United States Patent

Campbell

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[54] **ROD FORMING PROCESS AND APPARATUS**

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[52] **U.S. Cl.** **72/306,** 72/369, 72/377, 72/319

[51] **Int. Cl.**.....**B21d 11/04,** B21d 31/00

[58] **Field of Search**.....72/152, 306, 367, 369, 318, 72/319, 149, 316, 377; 29/157.4

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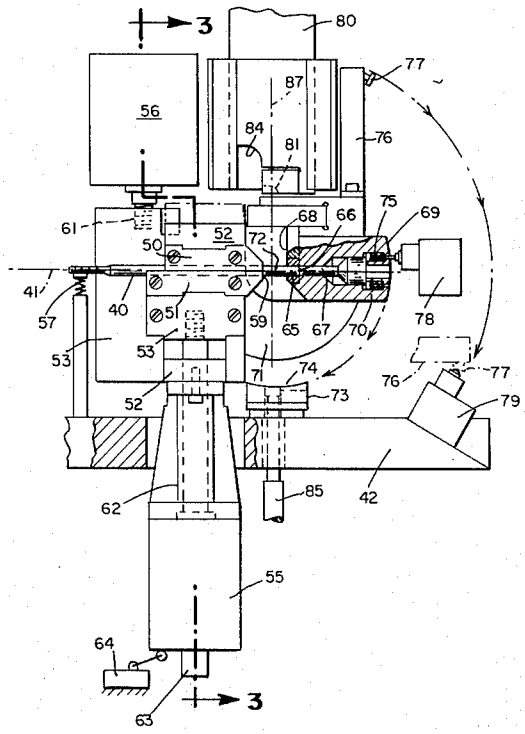
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[57] **ABSTRACT**

A process and apparatus for performing same are disclosed for making a uniform bend of original rod cross-section or larger than original cross-section, and coining a circular flange on the rod adjacent to the bend, without detrimental folding between flange and rod, in one clamping cycle, by first bending the rod about a pivot point displaced from the center line of the rod so as to produce with a minimum of tensile stresses a bend with a bulge of excess rod material at the point of the bend, and then pressing the rod at the bend to coin an annular flange partially from such excess material and partially from the bent rod extension, leaving the rod of a uniform diameter around the entire bend. The supporting structure which holds the rod during the pressing step is moved in the direction of the press force in coordination with the application of the press force, in order to take up material in the length of the bent rod extension while forming the flange, and to avoid bending anywhere along the rod except at the desired bend.

