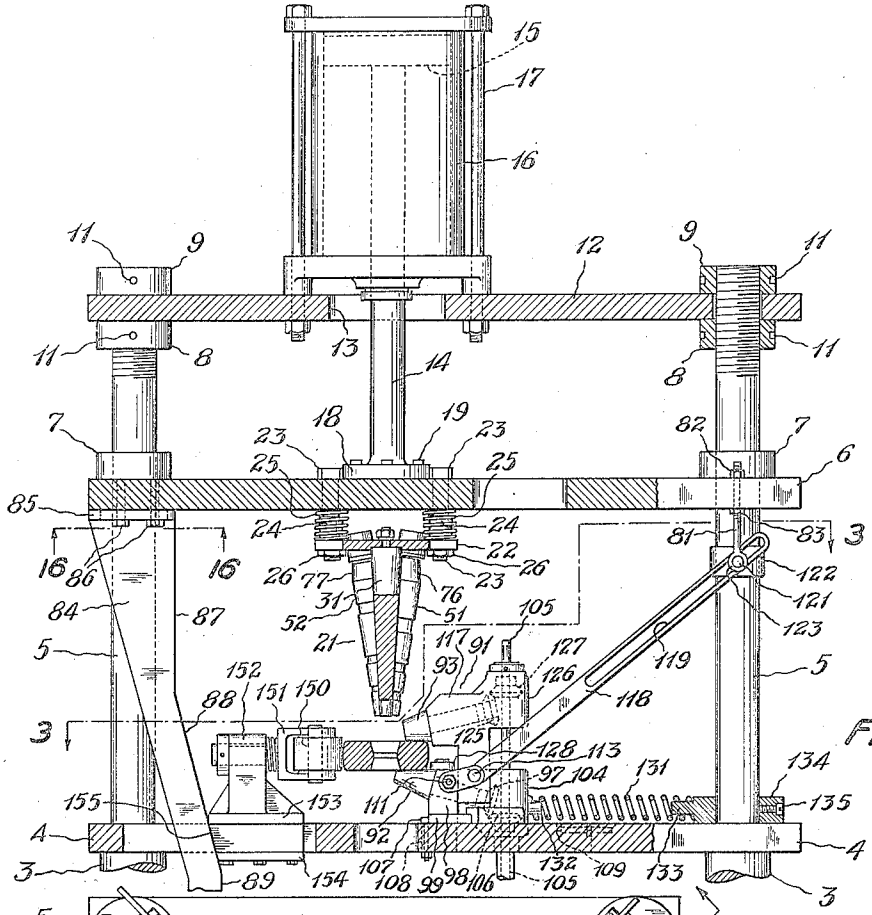


FIG. 2.

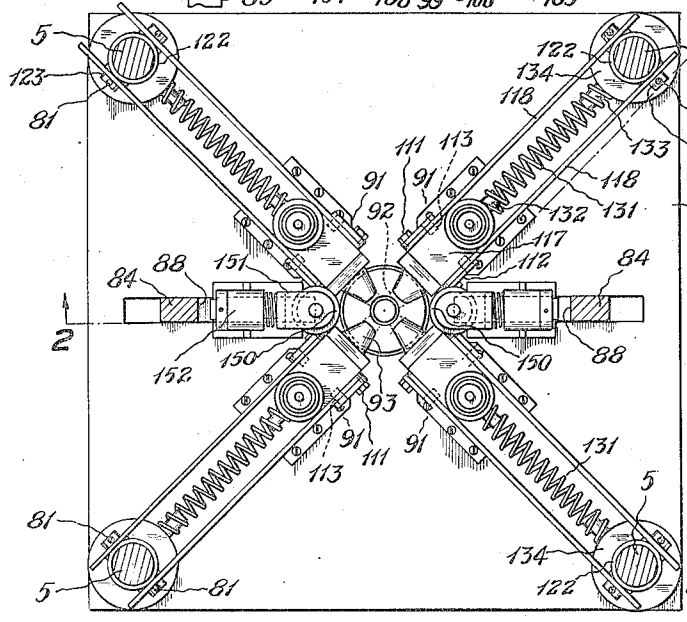


FIG. 3.

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METAL ROLLING APPARATUS AND METHOD FOR ANNULAR WORK

Filed Feb. 25, 1938 4 Sheets-Sheet 3

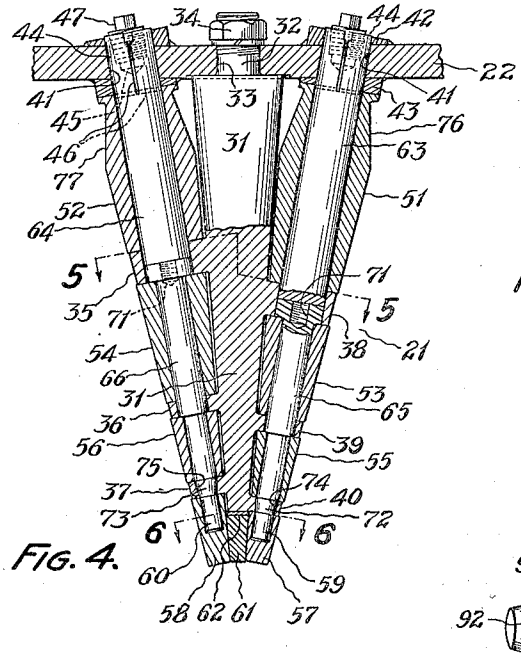


FIG. 4.

