H. E. PARMENTER.

METAL BENDING MACHINE.

APPLICATION FILED FEB. 23, 1907.

956,541. Patented May 3, 1910.

6 SHEETS—SHEET 1.

Fig. 3.

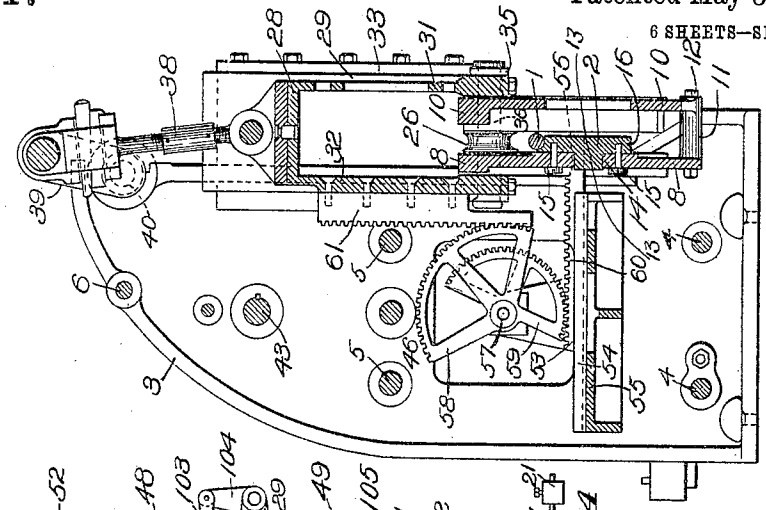


Fig. 2.

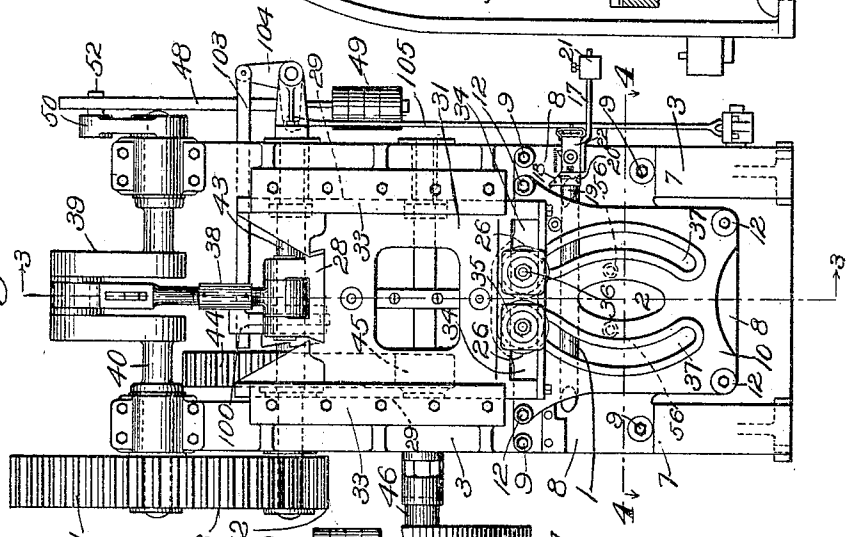
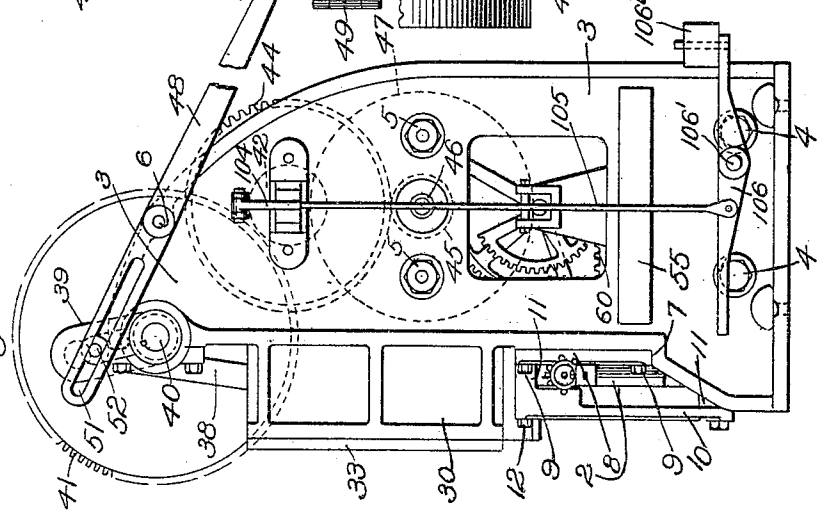


Fig. 1.



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6 SHEETS—SHEET 2.

Fig. 17.

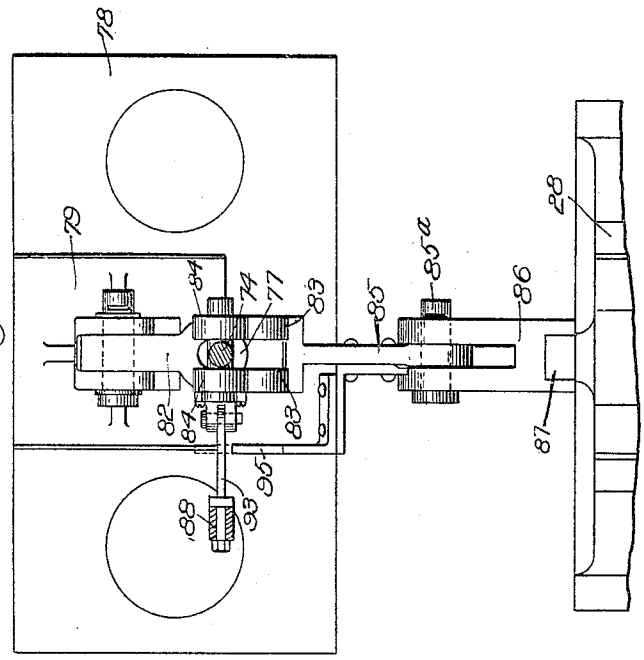


Fig. 4.