21 Claims, 13 Drawing Figures



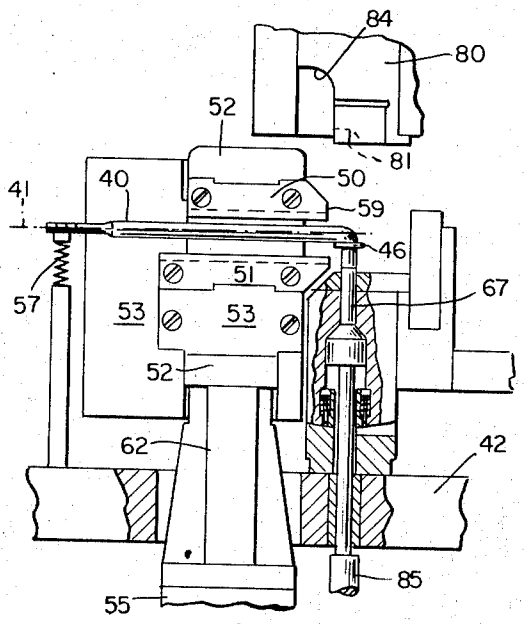


Fig. 9

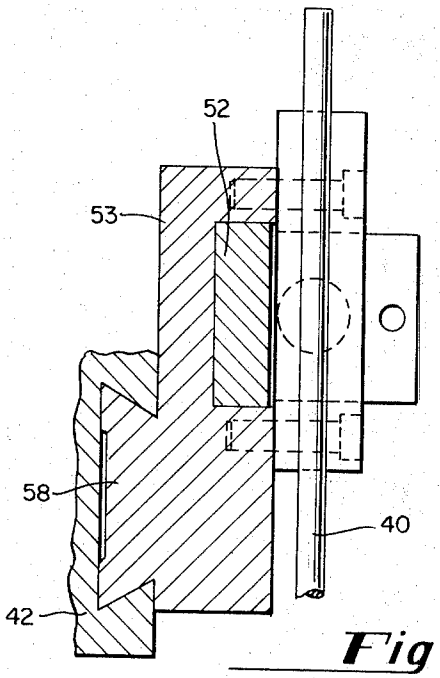


Fig. 4

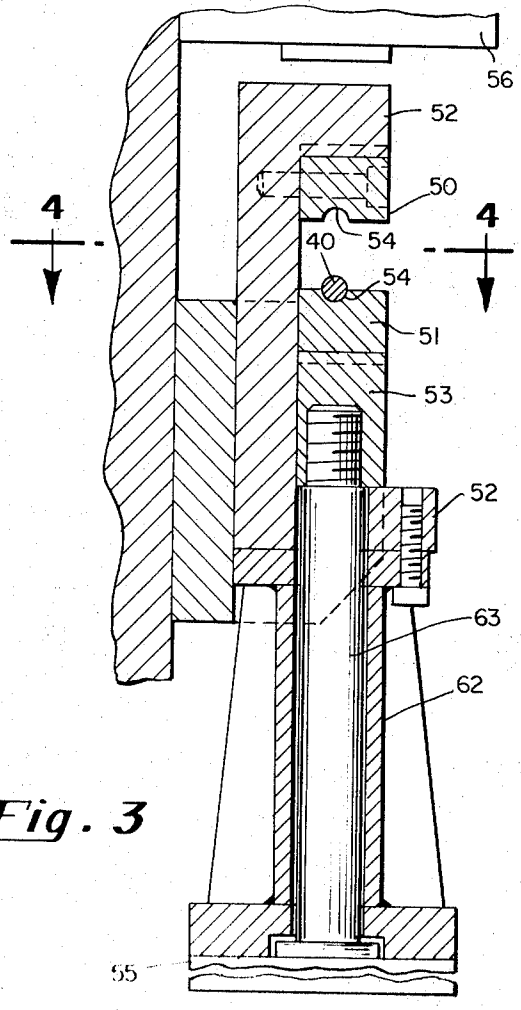


Fig. 3

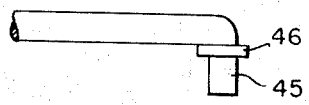


Fig. 1a

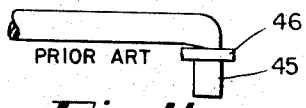


Fig. 1b

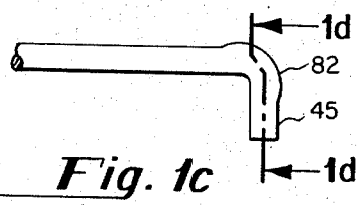


Fig. 1c

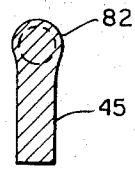


Fig. 1d

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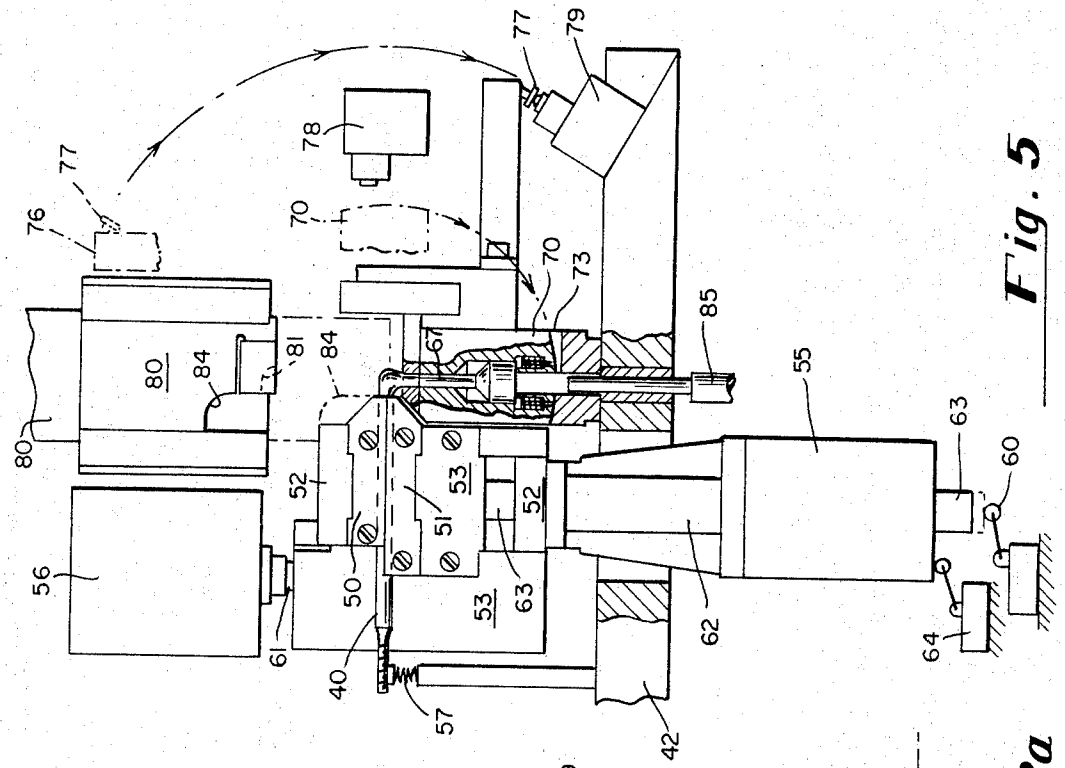