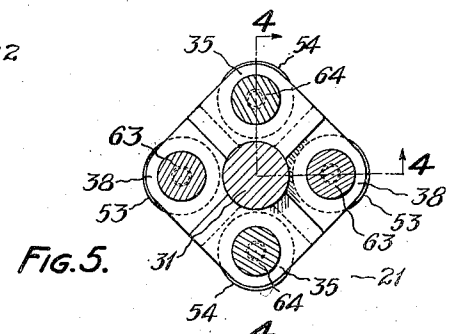


FIG. 5.

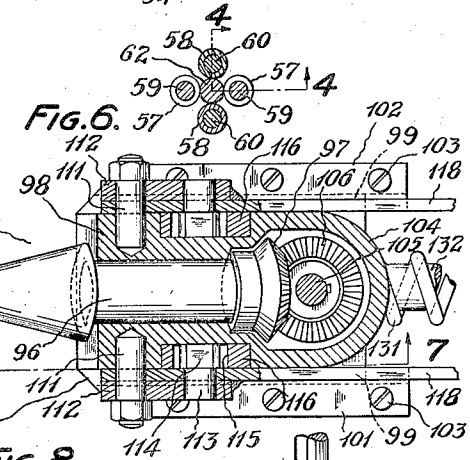


FIG. 6.

FIG. 8.

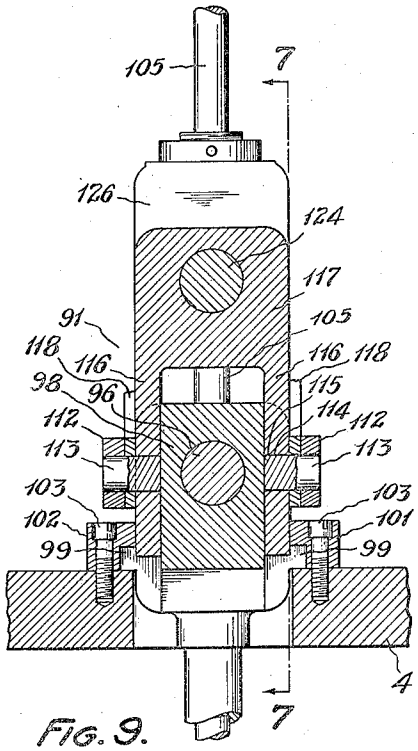


FIG. 9.

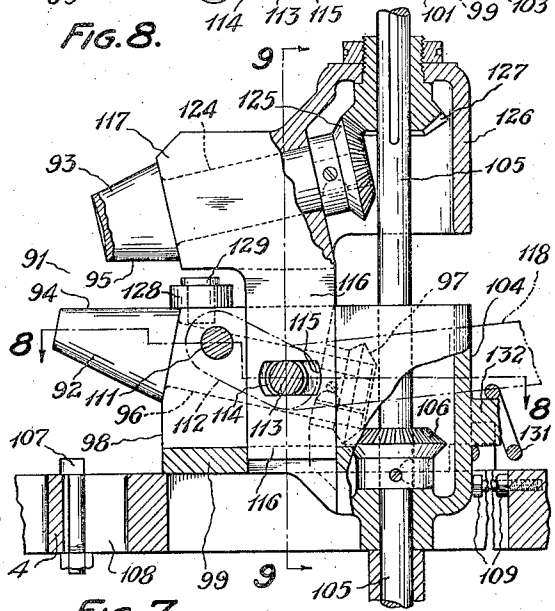


FIG. 7.

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Oct. 4, 1938. H. M. HUBBARD 2,132,370

METAL ROLLING APPARATUS AND METHOD FOR ANNULAR WORK

Filed Feb. 25, 1938 4 Sheets-Sheet 4

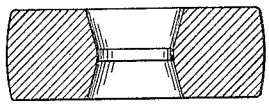


FIG. 13.



FIG. 14.

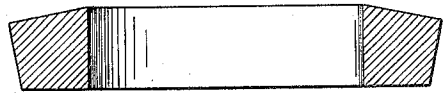


FIG. 15.

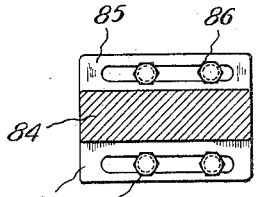


FIG. 16.

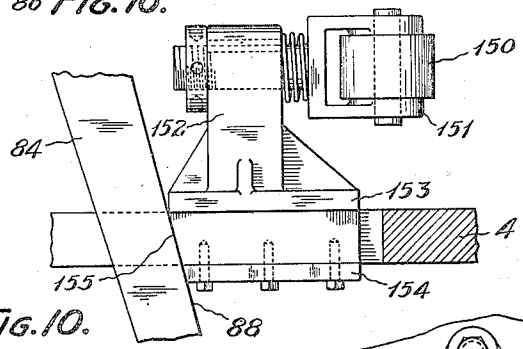


FIG. 10.

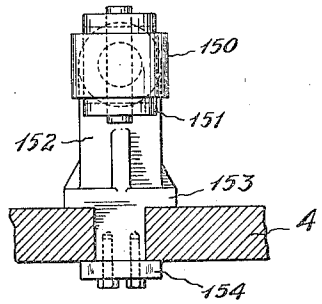


FIG. 11.