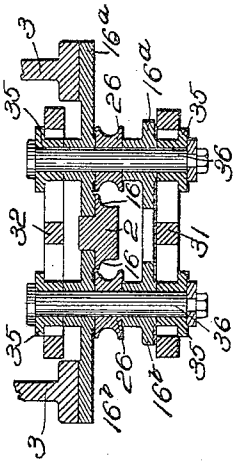
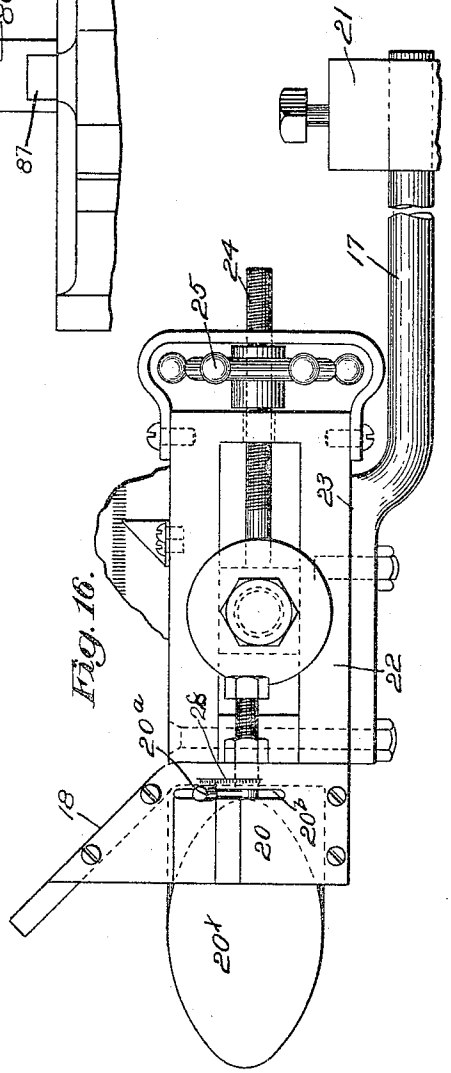


Fig. 16.



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6 SHEETS—SHEET 3.

Fig. 7.

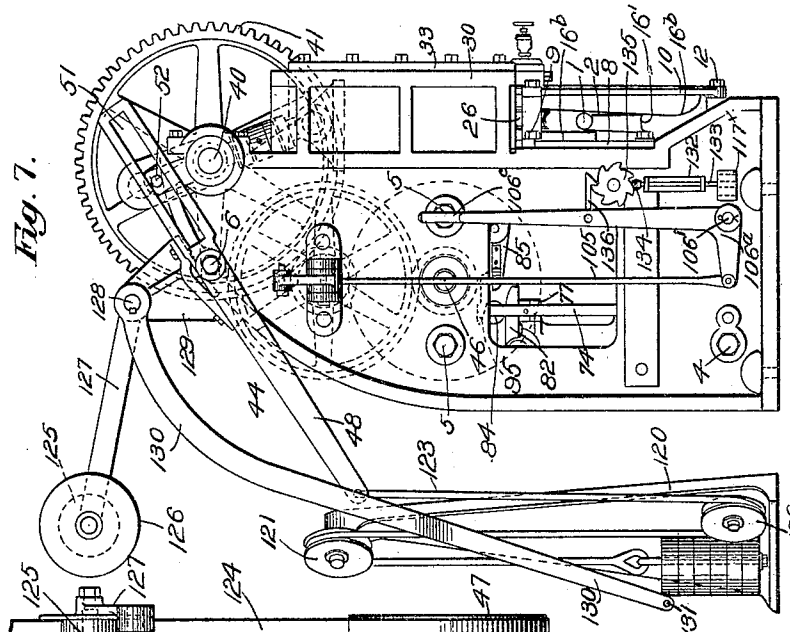


Fig. 5.

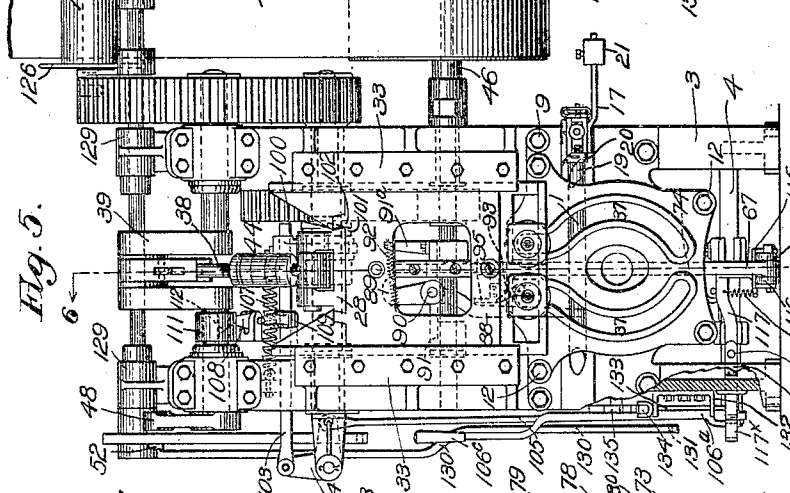
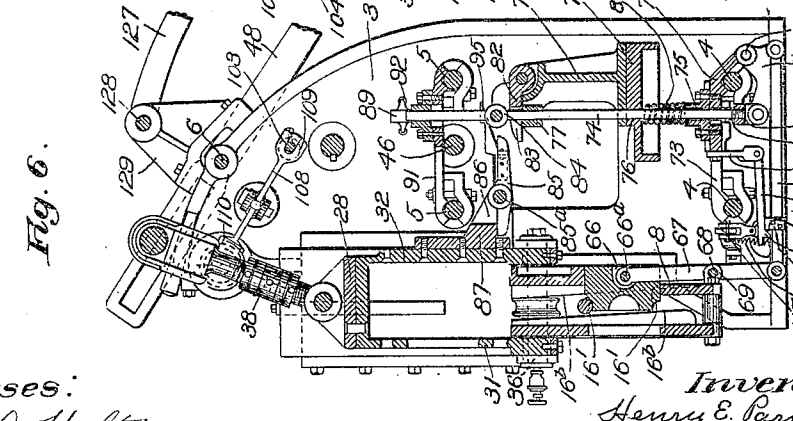


Fig. 6.



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6 SHEETS—SHEET 4.

Fig. 9.