Fig. 5

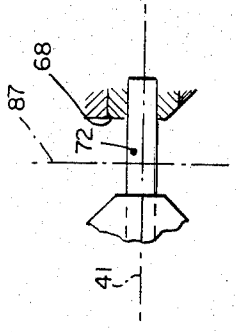


Fig. 2a

Fig. 2

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Fig. 6

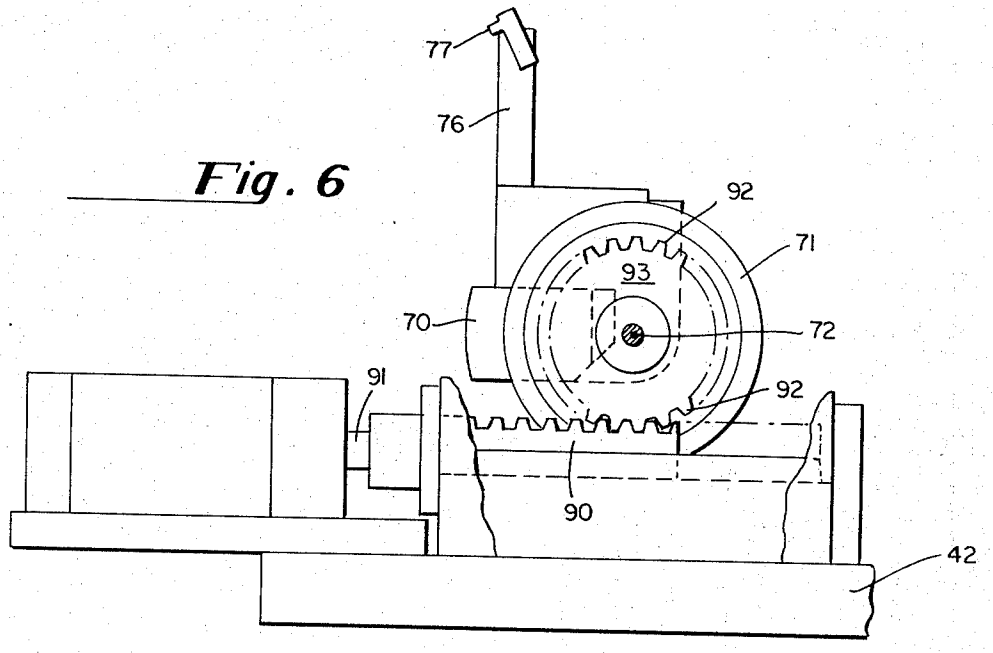


Fig. 7

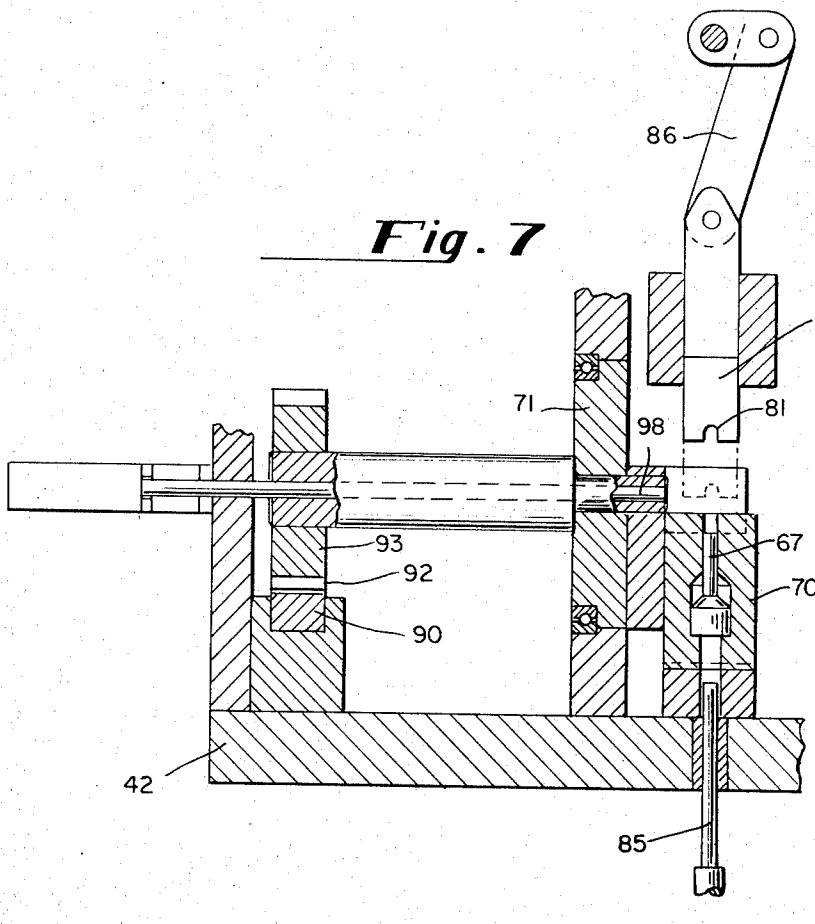
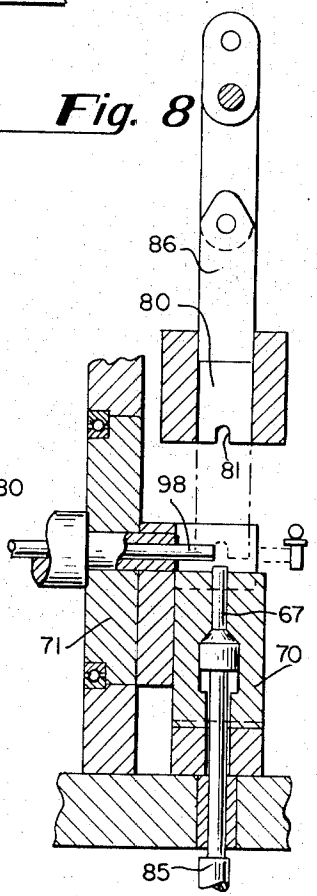