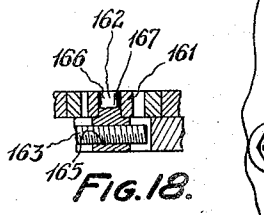


FIG. 18.

FIG. 17.

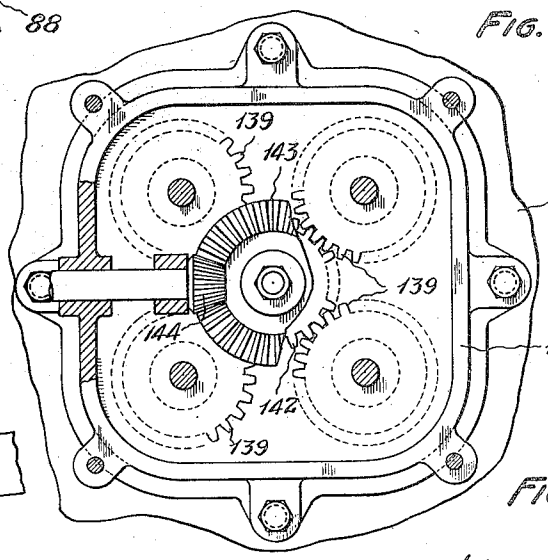


FIG. 12.

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Patented Oct. 4, 1938

2,132,370

UNITED STATES PATENT OFFICE

2,132,370

METAL ROLLING APPARATUS AND METHOD FOR ANNULAR WORK

Henry M. Hubbard, Cleveland, Ohio

Application February 25, 1938, Serial No. 192,519

17 Claims. (Cl. 80—5)

This invention, as indicated, relates to a metal rolling apparatus and method for annular work. More particularly, it comprises an apparatus and method for producing rolled metal circular or annular shapes at high speed and with a high degree of precision, and at the same time at lower cost than is possible through the use of present methods. The invention has in view the quantity production of circular or annular shapes, ready for machining or finishing operations, for use as various parts of manufacture, such as ring gears, bevel gears, internal gears and the like, pipe flanges, ball-bearing races, roller bearing races, hubs, brake drums, wheels, pulleys, and in fact substantially the full field of forged or rolled circular or annular shapes wherein strength and long service are desirable as well as low cost of production. The invention also has in view the providing of apparatus adapted to produce a variety of shapes and sizes through easy adjustment or substitution of parts.

The principal object of the present invention is to provide an apparatus adapted for accurate high speed production of circular and annular rolled shapes at low cost.

Another object of the invention is to provide a method of making circular or annular structures by operating over extended surfaces thereof simultaneously to shape such surfaces accurately to predetermined form and dimensions.

Another object of the invention is to provide a method of positioning, driving, and simultaneously shaping a circular or annular structure to modify its form and dimensions with precision at a high rate of production.

Another object of the invention is to provide an apparatus having multiple work-modifying elements adjustable to cooperate in shaping circular or annular structures over substantially the full area thereof at a high rate of speed and with accuracy of operation.

Another object of the invention is to provide an apparatus adapted to modify the shape of circular or annular units, and which, through the easy adjustment of its parts, can produce units of a variety of sizes with great precision and at high speed of production.

Another object of the invention is to provide an apparatus to modify circular or annular objects in shape and size, which is freely adjustable as to all of its operative members, and which can be maintained in service at a minimum of cost of time and labor.

A further object of the invention is to provide an apparatus adapted for easy manufacture, assembly, and repair, and operable at low cost for high speed accurate production.

A further object of the invention is to provide an apparatus wherein various different operative tools may be readily substituted and adjusted to conform accurately to various production requirements.

Other and further objects of the invention will appear in the course of the following description.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the means and method hereinafter fully described and particularly pointed out in the claims, the annexed drawings and the following description setting forth in detail certain means and methods embodying the invention, such disclosed means and method constituting, however, but several of various forms in which the principle of the invention may be used.

In said annexed drawings:—

Fig. 1 is an elevation partly in section, as seen along the line 2—2 shown in Fig. 3 looking in the direction of the arrows, showing an apparatus embodying the principles of the invention, with the operative parts in their lowermost finishing position;

Fig. 2 is an elevation partly in section, as seen along the line 2—2 shown in Fig. 3 looking in the direction of the arrows, showing the upper portion of the structure illustrated in Fig. 1 with the operative parts in work-receiving position;

Fig. 3 is a horizontal view partly in section of the structure shown in Figs. 1 and 2 as seen along the line 3—3 shown in Fig. 2 looking in the direction of the arrows;

Fig. 4 is an angular vertical sectional view of the central work-positioning and work-modifying element, as seen along the lines 4—4 shown in Figs. 5 and 6 looking in the direction of the arrows;

Fig. 5 is a plan view partly in section of the structure shown in Fig. 4 as seen along the line 5—5 shown in Fig. 4, looking in the direction of the arrows;

Fig. 6 is a plan view partly in section of the structure shown in Fig. 4, as seen along the line 6—6 shown in Fig. 4, looking in the direction of the arrows;

Fig. 7 is a side elevation partly in section of one of the horizontal work-modifying units, as seen along the lines 7—7, shown in Figs. 8 and 9, looking in the direction of the arrows;

Fig. 8 is a horizontal sectional view of the structure shown in Fig. 7 as seen along the line

8—8 shown in Fig. 7, looking in the direction of the arrows;

Fig. 9 is a vertical sectional view taken along the line 9—9, shown in Fig. 7, looking in the direction of the arrows;