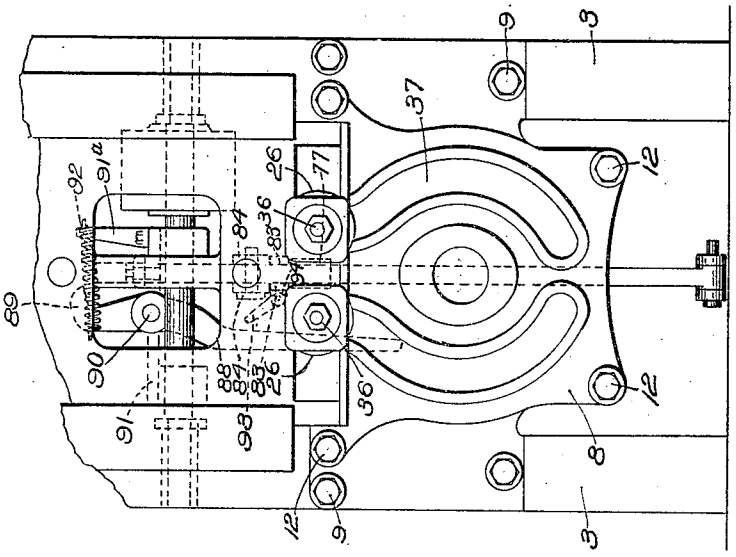
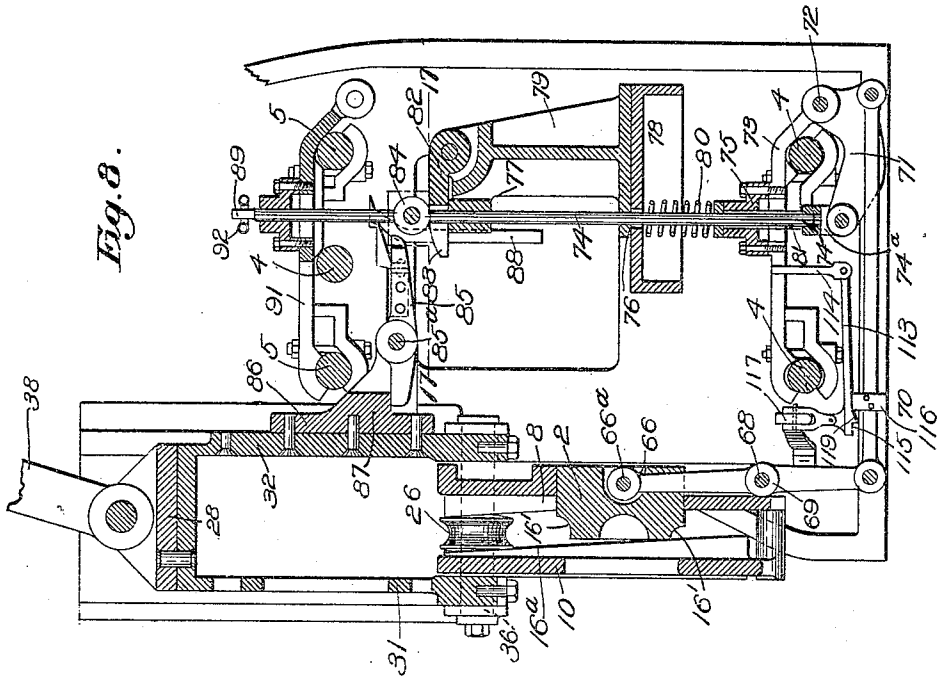


Fig. 8.



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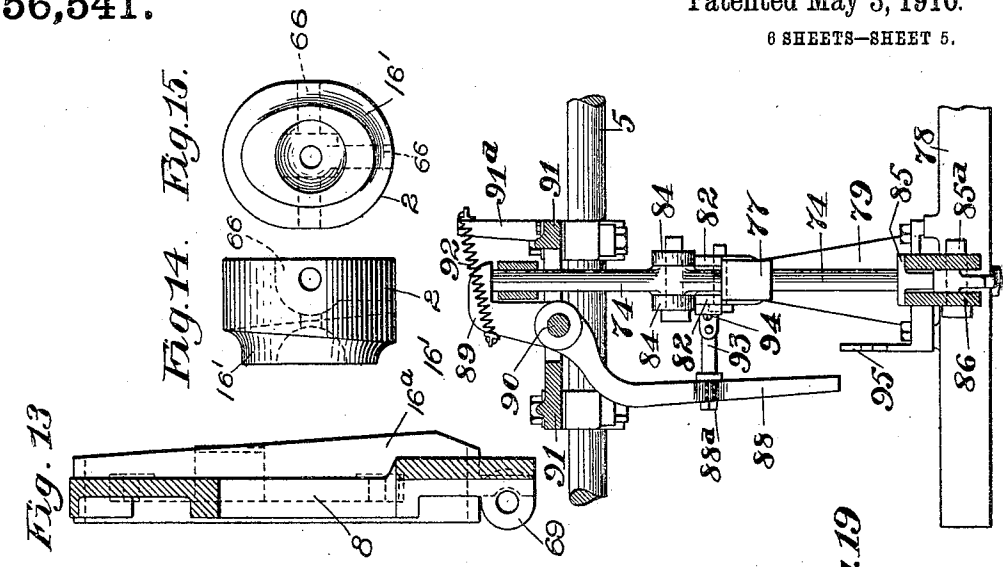
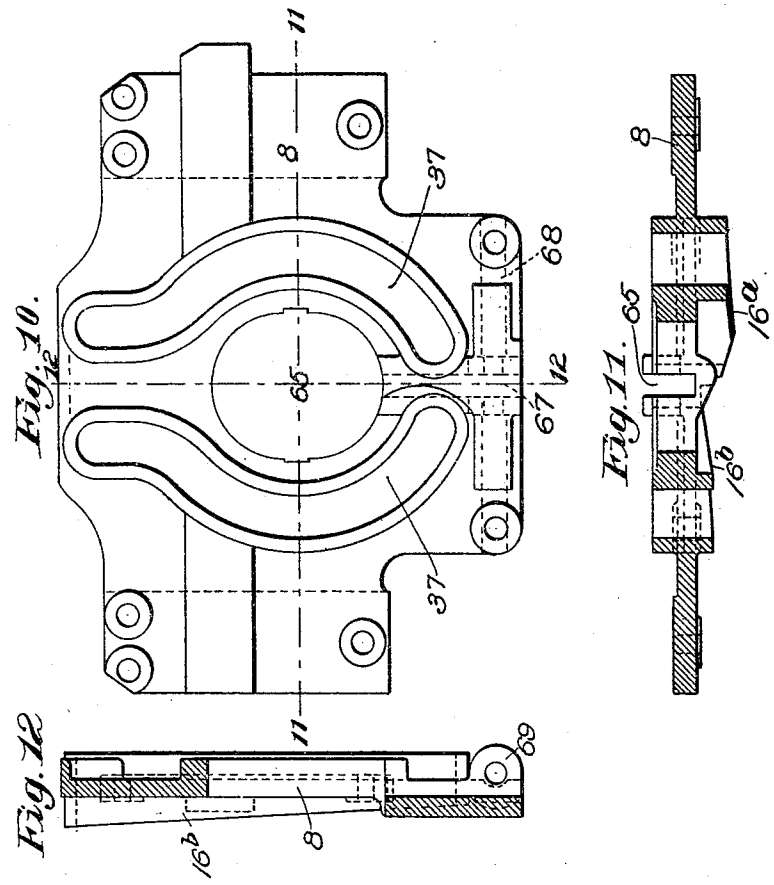
6 SHEETS—SHEET 5.