Fig. 8



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ROD FORMING PROCESS AND APPARATUS

BACKGROUND OF THE INVENTION

Field field of the Invention

this This lies in the field of rod forming processes and apparatus and, more particularly, a process and apparatus for placing a uniform bend in a rod and coining a flange on the bent arm of the rod adjacent to the bend, wherein the flange becomes an integral part of the adjacent bent portion without fracture and/or detrimental folding thereof.

2. Description of the Prior Art

In manually shifted automobiles and other similar apparatus, it is necessary to mechanically link remote shifting means with the transmission unit, through connecting rods. It is usually a requirement of such rods that they have a 90° bend at one end thereof, with a circular flange placed on the bent arm of the rod immediately adjacent to the bend, as shown in FIG. 1*a* of the drawings. The problem incurred in producing such a rod is that of making the bend and forming the flange without folding the flange against the rod, resulting in a weakened rod at that point. Present methods of bending and forming result in a fold on the inside portion of the bend. This fold not only is a point of weakness in the rod but also creates a stress raiser. An example of a typical result of the rod forming process presently used is shown in FIG. 1*b*. It is clear that if the rod is simple bent and then pressed, or headed, so as to drive material from a leg of the rod into a flange, a fold will result. The process and apparatus for carrying out such process of this invention overcome this prior difficulty, providing a reliable and inexpensive manner of producing rods of the desired form having dimensional repeatability, excellent grain structure and strength, and free of detrimental folds.

SUMMARY OF THE INVENTION

The primary object of this invention is to provide a connecting rod having a 90° bend and a coined annular flange member without a detrimental fold.

It is another object of this invention to provide, in one continuous process, for the bending and heading of the subject rod.

It is a further object of this invention to provide apparatus for efficiently and inexpensively forming connecting rods at a high rate of production, and with a reliability which represents a substantial improvement over the prior art.

Accordingly, this invention provides a process comprising the steps of clamping a straight rod securely in place, bending an end thereof about a pivot point eccentrically displaced from the center line axis of the rod, then applying pressure to the rod at the bend to shape the bend and simultaneously head rod material from the bend and from the bent arm, to form a circular flange capping the bent arm. The clamping structure moveably yields in the direction of the applied pressure and in conjunction therewith so as to prevent any bending or notching of the remainder of the rod. The apparatus includes a pair of jaws which hold the rod in a clamped position, one end of the rod being received into a rotatable element having a center point eccentrically displaced from the axis of the rod, rack driven means for rotating the rotatable element through 90° and thereby bending such received end, a ram having a coining for applying pressure to the bent portion and for forming a flange, means for adjusting the position of the clamping jaws and maintaining a tight clamp on the rod while the ram pressure is being applied, and an ejection mechanism for ejecting the formed rod.

BRIEF DESCRIPTION OF THE DRAWINGS

description of the drawings

FIG. 1*a* is an illustration of a rod formed by the method of this invention having a 90° bend and an annular flange.

FIG. 1*b* is an illustration of a rod produced by a typical prior art process.

FIG. 1*c* illustrates a side view of a rod after eccentric bending.

FIG. 1*d* illustrates a sectional view of the rod of FIG. 1*c* taken along lines 1*d*—1*d*.