Fig. 10 is an enlarged side elevation of one of the peripheral work-modifying units;

Fig. 11 is an end elevation of the structure shown in Fig. 10;

Fig. 12 is a plan view partly in section of the transmission mechanism for supplying driving power to the horizontal work-modifying mechanism, as seen along the line 12—12 shown in Fig. 1, looking in the direction of the arrows;

Fig. 13 is a central vertical sectional view of a blank, providing the work to be modified in the apparatus;

Fig. 14 is a similar view of a completed flanged collar made from the blank shown in Fig. 13, and preliminary to any machining operation thereon;

Fig. 15 is a similar view of a completed gear unit made from the blank shown in Fig. 13 and preliminary to any machining operation thereon;

Fig. 16 is an enlarged detail view taken along the line 16—16, indicated in Fig. 2, looking in the direction of the arrows, showing the adjustable supporting terminal of the control cam member for one of the peripheral work-modifying units;

Fig. 17 is a side view showing in enlarged detail a modified link structure providing rapid and accurate adjustment of the spacing of the rolls of a horizontal work-modifying unit; and

Fig. 18 is a sectional detail view of the structure shown in Fig. 17, taken along the line 18—18, shown in Fig. 17, looking in the direction of the arrows.

As is shown more particularly in Figs. 1, 2 and 3 the apparatus comprises a base plate 1 which may have pads or feet 2, said plate preferably being of square shape with equally spaced lower standards 3 mounted adjacent the corners thereof. The lower standards support at their upper ends a stationary work-table or plate 4, upon which certain of the operative mechanism is mounted as will hereinafter be described in detail. Above the plate 4 upper standards 5 are provided, said standards preferably being cylindrical members of smaller diameter than the lower standards and forming continuations thereof as corner frame members and providing slides for a sliding member or plate 6 having sleeves or collars 7 engaged about said respective upper standards. The upper ends of the upper standards 5 are preferably screw-threaded to receive threaded collars 8, 9, with spanner holes 11, said collars supporting intermediate the same a top member or plate 12 which completes the rigid frame of the apparatus.

The top member 12 is provided with a central aperture 13 to permit the central pressure bar 14 for the sliding plate 6 to pass freely therethrough. The pressure bar 14 at its upper end carries the piston 15 of a fluid pressure apparatus, which preferably is a hydraulic press of conventional construction, the cylinder 16 of which may be secured by bolts 17 to the top plate 12. The lower end of the pressure bar 14 is provided with a flange 18 secured by suitable means such as bolts 19 to the sliding plate 6.

The sliding plate 6 carries, on its under side, several operative elements which will be described in connection with their associated parts. Centrally of the under side of the sliding plate 6, there is mounted the central work-positioning and work-modifying element 21 which is carried on a base plate 22 of substantially rectangular shape, secured to the sliding plate 6 by resilient connection comprising four cylindrical studs 23 upon which collars 24 adjacent the corners of the plate are slidingly engaged. Coil springs 25 of suitable compression ratio are engaged over said studs and collars and serve to hold the base plate 22 at its lowermost position against nuts 26 secured to the lower threaded ends of the studs 23.

The central element 21 embodies a number of parts, as will be best seen in Figs. 4, 5 and 6, such parts comprising a central post or support 31 secured centrally to the plate 22 by means of an integral stud 32 passing through an aperture 33 in the plate and held in position by a nut 34 on the threaded end of said stud. The central post 31 is tapered to a narrow width at its lower end and is preferably of circular cross-section. At spaced intervals in pairs on opposite sides said post is provided with projecting flanges 35, 36, 37, 38, 39, 40 to provide supports for pins and rollers removably engaged therewith.

The central element 21 may embody two, three, four or more pin and roller assemblies, depending upon the number and spacing about the circumference of the object operated on of the work-modifying elements, but in the construction herein shown and described four pin and roller assemblies are provided.

In the form illustrated, the base plate 22 has four openings 41 set at an inward angle downward and is provided with reinforcing plates 42, 43, welded thereto adjacent to and reinforcing such openings for receiving and holding the upper ends of the pins 44 after said pins have been seated in position. The pins, at their upper ends, have tapered screw-threaded sockets 45 with cross-slots 46 and screw-threaded expansion plugs 47. The cross-slots provide an expansible upper end for each of the respective pins and when the expansion plugs are forced downwardly the screw-threaded tapered portions of the plugs and sockets will re-act to expand the pins into locking position with the openings in the reinforced areas of the base plate 22. When it is desired to withdraw the pins after the removal of the expanding plugs a suitable implement may be engaged in the screw-threaded sockets 45 to inter-lock therewith without expanding the same and thus pull the pins upwardly through the respective openings. The pins 44 may be formed as integral structures, but preferably are divided at the central portion of the first supporting flanges 35, 38, respectively, in order to permit the easy removal of the upper section of the pins for replacement of the upper roller members 51, 52, which control the finished inner diameter of the central opening in the article in course of manufacture. Below the dividing line, between the pin sections, the lower portions of the pins are reduced in stages as to their diameter to accommodate progressively smaller downwardly tapered roller members 53, 54, and 55, 56, respectively. The terminal roller members 57, 58, are held in position by the angular position of the pin ends 59, 60, and ride against a free central roller member 61 held in downward position by a disk 62 serving both as a bearing and as a shim. The roller members on opposite sides of the post 31 are of the same shape and height, but the