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6 SHEETS—SHEET 6.

Fig. 20

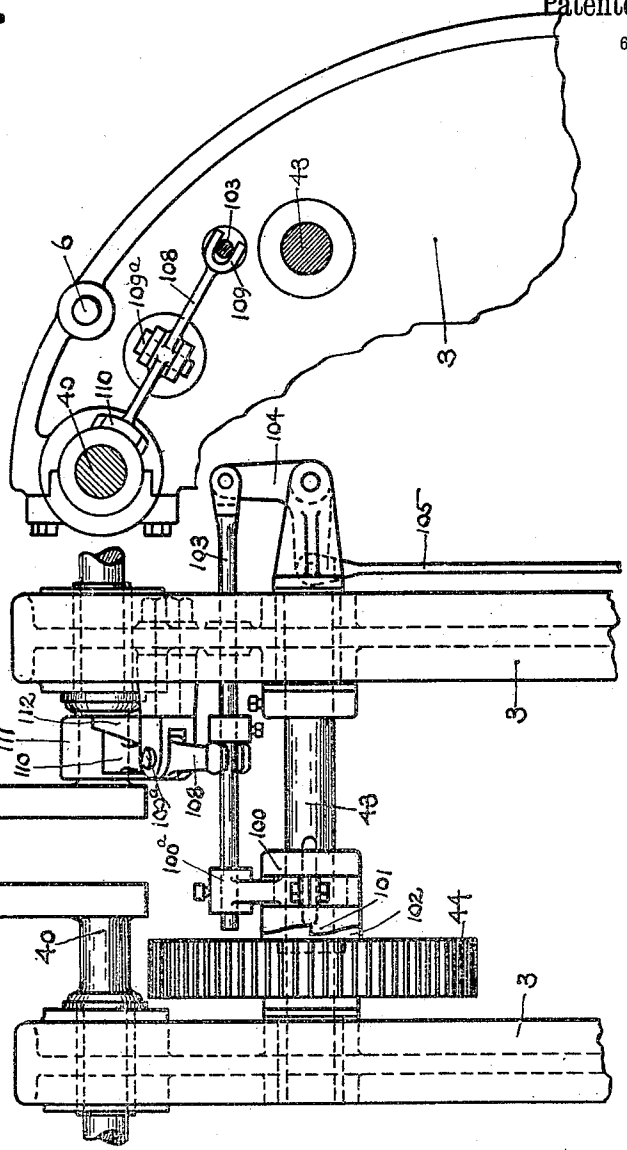

Fig. 18

WITNESSES.

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UNITED STATES PATENT OFFICE.

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METAL-BENDING MACHINE.

956,541. Specification of Letters Patent. Patented May 3, 1910.

Application filed February 23, 1907. Serial No. 359,002.

To all whom it may concern:

Be it known that I, HENRY E. PARMENTER, a citizen of the United States, residing at Newport, in the county of Newport and State of Rhode Island, have invented an Improvement in Metal-Bending Machines, of which the following description, in connection with the accompanying drawings, is a specification, like characters on the drawings representing like parts.

My invention relates to machines for bending metal rods or bars and more particularly, though not exclusively, to such as are employed for forming links for chains.

My invention aims, generally, to provide a machine that shall be simple and effective in operation and by means of which the operation of bending may be rapidly and effectively carried out, and to that end comprises novel features of construction and arrangement, that will be best understood and appreciated by reference to the following description, when taken in connection with the accompanying drawings, of a preferred embodiment of my invention, selected for purposes of illustration, its scope being more particularly pointed out and defined in the appended claims.

In the drawings: Figure 1 is an elevation of the right side of a machine illustrating one form of my invention and employed for forming or bending straight chain links; Fig. 2, a front elevation, with parts broken away; Fig. 3, a vertical section thereof on the line 3—3, Fig. 2; Fig. 4, a horizontal section on the line 4—4, Fig. 2, with the bending rollers on said line; Fig. 5 is a front elevation and partial vertical section of a machine for forming spiral links and illustrating a preferred form of my invention; Fig. 6, a vertical, central section, on the line 6—6, Fig. 5; Fig. 7, a left elevation thereof; Fig. 8, a sectional detail, on a somewhat larger scale, of the machine shown in Fig. 6; Fig. 9, a front elevational detail of the lower part of said machine, on the same scale as Fig. 8; Fig. 10, a front elevation, on a larger scale, of the back cam plate, to which reference will be made; Fig. 11, a horizontal section of the same, taken on the line 11—11, Fig. 10; Figs. 12 and 13, vertical sections on the line 12—12, Fig. 10, taken from the right and left respectively; Figs. 14 and 15, side and front elevations of the mandrel, detached; Fig. 16, a detail, on a larger scale, to show the end gage, employed for centering the metal bar on the mandrel in proper position; and Fig. 17 is a horizontal, sectional detail on the line 17—17, Fig. 8, but with the cross-head depressed, to show the mandrel locking lever latch and the tripping finger carried by the trip lever on the cross-head. Fig. 18 is a rear elevation (on larger scale than Fig. 5) to show the clutch and its mechanism for automatically stopping the machine at the end of the stroke. The machine can however, be stopped at any time by means of the operating lever. Fig. 19 is an elevation of that portion as shown by Fig. 17 and on the same scale. It is to more clearly show the method of locking the mechanism for operating the mandrel, so that it cannot be moved to the rear except at the predetermined time. Fig. 20 is a side elevation (on same scale as Fig. 18) to show the pivoted lever, one end of which bears on the cam on crank shaft, to transmit motion to withdraw or disengage clutch and thus automatically stop machine at end of stroke.