FIG. 2 is a right side elevation view of the apparatus of this invention, with a rod in clamped position, before bending.

FIG. 2*a* is an exploded view of the pivot point area.

FIG. 3 is a front elevation taken along lines 3—3 in FIG. 2, with the clamping jaws open.

FIG. 4 is a cross section taken along lines 4—4 in FIG. 3.

FIG. 5 is a right side elevation of the apparatus in the bend position.

FIG. 6 is a left side elevation of the apparatus of this invention.

FIG. 7 is a sectional view taken through line 7—7 in FIG. 2 with the apparatus in the bend position.

FIG. 8 is a partial sectional view taken through line 7—7 in FIG. 2 with the apparatus in the eject position.

FIG. 9 is a partial right side elevation of the apparatus in the eject position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 2, a straight rod **40** is shown placed in a horizontal position in the apparatus of this invention. The rod is held in a clamping position by an upper jaw **50** and a lower jaw **51**, which jaws have axial receiving grooves **54** forming a hollow cavity when the jaws are clamped, as illustrated more clearly in FIG. 3. the straight rod is supported at the rear by a spring support **57**, while the front portion of the rod extends into a receiving opening **65** in receiving element **70**. thus, the rod is supported at the back by spring device **57**, through the center by lower jaw **51**, and at the front by the receiving element **70**. Between the forwardmost edge **59** of clamping jaws **50** and **51** and the inner edge **68** of element **70**, the rod is unsupported and unenclosed. In the preferred embodiment, rod **40** has a serrated portion produced by projections integral to the cavities in jaws **50** and **51**, to improve clamping.

The cycle of the process is initiated by first placing rod **40** in position, by conventional injection means not shown, between open jaws **50** and **51**, with the forward end inserted into cavity **65** in receiving element **70**. Upper jaw **50**, originally raised as shown in FIG. 3, is then lowered into clamping engagement with lower jaw **51**. Upper jaw **50** is attached to C-shaped upper jaw frame **52**, which in turn is attached to moveable cylinder **55** through spacer **62**. When cylinder **55** is

moved downwardly, upper jaw **50** is brought into clamping engagement with normally fixed lower jaw **51**, as shown in FIG. **2**. The bottom edge of cylinder **55** activates switch **64** when jaw **50** is in its clamping position.

Lower jaw **51**, normally in a fixed position, is supported by lower jaw frame **53**, as seen in FIGS. **2**, **3** and **4**. The lower portion of frame **53** is attached to rod **63** which is moveable within cylinder **55**, and the upper portion is attached to rod **61** which extends from cylinder **56**. Rod **61** is normally fixed within cylinder **56**, thereby holding frame **53**, rod **63**, and lower jaw **51** in normally fixed positions. However, dovetail portion **58** of frame **53** is moveable within machine frame **42**, such that frame **53** and rod **63** may move downward when rod **61** is moved downward.

Referring again to FIG. **2**, receiving element **70** is mounted on a rotatable element **71** which is driven by means described hereinbelow. The center axis, or pivot point about which element **71** rotates is indicated at **72**, and is seen to be offset from the center axis **41** of the rod. Pivot point **72**, as seen in FIG. **2***a*, is also located to the right of center line **87** of ram **80** which comes down vertically to provide the press force in the flange forming step. Thus, pivot point **72** is located to the right of and above the intersection of the rod axis **41** and ram center line **87**, which center line is coincident with the axis of the bent arm **45** of the rod after the 90° bending step. Stating it another way, pivot point **72** is located eccentrically to the outside of the inner angle formed by the intersection of the axes of the two straight portions of the bent rod. The amount of pivot-point offset does, of course, vary with the dimensions of the rod being formed, and must be sufficient to produce primarily compressive forces throughout the bend, so as to prevent folding of material during heading of the flange. This offset also creates a bulge in the bend of the rod.

In practice, when rod **40** is inserted into position within the cavity formed by closed grooves **54**, as seen in FIG. **2**, its forward end contacts the tip **66** of plunger **67** and moves it to the right, causing it to make contact with element **75** which triggers switch **78** when full insertion is attained. When both switch **78** and switch **64** are triggered, an electrical circuit is activated causing rotatable element **71** to rotate through a 90° angle, carrying with it receiving element **70**, thereby placing a right-angle bend in rod **40**. Arm **76**, connected to element **71**, has a contact **77** connected at the end thereof, which contact engages switch **79** after a rotation of precisely 90°, switch **79** causing rotation of element **71** to terminate after the 90° swing.