other pairs of roller members vary in height from the first pair in order to break joints about the circumference of the post 31 and permit full coverage of the entire surface of the blank without producing lines or seams. Thus the terminal roller member 57 is shorter than the adjacent roller member 58, and its apertured flange 40 is lower on the post 31 than the apertured flange 37 for the roller 58. The roller members and pin lengths will correspondingly vary between the pairs of rollers to suitably break joint as stated, the roller members 53 being shorter than the roller members 54, and the roller members 52 being shorter than the roller members 51. The upper pin sections 63 will be longer, and the supporting flanges 38 lower down on the post than the pin sections 64 and flanges 35. The pin sections 65 will be shorter, and flanges 39 lower down on the post than the pin sections 66 and the flanges 36. The upper pin sections 63 and 64 are separately removable as stated to permit ready replacement of, or substitution for, the upper rollers. The lower pin sections can be drawn upwardly through the use of an implement engaged in the pulling apertures 71. The stepped pin sections pass through the apertures in the upper flanges, the shoulder of the steps resting on the roller members adjacent and below the same. In place of shoulders connecting the lowermost pin sections with those next adjacent, beveled or conical intermediate portions 72, 73, are provided which are engaged in complementary beveled seats 74, 75. Each of the roller members projects outwardly at slightly greater distance than the adjacent outer flange members of the post 31, and thus there is no time when the surface of the object operated upon will be brought against any other portion of the central element than the various roller members. The upper roller members 51, 52, are tapered downwardly over the greater portion of their extent but adjacent their upper ends have conical areas 76, 77, presenting a vertical line contact at their outermost part which serves to provide a substantially vertical inner surface on the inner wall of an annular unit operated upon.

As has been indicated above, the sliding plate 6 carries means for controlling the position and action of work-modifying and work-rotating units carried on the stationary plate 4. These elements include adjustable link actuating bars 81 secured to the sliding plate adjacent the collars 7 on the corner posts 5 and connected to said plate 6 by nuts 82, 83, bearing against the upper and lower faces of said sliding plate 6, such mechanism serving to control the action of the work compressing and driving rolls presently to be described. Said elements also include depending cam bars 84 having lateral flanges 85 by means of which they may be secured by bolts 86 to the under side of the sliding plate. One such cam bar is provided for each vertical peripheral roller unit and suitable straight and inclined cam surfaces 87, 88, and 89 are provided on its active side to coact with said vertical roller units as will be hereinafter described.

The horizontal roller units 91 which have a combined work-modifying and work-rotating function are shown in detail in Figs. 7, 8 and 9 of the drawings. Said units provide a pair of conical roller members 92, 93, having substantially adjacent line contact areas 94, 95, between which the work is engaged.

The horizontal roller assembly is adapted to be moved as a whole radially from the center of the apparatus and the spacing between the active faces of the roller members is arranged to be varied in a predetermined degree.

The lower roller member 92 has a short shaft 96 which is concentric with the axis of the conical section and carries a bevel gear 97 at its opposite end. The shaft is journalled in a sliding frame member 98 with lateral flanges 99 engaging beneath guide plates 101, 102, secured by bolts 103 to the plate 4. The rearward portion of the sliding frame member 98 is shaped to provide a hollow housing 104 for the drive shaft 105 and drive bevel gear 106 which actuates the shaft 96 through its bevel gear 97. An adjustable stop member 107 is engaged in a narrow slot 108 in the plate 4 to limit forward movement of the frame 98 and another adjustable stop member 109 is provided adjacent the housing to limit rearward movement. The frame carries stud bolts 111 upon which link members 112 are pivoted, said link members at their free ends being engaged over projecting pins 113 having flattened inner portions providing slide blocks 114, which are received in elongated horizontal slots 115 on the depending arms 116 of the upper sliding frame member 117. The means for operating the upper sliding frame member comprises a pair of lever arms 118 engaged through suitable apertures over the stud bolts 111 and the pins 113 inside of the link positions. Said lever arms have elongated slots 119 which engage over pins 121 carried by a sliding collar 122 on the standard 5 of the frame, said pins being engaged by terminal eyes 123 at the lower ends of the actuating bars 81 secured to the sliding plate 6 as heretofore described. It is obvious that movement of the sliding plate 6 will change the spacing between the roller members 92, 93, through the linkage mechanism just described.

The upper horizontal roller member 93 is provided with a short shaft 124 and a bevel gear 125, like its companion member. The frame 117 is also shaped to provide a shaft and gear housing 126, within which the reverse drive gear 127 is received, such gear being splined to the shaft to permit free vertical movement of the frame 117 relative to the drive shaft 105.

On the upper side of the lower frame 98 a peripheral contact roller 128 is pivoted on a pin 129. This roller serves to move each horizontal roller assembly 91 radially outward with the expanding peripheral portion of the work. Such outward movement is provided for through the compression of the coil spring 131 engaged on a boss 132 on the housing 104 at one end, and on a like boss 133 on a collar 134 secured by a set screw 135 to the standard 5 of the frame.

The horizontal rollers, it is to be noted, fully overlap the entire upper and lower work surfaces since their end portions are accommodated intermediate the spaced tapered roller series of the central element.

The means for driving the horizontal roller units comprises the shaft 105 provided with a universal joint 136 and a slip joint 137 and a second universal joint 138 mounted on the shaft of a gear 139 in the transmission housing 141, shown in Figs. 1 and 12. Each of the four gears 139 is driven by a central gear 142 having a bevel drive gear 143 operated by a bevel pinion 144 on the drive shaft 145 suitably connected to an electric motor 146.