Referring to the drawings, Figs. 1 to 3, and to the particular form of my invention therein selected for illustration, I first show a machine for forming or bending straight links, which are subsequently welded together to form chains or cables for vessels and the like, though it is to be understood that my invention is not limited to such use, as it is equally adapted for other purposes. In the manufacture of these chains, the metal bars or rods employed are drawn from the furnace or heater, sawed into the requisite length, and presented to the link bending machine which bends them into the desired link form. These short lengths of bar metal are usually formed by sawing or shearing a long bar into bars of such length that when bent into link shape each link will be of the same length. The long bar may be cut by sawing across at right angles or obliquely to form beveled or scarfed ends, by which the ends of the link may subsequently be welded together. In the present embodiment of my invention one of the short metal rods, represented at 1, Fig. 2, is fed into the machine from one side (the left Fig. 2) and centered and supported on a centrally mounted former or mandrel 2. The rod is then bent around the mandrel to cause it to conform in shape thereto and is then displaced and dropped, to be thereafter removed. As the links thus

formed are bent into shape by bending them vertically, machines of this type are denominated vertical link bending machines.

The machine is provided with a suitable frame for supporting the various operative parts comprising, in the present instance, see Figs. 1 to 3, the vertical side frames 3, suitably connected together by horizontal tie rods 4, 5 and 6, and by a lower horizontal tie plate 55. At their front lower portions, said side frames 3 are provided with a ledge 7 (Figs. 1 and 2), forming a seat or support for a vertical plate 8 extending across the front of the machine between said frames and bolted thereto as at 9, and which I denominate a cam plate, since it is constructed to impart a predetermined movement to the bending rollers 26, hereinafter described, that shape or bend the rod 1, around the former or mandrel 2 to form the link. In front of this vertical cam plate 8 is a second, similar cam plate 10, offset in front of the former (Fig. 4) and secured in any suitable manner thereto and to said side frames 3. As here shown, this second cam plate 10 is provided at its head and foot with rearwardly projecting tubular lugs 11 (Figs. 1 and 3), having axial bolt holes extending through said plate to receive bolts 12, by which it is secured to the rear cam plate 8, the lugs 11 separating said plates to provide suitable clearance between them for the reception of the work or metal rod 1 that is to be bent, and for the mandrel 2 that supports it and around which it is to be bent. The upper bolts 12 extend through the head of the rear cam plate 8 and are secured in said side frames, so that both the front and rear cam plates are rigidly secured to and supported by the machine frame. Said mandrel 2 (see Figs. 3 and 4) is provided with a rearwardly projecting hub 13, by which it is removably mounted in a suitable support 14, here shown as an aperture, centrally formed in the rear cam plate 8, suitable bolts 15 being also provided for rigidly securing the mandrel in position. The periphery of this mandrel is given any desired shape, here shown as preferably elliptical and corresponding to the contour of the link that is to be formed, said mandrel having its major axis extending vertically for convenience in bending the link around it. The periphery of the mandrel is also provided with a groove 16 of desired shape, here shown as preferably semi-circular, adapted to the periphery or cross section of the rod to be bent and into which the latter is forced to give it the desired shape.

My invention contemplates the provision of a plurality of mandrels, of different sizes and shapes and for different purposes, so that by the term "mandrel" I mean any supporting and forming matrix or means around which the rod or work is shaped and whether of elliptical or other form.

In inserting the short rod 1 into the machine, it may be moved inwardly by the usual handling irons and balanced upon the top of the mandrel or former and with its arm portions immediately below the bending rollers 26, mounted upon a cross-head 28, presently described, but I preferably provide a gage for positioning the entering end of said rod and thereby centering the same upon the mandrel. For thus centering the rod or bar of metal 1 upon the top of the former 2, as described, so that when bent its two arms may be of the same length and their ends also brought into juxtaposition at or adjacent the lower end or the opposite extremity of the major axis of the mandrel, any suitable gage means may be employed, though I prefer that here shown (Figs. 2 and 16), wherein a counterbalanced lever 17 is pivotally mounted at the front and right side of the rear cam plate 8. At its inner end this lever has a longitudinally adjustable gage 18, adapted to be engaged by the scarfed end 19 (Fig. 5) of the rod 1 to be bent, said gage, as here shown, being preferably provided with a vertically arranged plate 20 constituting a guide and lateral support for the curved periphery of the end of said rod 1, the gage proper having an angular abutment $20^{\times}$ to receive the flat scarfed face of said end 19 and not only forming a convenient means for centering or gaging the rod upon the mandrel, but positioning the same, so that the scarfs will be in proper opposed positions for welding. Before bending, this gage not only forms an abutment for said rod but also forms a rest for its inserted end and thus coöperates with the mandrel in supporting said rod. At its outer end this lever 17 has a counterbalance weight 21, which is adjustably mounted thereon so as to be secured at any desired distance from the fulcrum of the lever. This weight normally maintains the gage in operative position, permits it to move with the gaged end of the rod as the latter is bent down by the bending rollers, and finally releases said end and returns to normal position for gaging the next rod fed to the machine. That the gage 18 or said abutment $20^{\times}$ and guide plate 20 may be adjusted in and out or placed in proper position to engage the end of rods of different length employed for making shorter or longer links, when the mandrel and cam plates are also changed, or for other purposes, said gage is carried by a suitable recessed block 22, mounted to slide in guideways 23 on the inner arm of said lever, and moved and locked in any desired position by means of the screw 24 and hand wheel 25. The abutment $20^{\times}$ constituting the gage proper is similar in shape to the scarfed end of one

of the rods and is rotatively and adjustably mounted in said block 22 so that it may be turned to move the flat face of said gage abutment to a desired angular position, the shank of said abutment having a projecting arm, indicated at 20^a, movable in a vertical slot 20^b in said block 22. The block adjacent said slot has graduations 20^c to represent the angular inclination of said face when said arm is opposite or is alined therewith.