After the 90° swing, but before coining of the flange, the rod is formed as shown in FIGS. **1***c* and **1***d*, having a right angle bend with a bulge of material at the bend as shown at **82**. This bulge is the result of eccentrically displacing pivot point **72**, and it is this excess material which prevents folding and is available for heading the desired flange in the next step. Further, due to the controlled eccentricity of the bending operation, the material in the bend is under unobjectionable compressive stresses, as opposed to the undesirable tensile stresses produced by conventional methods of bending.

Referring now to FIG. **5**, receiving element **70** is shown displaced 90° from its normal position, causing a 90° bend in the rod **40**. Bent portion **45** of the rod is shown pivoted 90° with respect to the main axis **41** of the rod. The curved outer edge **69** of element **70** is seated on receiving surface **74** of mounting element **73**. when in this position, contact element **77** carried by arm **76** engages switch **79**, the operation of which switch also initiates the pressing action designed to form flange **46** in the rod. It is noted that in the bent position, the axis of bent portion **45** of the rod is in alignment with the axis of ram **80**, as well as the axis of plunger **67** and vertical eject plunger **85**.

During the pressing operation, ram **80** is lowered into contact with the rod, by the mechanism shown in FIGS. **7** and **8**. The pressure of the ram **80** is transmitted through coining cavity surface **81** and received at the bend of the rod, and transmitted through the bent portion of the rod to plunger **67**, from plunger **67** to element **70**, and from element **70** to support **73** which is mounted on machine frame **42**. When ram **80** moves downward, coining cavity **81** confines the material in the band, forces some of the excess material to flow to the inside of the bend, thus preventing folding, and leaves a smoothly rounded edge conforming to the surface **81** of the coining cavity. As shown in phantom in FIG. **5**, the ram moves into wedging engagement around the 90° bend, nesting the outer curvature of the bent portion. When at its fully extended position, the ram lowers the upper bulge surface of the bend to approximate tangential alignment with the rod proper, resulting in a smooth curvature around the bend. The excess bulge metal which is pressed downward by ram **80** flows radially outward and is joined by material from the adjacent bent portion, to form flange **46** between the lower surface of ram **80** and the inner surface **68** of receiving element **70**. The flange **46** is thus formed of homogeneous material, and without detrimental folding which would induce a stress raiser at the juncture of flange **46** and the inside bend of the adjacent main length of rod.

It is to be noted that a great pressure is required from ram **80**, which pressure varies in accordance with the rod material and size. When this ram pressure is applied to the bend and material flows radially, clamp jaws **50** and **51** are caused to move downward in unison with ram **80** to prevent offsetting or partial shearing of the rod at surface **59**. In order to achieve such controlled downward motion of jaws **50** and **51**, ram **80** has a contact surface **84** which, upon lowering of the ram, contacts upper frame **52** as shown by the dashed lines in FIG. **5**. Contact surface **84** is designed so that it just makes contact with frame **52** when the coining cavity **81** contacts the bend of the rod. Any further downward movement of the ram is accompanied by a corresponding downward movement of jaws **50** and **51**, due to the pressure exerted through contact surface **84**. In order that jaws **50** and **51** be permitted to move downward, the fluid in cylinder **56** is bled off at a controlled predetermined rate as ram **80** is moved downward, permitting a restricted downward movement of rod **61** and lower jaw frame **53**. Since the downward movement of lower jaw **53** is restricted, it continues to provide an upward pressure on jaw **51**, adding to the clamping force already supplied by cylinder **55**, such that jaws **50** and **51** remain in a tightly clamped condition during the entire coining operation.

Upon completion of the coining operation, the rod ejection step is initiated, as illustrated in FIGS. 7, 8 and 9. After coining, the ram is at the bottom of its down stroke and at this point, through its contact with upper jaw frame 52 and the controlled bleeding of cylinder 56, has driven the lower extension of rod 63 into contact with switch 74. Switch 74, through control means in conjunction with the monitored position of ram 80, reverses the force direction of cylinder 55 to attempt to open upper jaw 50 against the resistance of ram 80 which is in contact with upper jaw frame 52, and also to initiate the force applied to vertical ejector plunger 85, which in turn transfers its force to rod 67 to perform the ejection of the bent rod from its confinement. When these forces are initially applied, no action occurs due to restraint from the ram in its lowest or bottom stroke position. The forces restrained by the ram cause the simultaneous upward movement of upper jaw 50 and ejection plunger 67 with ram 80, when ram 80 starts up. As upper jaw 50 and ejector rod 67 reach their uppermost position, the lower portion of the ejector plunger 85, not shown, activates a control circuit which results in instantaneous out and in operation of horizontal ejector plunger 98 to eject the coined rod, after a predetermined time delay allows for additional upward movement of the ram to clear the ejection area. After ejection, ram driving mechanism 86 returns ram 80 to its full upward position, and rotatable member 70 returns to its horizontal position. Fluid is reintroduced into cylinder 56, bringing jaw frame 53 and lower jaw 51 upward to their normally fixed positions. At this point all members are at rest and in a condition to receive a straight rod and start a new cycle.