The peripheral vertical roller members 150 are mounted in yoke supports 151 engaged in a slide-

way in a standard 152 on the slide member 153 operating in a radial slot in the plate 4, and having a removable base member 154. The cam surfaces 87, 88 and 89, of the cam bar 84 heretofore described serve to position the slide member and its roller in operative position by contact with a bearing surface 155 on the slide member. A spring is engaged on the yoke support of the roller member 151 so that a cushioned effect is introduced to accommodate slight irregularities on the blank surface. It also provides for easy release of the finished work which is also assisted by the long vertical surface 87 on the cam bar 84.

In order to provide for quick adjustment to various sizes of product the links may be provided with adjustable slide bars 161, as shown in Figs. 17 and 18, whereby the pivots 162 may be shifted to change the space between the horizontal roller members.

The slide bars 161 are moved by means of a threaded bar 163 mounted for free rotation in a socket in said link and adapted to be turned by means of a collar 164 secured to said threaded bar at one end of said slot. The free end of the threaded bar 163 engages a threaded socket 165 in a T-shaped fitting 166 with the shank thereof engaged in an aperture 167 in its respective slide bar. Through the mechanism just described it will be noted that by turning the collar 164 any desired adjustment of the pivots of the linkage system may be provided for, which will change the spacing between the active faces of the horizontal rollers, and thus establishing the finishing limits of the work in the course of production.

The operation of the apparatus has been indicated in part in connection with the description of the various units of the structure. However, the procedure in producing the flanged pipe collar, such as is shown in Fig. 14, or a gear blank, such as is shown in Fig. 15, from a blank, such as is shown in Fig. 13, may be briefly summarized as follows:—

The blank in approximately the form shown in Fig. 13 is inserted between the horizontal rollers with the machine in substantially its uppermost limits of motion and with various tools retracted to their full extent. In such a position the blank will be approximately centered, and upon turning on the fluid pressure in the cylinder 16 at the top of the apparatus the sliding platform will be lowered to bring the work-centering and work-modifying elements into central engagement with the annular member and to bring the peripheral roller members 150 into marginal contact with the article. When an article of the type shown in Fig. 14 is to be made with substantially parallel upper and lower faces a short roller 93 having a horizontal roller face is mounted in the upper frame 117 of the horizontal roller assembly, and such roller when brought into contact with the work will leave the metal at the center of the blank in its original form and will press the metal beneath the same into flattened form being fed backwardly through the action of the flange portion so formed. With no flange, the contact of the outer periphery of the annulus with the roller 128 on the upper side of the lower frame moves the horizontal roller assembly. The degree with which the pressure is applied to the annular member is controlled by the adjustment of the lever system for bringing the horizontal rolls toward each other through the linkage actuated by the adjustment link actuating bars 81 secured to the sliding frame member 6 adjacent each of the corner posts. It will be noted that the cam bar 84 is lowered at the same time that the central member and linkage system is carried outwardly, and this has the effect of allowing the vertical roller member 150 to move backwardly from the peripheral of the annulus at the predetermined ratio established by the cam face 88 on said cam bar 84. As the work nears the finishing point, the vertical face 87 will be brought into contact with the edge of the vertical roller assembly thereby allowing certain range of movement of the cam bar without affecting the position of such vertical roller member. This permits the release of the work through the elevation of the sliding plate 6 and simultaneously therewith, the release of the pressure of the horizontal rollers and the full retraction of the tapered central element of the apparatus. The work can then be readily removed, preferably through the use of an auxiliary knockout apparatus which will discharge the work through a chute, and which preferably will be coupled with a blank feeding device to automatically place new blanks in position, structures of this type being well known in the art for this purpose.

When a gear blank of the type illustrated in Fig. 15 is to be formed an upper roller member having upwardly inclined line contact with the work on its under face is used instead of the shorter member with the horizontal line contact area. The new roller is also of sufficient length to fully cover the upper surface instead of being short so as to leave an upwardly projecting flange member as in the instance first described.

It will be noted that free adjustment of all the work-modifying members may be made preliminary to starting a production routine on a new type of product. When the machine is so set no further adjustment is necessary, except for long periods of use at a fixed adjustment when slight adjustment for wear may be desirable. The drive adjustment for the horizontal rollers automatically takes care of itself. The apparatus can be operated even though the center work-position and work-modifying member is not used. It is especially to be noted that through elimination of flash and trim important reductions of costs, based on savings in stock, are brought about.

As has been indicated above, the central element 21 may be provided with two, three, four or more pin and roller assemblies, in accordance with the character of the work to be operated on and the size of the central aperture of the annular member. Thus where a wheel flange or the like is to be constructed the tapered central element may comprise a large number of pin and roller assemblies, the size of the element providing ample space intermediate the assemblies for receiving the inner ends of the horizontally disposed work-modifying elements. The size of the article operated on may also determine the number of work-modifying elements to be distributed around the circumference of the article irrespective of whether or not the tapered central element 21 is utilized in the apparatus. When such central element is dispensed with the centering of the work is controlled by the circumferentially positioned elements, and their position and spacing must be such that they will maintain the work in balance during its modification. Thus when three such elements are provided they may be distributed at distances of 120° about the circumference.

When the central tapered element 21 is utilized,

if the work is of an easily deformable material, it may be permissible to operate the apparatus with a fewer number of work-modifying units than otherwise, and these may be spaced in accordance with the requirements of the special shapes being formed so long as injurious vibration is not introduced into the apparatus.