Any suitable means may be employed for bending the rod around the mandrel, but I have found that the most efficient and satisfactory results are attained by the use of preferably grooved bending rollers, which are moved in predetermined directions and by their engagement with the opposite arms or ends of rod cause them to move therewith and bend the rod around the mandrel. As here shown, I have preferably provided a pair of bending rollers 26, Figs. 2 and 3, mounted in any suitable manner on a vertically movable cross-head 28, slidable in guideways 29, formed by vertical wings or guide plates 30 (Figs. 1 and 3) projecting forwardly, at the front of the machine, from the inner faces of the side arms 3, so as to overhang the cam plates 8 and 10 directly below them. At its under side, this cross-head has a depending yoke or rectangular frame comprising the front and rear roller carrying plates 31, 32 (Fig. 3) respectively, which straddle said plates 8 and 10 and respectively engage and slide upon the front face of the front cam plate 10 and the rear face of the rear cam plate 8, face plates 33 at the front edge of said guide plates 30, retaining the cross-head 28 and said yoke or plates 31, 32 in said guideway. At their lower ends, these cross-head plates 31, 32 each are provided with horizontal alined guideways 34 (Figs. 2 and 4), one in each lateral half of said plates, in which are slidably mounted bearing boxes 35 for the horizontal roller carrying pins 36, upon which are loosely mounted the bending rollers 26 referred to, this arrangement permitting the boxes 35, said pins 36 and bending rollers freely to move in and out or toward and from the mandrel.

In the vertical reciprocation of the cross-head, the bending rollers 26 slide vertically upon and between the cam plates 8 and 10, and to permit this movement the bearing pins 36 are inserted through or mounted in curved cam slots 37 provided in each lateral half of said cam plates 8 and 10. Two such slots are thus provided in each plate and on opposite sides of the mandrel, the curve of each corresponding, or being parallel, to that of the adjacent side of the mandrel.

In the operation of the machine, the vertically movable rollers 26 engage the inserted metal rod or bar 1 on its upper side and, as the cross-head descends carrying said rollers with it, their bearing pins are forced to slide in said cam slots 37, moving the bearing boxes 35 and said rollers out and in or from and toward the mandrel center. By this movement the grooved rollers in engagement with said rod 1 force or bend it into and around the groove 16 of the mandrel, thus to give it the desired shape or form. By this construction, the link is vertically supported on its former or mandrel during the bending movement of the rollers, the latter forming the link by the vertical descent of the cross-head. In their reverse movement, the rollers again move in the path determined by said cam slots and return to their normal inner and upper position, ready to act upon a second bar at the next descent of said cross-head.

Any suitable means may be employed to produce the desired vertical reciprocation of the cross-head and its bending rollers, but in the present instance I prefer that herein provided, wherein said cross-head is connected by an adjustable link 38, Figs. 1–3, with a double crank 39 on an upper horizontal countershaft 40, suitably mounted in the heads of the frames 3. For rotating this shaft, it is provided at its left end (Fig. 2) with a gear wheel 41, meshed with a pinion or gear wheel 42 on a lower countershaft 43, which is provided, immediately inside of the left side frame 3, with a large gear wheel 44, loose on said shaft and adapted to be clutched thereto by suitable clutch mechanism hereinafter described. This gear wheel is constantly driven by a pinion 45 on the main drive shaft 46 (Fig. 2), the latter having a pulley 47 belted to a convenient and suitable source of power.

In order that the cross-head and its operative connections may be suitably balanced, I provide a counterbalance lever 48 (Fig. 1), fulcrumed on the cross tie 6 and having a counterbalance comprising one or more weights 49 suitably connected with and supported by its rear end. This lever is slidably connected at its front end with a crank arm 50 on the right end of said shaft 40 and arranged parallel with the crank 39, the front end of this lever in the present instance having a longitudinal slot 51 in which plays a crank pin 52 carried at the end of said crank arm 50.

In operation, the forward movement of the crank, and consequent vertical movement of the connected cross-head, elevates and depresses the front end of the counterbalance lever, thereby respectively lowering or raising the counterbalance and adding to the momentum of the cross-head in one or the other direction, according to the adjusted weight of the counterbalance. By this arrangement not only may the weight of the cross-head be counterbalanced, but the bend-

ing force applied to the rollers 26 to bend the links may be increased or diminished, which is provided for by the provision of a plurality of weights. It will be understood by those familiar with the art that the heated bar to be bent is inserted sidewise into the machine, and centrally supported by the mandrel. Upon starting the machine, the descent of the cross-head causes the rollers, engaging the upper side of the bar, to move down and out and in, as their carrying pins are guided by the cam slots 37, said movement correspondingly shaping or bending the bar around the mandrel and bringing its scarfed ends in juxtaposition for subsequent welding.

As my invention, as has been stated, contemplates the provision of a variety of sizes and types of cam plates and mandrels, shaped to form different sizes and forms of links or other shapes of metal, the vertical movement of the cross-head should be made adjustable, which is provided for by making the link 38 adjustable in length, by a usual right and left screw coupling. This arrangement also permits varying or regulating the descent or position of said cross-head when but one set of cam plates are provided and as may be desired if the amount of vertical bending is to be stopped at any point. After the vertical link has thus been formed, it is released automatically and dropped to the floor in convenient position to be removed. This release is effected by producing relative movement between the formed link and the former or mandrel on which it is seated, and to that end, and in the present embodiment of my invention, I provide what may be termed pushers 53 (Fig. 3), arranged to reciprocate horizontally in suitable guideways 54 provided in a cross or tie plate 55 connecting said side frames 3. The front end of these pushers have forwardly projecting ends 56 (Fig. 2) that in their forward movement pass through suitable apertures in the rear cam plate 8 and engage the arms of the formed link just above their center of gravity and push the link forward off the mandrel, permitting it to drop to the floor through the clearance space between the cam plates 8 and 10. To actuate these pushers, the said side frames 3, Fig. 3, are centrally provided with a horizontal rock shaft 57 having a central segmental rack 58 and at each side thereof segmental racks 59, (Figs. 1 and 3), the latter meshing with suitable horizontal racks 60 formed upon said pushers 53, the rack 58 meshing with a vertical rack 61 secured to the rear yoke arm 32 of the cross-head 28. In operation, the segmental rack 58 is swung forwardly by the descent of said cross-head and its rack 61, the lower segmental racks 59 simultaneously moving rearwardly and carrying with it said pushers 53. After the link is formed and the cross-head 28 moves up, the ends 56 of the pushers, by the reverse movement of the latter produced through the reverse movement of said racks, are brought forward to engage the rear sides of the link arms and push the link off the mandrel, this engagement being so timed as to take place just as the bending rollers 26 are moved to their upper position.