Referring now to FIG. 6, a left side elevation, there is shown the means for rotating element 71 so as to provide the right angle bend. A toothed rack 90, driven by cylinder rod 91 which is actuated in response to the signal from switch 78, is moved laterally, the teeth of the rack engaging teeth 92 of gear 93, as also seen in FIG. 7. The rotation of gear 93 is transmitted to rotatable element 71, which in turn supports and carries receiving element 70.

It is understood that the electrical controls, not shown except for the switches identified above, are of a conventional nature. Thus, ram 80 may be actuated by a solenoid device which in turn is triggered by a signal from switch 79. Similarly, the movement of rack plunger 91, vertical eject plunger 85 and horizontal eject plunger 98 may be energized through solenoid actuators which are conventional in the art.

From the above, it is seen that the process and apparatus of this invention provide for repetitive and extremely accurate bending and coining of linking rods, resulting in rods with the desired form, i.e., without the folding and cracking of material at the point of intersection of the flange with the inside bend of the rod, as found in the prior art. It is seen that by performing the bending about a pivot point eccentrically displaced from the center axis of the unbent rod, the rod is preshaped into a deliberately distorted form which compensates for the distortion otherwise caused by the coining process, resulting in an undistorted and smoothly curved bend. The apparatus as described above for carrying out the steps of the process provides for fully automated and repretitive production of such bent rods.

It is appreciated that minor variations may be made in the apparatus of this invention within the spirit and scope of the invention. While the preferred embodiment as illustrated provides for a 90° bend and an annular flange, it is understood that any angle of bend may be accommodated by the process and apparatus of this invention, and various shapes may be coined into the rod in the coining step. Further by way of illustration, the coining step may be accomplished by holding the coining cavity in a fixed position and nested against the rod bend, and applying pressure from another source to push the rod into position against the coining cavity surface.

It is seen from the above that the process and apparatus of this invention provide an efficient and reliable means for repetitively forming rods with the uniform bends, the uniformity of dimension around the bend preventing cracking and splitting out of the rod material. The apparatus of this invention also incorporates a substantial saving of economy in providing complete bending and coining in a one-cycle operation.

I claim:

1. A rod forming process comprising the following steps:
   a. clamping a first portion of a straight rod, such clamped portion defining a first axis;
   b. eccentrically bending a second portion of said rod relative to said clamped portion by a receiving means which constrains the second portion for pivotal bending movement about a pivot point displaced from said first axis; and
   c. coining said rod to produce a bend of uniform thickness between said clamped portion and said bent portion.

2. The process of claim 1 wherein said coining step includes forming a flange extending from the bent portion of the rod, and adjacent said bend, such that there is no folding of rod material between said flange and said rod.

3. The process of claim 1 wherein said bent portion defines a second axis, and said pivot point is displaced from the intersection of said first axis and said second axis.

4. A rod forming process comprising the following steps:
   a. clamping a first portion of a straight rod, such clamped portion defining a first axis;
   b. eccentrically bending a second portion of said rod relative to said clamped portion, about a pivot point displaced from said first axis so that said bending step produces a bend with a bulge of rod material having a thickness greater than that of said clamped portion and said bent portion, and such that the rod material undergoes primarily compressive stress at the bend; and
   c. coining said rod to produce a bend of uniform thickness between said clamped portion and said bent portion.

5. The process of forming a bend in a rod, defining two straight portions with the bend therebetween, and coining a circular flange extending radially from one of said portions and adjacent the bend, comprising:
   a. bending said rod by constraining said portions for pivotal bending movement of at least one of said portions about a pivot point displaced from the intersection of the axes of the two straight portions of the bent rod; and

b. applying pressure at said bend, to form a bend of uniform thickness and having an outer curvature tangential to said two straight portions.

6. The process of claim 5 wherein said flange is concentric with said one straight portion.

7. A process of rod forming comprising:

a. securing a first portion of a straight rod in a clamped position;

b. bending a second portion of said rod at an angle of about 90° with respect to said clamped portion, said bending being about a pivot point displaced toward the outside curvature of said bend from the intersection of the axis of the clamped portion and the axis of the bent portion, causing a bulge of rod material at the bend; and

c. coining said rod at the bend to force rod material from said bulged bend area and from said second portion into a radially extending flange, resulting in a bend of uniform thickness with a flange adjacent said bend, such that there is no detrimental fold between said flange and said rod.

8. The process as described in claim 7, comprising clamping said first portion of said straight rod between opposing jaws, and inserting said second portion of said rod within a receiving opening in a rotatable element;

rotating said element about 90°, thereby putting about a 90° bend in said rod; and

simultaneously applying pressure to the rod at the area of the bend and yieldingly moving said jaws in the direction in which said pressure is applied, while maintaining said first portion clamped between said jaws, thereby coining said rod without shearing it at the bend.