Other modes of applying the principle of my invention may be employed instead of those explained, change being made as regards the means and steps herein disclosed, provided the means stated by any of the following claims or the equivalent of such stated means be employed.

I therefore particularly point out and distinctly claim as my invention:—

1. A metal rolling apparatus for annular work, having in combination a single central work-centering and work-expanding unit provided with a plurality of active roller contact elements, means for moving said unit relatively to the work to bring said elements into contact with the full width of the inner circumference of said work whereby said rollers exert an outward radially directed force on said annular work, a plurality of rolls disposed in spaced relation about said central unit and having rolling contact with the outer circumferential surface of said work and a plurality of rolls disposed in spaced relation about said central unit and having rolling contact with the upper and lower surfaces of said work, to produce certain cross-sectional shapes of said annular work.

2. A metal rolling apparatus for annular work, having in combination a single central work-centering and work-expanding unit provided with a plurality of active roller contact elements, means for moving said unit relatively to the work to bring said elements into contact with the full width of the inner circumference of said work whereby said rollers exert an outward radially directed force on said annular work, a plurality of rolls disposed in symmetrical spaced relation about said central unit and having rolling contact with the outer circumferential surface of said work, and a plurality of pairs of rolls disposed in symmetrical spaced relation about said central unit intermediate said last-mentioned rolls, and having rolling contact with the upper and lower surfaces of said work, to produce certain cross-sectional shapes of said annular work.

3. A metal rolling apparatus for annular work, having in combination a single central work-centering and work-expanding tapered unit provided with a plurality of active staggered overlapping roller contact elements, means for moving said unit relatively to the work to bring said elements into contact with the full width of the inner circumference of said work whereby said rollers exert an outward radially directed force on said annular work, a plurality of rolls disposed in spaced relation about said central unit and having rolling contact with the outer circumferential surface of said work, and a plurality of rolls disposed in spaced relation about said central unit intermediate said roller elements of said tapered unit, and having rolling contact with the upper and lower surfaces of said work, to produce certain cross-sectional shapes of said annular work.

4. A metal rolling apparatus for annular work, having in combination a single central work-centering and work-expanding unit provided with a plurality of active roller contact elements, means for moving said unit relatively to the work to bring said elements into contact with the full width of the inner circumference of said work whereby said rollers exert an outward radially directed force on said annular work, a plurality of rolls disposed in spaced relation about said central unit and having rolling contact with the outer circumferential surface of said work and a plurality of rolls disposed in spaced relation about said central unit and having rolling contact with the upper and lower surfaces of said work, to produce certain cross-sectional shapes of said annular work, and means for applying power to certain of said rolls to rotate the annular work.

5. A metal rolling apparatus for annular work, having in combination a single central work-centering and work-expanding unit provided with a plurality of active roller contact elements, means for moving said unit relatively to the work to bring said elements into contact with the full width of the inner circumference of said work whereby said rollers exert an outward radially directed force on said annular work, a plurality of rolls disposed in spaced relation about said central unit and having rolling contact with the outer circumferential surface of said work and a plurality of pairs of rolls disposed in spaced relation about said central unit and having rolling contact with the upper and lower surfaces of said work, to produce certain cross-sectional shapes of said annular work, and means for applying power to certain of said pairs of rolls to rotate the annular work.

6. A metal rolling apparatus for annular work, having in combination a single central work-centering and work-expanding unit provided with a plurality of active overlapping roller contact elements, means for moving said unit relatively to the work to bring said elements into contact with the full width of the inner circumference of said work whereby said rollers exert an outward radially directed force on said annular work, a plurality of rolls disposed in spaced relation about said central unit and having rolling contact with the outer circumferential surface of said work and a plurality of rolls disposed in spaced relation about said central unit and having rolling contact with the upper and lower surfaces of said work, to produce certain cross-sectional shapes of said annular work, each of said rolls and the overlapping roller contact elements, being of a length to contact with the work over the full extent of the surface operated on during each cycle of rotation.

7. A metal rolling apparatus for annular work, having in combination a single central work-centering and work-expanding unit provided with roller contact elements, means for moving said unit relatively to the work to bring said elements into contact with the full width of the inner circumference of said work, a pair of rolls disposed in symmetrical relation about said central unit and having rolling contact with the outer circumferential surface of said work and a plurality of pairs of rolls disposed in symmetrical spaced relation about said central unit intermediate said last-mentioned rolls, and having rolling contact with the upper and lower surfaces of said work to produce certain cross-sectional shapes of said annular work, and means for simultaneously moving said central unit and pairs of rolls in pressure relation to the annular member operated upon.

8. A metal rolling apparatus for annular work, having in combination a single central work-centering and work-expanding unit provided with roller contact elements, means for moving said unit relatively to the work to bring said elements

into contact with the full width of the inner circumference of said work, a pair of rolls disposed in symmetrical relation about said central unit and having rolling contact with the outer circumferential surface of said work and a plurality of pairs of rolls disposed in symmetrical spaced relation about said central unit intermediate said last-mentioned rolls, and having rolling contact with the upper and lower surfaces of said work to produce certain cross-sectional shapes of said annular work, and means for controlling the degree of outward movement of said rolls bearing on the outer circumference.