When scarfed rods are employed, this machine operates to form a link having its opposed and scarfed ends lying in the same plane with the body of the link, and, that another similarly formed link may be linked thereto, said ends have to be separated or the lower part of the forming mandrel suitably shaped to prevent said ends from being brought too close together. After a second link has been inserted into the opening between the arms of the first, these ends have to be brought together for welding and in doing so, the link frequently loses its elliptical form and hence its strength. To overcome this difficulty, I have so modified the machine just described, as to form a link known as a spiral link, wherein the metal bar 1, is bent from its mandrel supported center to form a continuous spiral having its scarfed ends laterally separated, so as to provide suitable space between them to receive a second similar link, the said ends being subsequently closed upon one another by bending the arms back into the same plane. Bending the rod to form a continuous spiral is effected by bending one arm, the right, forwardly from the top of the cam plate and the other or that on the left side, Figs. 8 and 11, rearwardly, said arms being bent simultaneously and laterally in opposite directions during the vertical bending movement. After the insertion of a second link and rebending the arms into the same plane, the scarfed ends are in position to be subsequently welded together. Furthermore, as the welding surfaces of the scarfed ends extend obliquely across the plane of the link as will be apparent from their position shown in Fig. 5, before the bar is bent, said ends will not have to be separated so much as when straight links are formed, and the operation of separating them is eliminated.

Referring now to Figs. 5–7 and to the particular embodiment of my invention selected for illustration therein, the vertical spiral link forming machine there shown, comprises side frames 3, cross-head 28, its depending yoke arms or plates 31 and 32, the bending rollers 26 carried thereby, the adjustable link 38, crank 39 and driving means being preferably and substantially the same as in the machine just described. To form a spiral link, however, the former or mandrel 2, is provided with a semicircular groove 16′, best shown in Figs. 6 and 8 and

in detail Figs. 14 and 15, arranged spirally around its periphery, and in which the arms of the rod, 1, are to be forced by the bending rollers 26, which, for this purpose, are moved laterally, one toward the front and the other toward the rear of the machine, simultaneously with their vertical movement. To effect this lateral movement of said bending rollers, the cam plates 8 and 10, which in other respects are similar to those described, are each provided with two inclined inner cam faces, 16^a, 16^b, formed upon the right and left halves or sides respectively of both cam plates and respectively inclined from the top of said cam plates toward the rear and front of the machine and each parallel to the inclination or slope of the spiral groove in the adjacent side of the mandrel. By this arrangement, the inclined surfaces on the opposed or corresponding sides or halves of the two cam plates are parallel to each other and with the slope of the mandrel groove but are inclined to those on the other halves of said plates. This is best shown in Fig. 8, where the rearwardly inclined surfaces 16^b on the left halves of the cam plates are represented with the left bending roller 26 between them, and in Figs. 10–13 which shows the rear cam plate in plan and in vertical and horizontal section.

For centering or gaging the inserted bar and to place it in desired bending position upon the mandrel, I preferably use this machine with the gage 18 described. In operating with this machine, however, the lateral or forward and back bending movement imparted to the ends of the rod in forming the spiral link, bends the flat faces of the scarfed ends into different planes, so that they will not lie in parallel planes when the link is straightened. To prevent this or cause said surfaces to be parallel when the said scarfed ends are brought in juxtaposition, the long rod is turned or rotated through an angle of about 30° between each sawing operation, so that the flat faces of said scarfs are at an angle of 30° with one another. The flat face of the abutment 20^x provided upon the centering gage, in this case is not vertical but is set or adjusted at an angle of 15° or half of the 30° between the scarfed faces of the rod, so that when the latter is bent spirally to move its arms in opposite directions, said faces will be brought into parallel planes, when the link is closed for welding. In operation the vertical descent of the cross-head, 28, carrying with it the loosely mounted bending rollers, 26, compels the latter to move between the inclined surfaces of the cam plates, the left roller being moved rearwardly corresponding to the slant of the cam plate faces on the left side of the machine and the other roller forwardly, by the action of the cam faces on the right side. By this construction, the metal rod, 1, being first seated or balanced in the groove at the top of the mandrel, the two arms are bent in opposite directions in a spiral manner to conform to the spiral groove of the mandrel, offsetting their ends one from another, the pitch of the spiral and the inclination of the surfaces being such as to secure the desired separation between the scarfed ends of the formed link. It will be understood, that the slope of the cam surfaces 16^a, 16^b, of the cam plates employed will or may be varied for different shapes, forms or sizes of links, or in bending the bars, 1, to other shapes. This machine is also provided with means for producing relative movement between the formed link and the mandrel, upon which it is formed, the latter in the present instance, being preferably made movable. To this end, the mandrel is mounted to be moved rearward within a central recess 65, Fig. 10, shaped to receive it in the rear cam plate 8, and which also constitutes a seat or support therefor. By this rearward movement, the side of the link strikes the front face of the rear cam plate 8, which limits the rearward movement of said link, the continued movement of the mandrel displacing said link from the mandrel groove 16′ and permitting it to drop as the mandrel is withdrawn from under it.