9. The process as described in claim 8 wherein said pressure is applied along the axis of said bent portion.

10. The process as described in claim 9, wherein said pivot point is located radially outward from the intersection of the axis of the two portions.

11. The process as described in claim 10, comprising transferring the straight rod into a receiving groove in the lower of said two clamping jaws; clamping the upper of said two jaws against said lower jaw, thereby clamping said first portion in place; and, ejecting said bent and coined rod from said jaws after said bending and coining steps.

12. A process for forming a rod, such formed rod having a first straight portion and a second straight portion bent at about a 90° angle with respect to each other, comprising the following steps:

a. placing a first portion of a straight rod on a first supporting jaw, the opposite portion of said rod being received in a rotatable member;

b. clamping a second jaw against said first jaw, said first and second jaws having grooves in registry with each other so as to securely clamp said first portion of said rod;

c. rotating said member through a predetermined angle, thereby bending said opposite portion about a pivot point displaced from the intersection of the axis of said first portion and the axis of said bent opposite portion;

d. applying pressure to the outer surface of the bend of the rod to coin same, thereby causing material to flow from said bend area and from said bent portion into an annular flange on said bent portion;

e. moving said jaws in the direction of said applied pressure during the application of such pressure, whereby said first portion of said rod is displaced uniformly with said bend undergoing said pressure; and

f. ejecting said bent and coined rod.

13. Apparatus for rod forming comprising:

a. clamping means for clamping and holding a portion of a rod;

b. bending means for bending another portion of said rod at an angle relative to said clamped portion, the bending means including a receiving portion for receiving said other portion and constraining it for bending about a pivot point displaced eccentrically from the intersection of the axis of the clamped portion and the axis of the bent portion; and

c. coining means for coining said rod in the vicinity of the bend.

14. The apparatus as described in claim 13 wherein said receiving portion is mounted on a rotating element which rotates about said eccentric pivot point.

15. The apparatus as described in claim 14 comprising angle control means for causing said rotating element to rotate about 90°, thereby forming about a 90° bend in said rod.

16. The apparatus as described in claim 15, wherein said coining means produces an annular flange about the bent portion of said rod, and adjacent to said bend, said bending means and said coining means cooperating such that no fold is produced between said flange and said rod.

17. The apparatus as described in claim 13, comprising eject means for ejecting the formed rod from the apparatus after the bending and coining operations.

18. The apparatus as described in claim 13, wherein said clamping means is moveable in cooperation with said coining means, such cooperative moving maintaining said rod straight except at the point of bending.

19. Apparatus for forming a rod comprising:

a. clamping means for clamping a portion of an unformed rod;

b. receiving means for receiving an end portion of said unformed rod, said receiving means being displaced from said clamping means so as to provide an unengaged portion of said rod;

c. rotating means, for rotating about a pivot axis, said rotating means carrying said receiving means;

d. first actuating means, for actuating rotation of said rotating means following clamping by said clamping means;

e. stopping means, for stopping rotation of said rotating means after rotation through a predetermined angle;

f. said rotating means rotating about a pivot point displaced from the intersection of the axis of said clamped portion of said rod with the axis of said portion bent through said predetermined angle, such that said bending produces a bulge of excess rod material in the area of the bend;

g. coining means, for applying pressure to said rod in said bend area, said pressure causing flow from said excess material and from said bent portion into a flange;

h. second actuating means, actuating operation of said coining means after rotation of said rotating means through said predetermined angle;

i. clamp adjusting means, for moving said clamping means in cooperation with said coining means;

j. ejection means, for ejecting said formed rod after operation of said coining means; and

k. third actuating means, for actuating said ejection means after operation of said coining means.

20. The apparatus as described in claim **19** wherein said clamping means comprises upper and lower jaws, said jaws having grooves containing projected ridges for tightly clamping said rod.

21. An apparatus for forming a bend in a rod, defining two straight portions with the bend therebetween to facilitate coining a flange or the like extending outwardly from the rod adjacent the bend, comprising:

bending means including means for receiving said portions and constraining said portions during bending for pivotal bending movement of at least one of said portions about a pivot point displaced from the intersection of the axes of the two straight portions of the bent rod.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,698,228 Dated October 17, 1972

Inventor(s) WILLIAM G. CAMPBELL

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 5, delete "this"; same line, after "This" insert --invention--.

Column 2, line 1, after "coining" insert --cavity--.

Column 2, line 48, change "the" (first occurrence) to --The--.

Column 2, line 50, change "thus" to --Thus--.

Column 4, line 5, change "when" to --When--.

Signed and sealed this 27th day of March, 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

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