9. A metal rolling apparatus for annular work, having in combination a single central work-centering and work-expanding unit provided with roller contact elements, means for moving said unit relatively to the work to bring said elements into contact with the full width of the inner circumference of said work, a pair of rolls disposed in symmetrical spaced relation about said central unit and having rolling contact with the outer circumferential surface of said work, cam elements for controlling the outward movement of said last-mentioned rolls, and a plurality of pairs of rolls disposed in symmetrical spaced relation about said central unit intermediate said last-mentioned rolls, and having rolling contact with the upper and lower surfaces of said work to produce certain cross-sectional shapes of said annular work, and means for simultaneously moving said central unit and pairs of rolls in pressure relation to the annular member operated upon.

10. A metal rolling apparatus for annular work, having in combination a single central work-centering and work-expanding unit provided with roller contact elements, means for moving said unit relatively to the work to bring said elements into contact with the full width of the inner circumference of said work, a pair of rolls disposed in symmetrical spaced relation about said central unit and having rolling contact with the outer circumferential surface of said work, cam elements for controlling the outward movement of said last-mentioned rolls and to release said work at the final stage of the operation, and a plurality of pairs of rolls disposed in symmetrical spaced relation about said central unit intermediate said last-mentioned rolls, and having rolling contact with the upper and lower surfaces of said work to produce certain cross-sectional shapes of said annular work, and means for simultaneously moving said central unit and pairs of rolls in pressure relation to the annular member operated upon.

11. A metal rolling apparatus for annular work, having in combination a work-centering and work-expanding unit having roller contact elements bearing against the full width of the inner circumference of the work, rolls disposed symmetrically about said unit, in pairs, for pressing against the upper and lower surfaces of said work, unitary means to move said pairs of rolls against said work, and means for changing the spacing of said pairs of rolls to operate on different sizes of annular work.

12. A metal rolling apparatus for annular work, having in combination a work-centering and work-expanding unit having roller contact elements bearing against the full width of the inner circumference of the work, rolls disposed symmetrically about said unit, in pairs, for pressing against the upper and lower surfaces of said work, unitary means including linkage simultaneously to move said central unit and said pairs of rolls against said work, and means comprising a slot and adjustable pivot in said linkage for changing the spacing of said pairs of rolls to operate on different sizes of annular work.

13. A metal rolling apparatus for annular work having in combination a frame having top and bottom plates, a stationary intermediate plate, spaced from the bottom plate, and a sliding plate, all supported on spaced standards, slidably supported rolls mounted on said intermediate plate for contacting with the outer circumferential, and the top and bottom faces, respectively, of an annular work unit, a drive mechanism for said rolls, a single central tapered unit and roll positioning members connected with said sliding plate, and pressure applying means supported on said top plate for simultaneously moving said sliding plate and operating in predetermined ratio the tapered unit and the associated rolls.

14. A metal rolling apparatus for annular work having in combination a frame having top and bottom plates, a stationary intermediate plate, spaced from the bottom plate, and a sliding plate, all supported on said spaced standards, slidably supported spring pressed rolls mounted on said intermediate plate for contacting with the outer circumferential, and the top and bottom faces, respectively, of an annular work unit, adjustable limit stops for said rolls, a drive mechanism for said rolls, a single central tapered unit and roll positioning members connected with said sliding plate, and pressure applying means supported on said top plate for simultaneously moving said sliding plate and operating in predetermined ratio the tapered unit and the associated rolls.

15. A metal rolling apparatus for annular work having in combination a frame having top and bottom plates, a stationary intermediate plate, spaced from the bottom plate, and a sliding plate, all supported on spaced standards, slidably supported rolls mounted on said intermediate plate for contacting with the outer circumferential surface of an annular member, and pairs of horizontal rolls slidably supported on said intermediate plate for contacting with the top and bottom faces of said annular member, a drive mechanism for said rolls supported on said bottom plate and flexibly connected with certain of said pairs of rolls, a single central tapered unit and roll positioning members connected with said sliding plate, and pressure applying means supported on said top plate for simultaneously moving said sliding plate and operating in predetermined ratio the tapered unit and the associated rolls.

16. A metal rolling apparatus for annular work having in combination a frame having top and bottom plates, a stationary intermediate plate, spaced from the bottom plate, and a sliding plate, all supported on spaced standards slidably supported rolls mounted on said intermediate plate for contacting with the outer circumferential surface of an annular member, and pairs of horizontal rolls slidably supported on said intermediate plate for contacting with the top and bottom faces of said annular member, a drive mechanism for said rolls supported on said bottom plate and flexibly connected with certain of said pairs of rolls, a single central unit tapered over its lower section and substantially cylindrical over its upper finishing section, supported on said sliding plate, and roll positioning cam and linkage members connected with said sliding plate, pressure applying means supported on said

top plate and operating in predetermined ratio the tapered unit and the associated rolls, and means on said cam and central unit for releasing the finished annular member.

17. A method of producing annular metal shapes by the use of rolling pressure which includes the steps of progressively and continuously enlarging the central opening of an annular unit by pressure at a plurality of equally spaced lines of contact over the full width of the inner wall surface of said opening, and distributing said pressure about the entire inner face of said opening by relative rotation of the work with reference to said lines of contact, and simultaneously applying pressure from a unitary source in connection with and in predetermined ratio to the pressure on said lines of contact, along lines of contact over the width of said annular member at its outer circumference, and also applying pressure from said unitary source along radial lines of contact completely across the top and bottom surfaces of said annular member at points intermediate said first mentioned lines of pressure.

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