While any suitable means may be provided for moving the mandrel, I prefer that herein shown, wherein its rear face is recessed at 66 to receive a pivot pin 66^a (Figs. 6 and 8) and also the head of a vertical lever 67 fulcrumed upon a horizontal pivot shaft 68 (Figs. 6, 8 and 10). This shaft is suitably mounted at the ends in rearwardly projecting ears 69 (Figs. 12 and 13) at the bottom of the rear cam plate 8. At its lower end, said lever 67 is connected by a horizontal link 70 (Fig. 8) with a bell crank 71 fulcrumed at 72 on a suitable horizontal bearing and guide plate 73, shown as clamped to the lower tie rods 4, the oscillations of said bell crank moving the mandrel in and out periodically to displace and release the link as described. For actuating this bell crank, its front end is connected by a coupling 74^a, Figs. 6 and 8 to a vertically movable trip rod 74, Figs. 8, 17 and 19, slidably mounted in a suitable bearing 75 upon said plate 73, and bearings 76 and 77 in a longitudinal tie plate 78 and bracket 79 mounted thereon, respectively, which guide the movements of said trip rod vertically. This trip rod 74 is normally maintained in the lowest or depressed position by a coil spring 80 encircling said rod and interposed between its bearing 76 and a loose sleeve 81, slidably mounted in the lower bearing 75 and abutting, at its lower end, the rod coupling 74^a. To lift the rod and through its connections

to withdraw said mandrel so as to displace and release the formed link, a horizontal lever 82 (Figs. 6, 8, 17 and 19) pivoted at its rear end to the head of said bracket 79, has it front end forked to embrace said rod, the latter being provided, immediately above the cam faces 83, formed upon the upper edge of the lever fork, with a projection or roller 84, adapted to be engaged by said cam faces and lifted as the projecting forked end of said lever is lifted. The forked end of this lever 82 constitutes lift toes adapted to be engaged by a normally horizontal trip lever 85, Figs. 8, 17 and 19, pivoted at 85[a] to the arms of a rearwardly projecting bracket 86 on the back of the rear yoke arm 32 of the cross-head 28. When in a horizontal position the front end of this lever underlies or engages a lug 87 on said bracket, which limits the elevation of this end of the lever and prevents depression of its rear end, though permitting them to move freely in the opposite direction, the lever being mounted to swing freely on its fulcrum. The rear arm of this lever normally extends rearwardly and in the depressed position of the cross-head to underlie the forwardly projecting toes of the lever 82. By the ascent of said cross-head, said lever 85 lifts the lever 82 and thereby the trip rod 74, until the continued elevation of said lever 82 moves it out of the path of the trip lever and releases the same, permitting said trip lever to pass above it and said trip rod to be returned to normal position by the action of the spring 80. In the descent of the cross-head, the rear end of the trip lever 85 is tripped up by the toes of the lifting lever 82 to pass by and below it, and return to normal horizontal lug-engaging position, in position again to lift the trip rod on the next ascent of the cross-head.

The lifting of the trip rod is timed to take place just as the bending rollers leave the formed link, Fig. 8 showing the relative positions of the operative parts immediately following the release of the lifting lever 82. As it is also desirable to prevent any movement of the mandrel during the link forming operation or until the cross-head approaches the upper limit of its travel, I have provided suitable means for locking the trip rod in its lower position. As herein shown, said locking means comprises a vertical lever 88 (Figs. 8, 9, 17 and 19), having an angular or laterally projecting head 89 adapted to overlie the head of said trip rod and prevent it being moved vertically. This lever is pivoted at 90, Figs. 9 and 19, on a suitable supporting plate 91, clamped to the tie rods 5. The depending and heavier arm of this lever is at one side of said pivot, so that said arm normally tends to swing inward or down, Figs. 9 and 19, swinging its head 89 outward and thus permitting elevation of the trip rod. This movement, however, is partially prevented by the action of coil springs 92, connecting the head of said lever with a vertical bracket arm 91[a] secured to said plate 91. The lever is normally locked in said position by a gravity latch 93, pivoted at the left side of lever 82, and engaging the lower depending arm of said lever 88. Said springs 92 and the dog 93 coöperate to maintain the locking head 89 of said lever 88 in its inner position overlying the head of the trip rod 74. This construction prevents the trip rod being lifted, except at such times as the gravity latch 93 is lifted, when, the springs 92 not being powerful enough in themselves to hold the lever in its locking positions, the heavier arm of the latter swings inward by gravity and the action of the latch resting upon it, see Figs. 9 and 19, and the overlying head 89 simultaneously swings away from the head of said trip rod to release the latter and permit its elevation. In its locking position, the heavier arm of the locking lever is swung to one side of the position it normally assumes under the action of gravity or its greater weight, said latch holding it there until the latter is automatically tripped up and the lever is automatically released by the movement of the cross-head to its upper position.

That the latch may be prevented from swinging down below a horizontal position, it is provided with a stop member or toe 94, that engages the side of the lever 82. For tripping the latch up automatically, at the proper time, to permit the lower arm of the vertical locking lever 88 to swing inwardly and its locking head to release the trip rod, as just described, the rear end of the trip lever 85 has a right angular forwardly projecting finger 95, best shown in Fig. 17 and Fig. 19, which, on the ascent of the cross-head, underlies said latch and lifts it. Upon thus lifting the latch, the vertical locking lever swings, as described, to release the trip rod 74, as the latter is elevated at the proper time to move the mandrel to release the formed link. As indicated at 88[a] Figs. 17 and 19, the lever 88 is enlarged in section by a bolt, so that the latch 93 can have a larger bearing surface on 88, and adjustment be made as to correct distance for length of 93. In Fig. 17 lever 88 is shown in section through the enlargement. The continued vertical movement of the trip lever 85 swings the lever 82 upward and rearward until its toe portions 83 slide off the rear end of the lifting lever 85. When this movement takes place, the lever 82 immediately swings down by gravity to its normal horizontal position, as best shown in Fig. 8. The gravity latch 93 is similarly tripped up by and released from en-

gagement with the tripping finger 95 during the movement of the cross-head to its upper position, said latch, upon its release, swinging outward, to the left Figs. 9 and 17, until its end bears against the inner side of the locking lever 88. In this position the latch by gravity tends to swing down to its horizontal position or lever locking position and thus coöperates with the springs 92 in swinging the vertical arm of the locking lever 88 outward and its head 89 inward to a locking position overlying the head of the trip rod, this movement taking place immediately following the return of the trip rod to its lower position. Upon the descent of the cross-head, the rear ends of said lifting lever 85 and its finger 95 respectively overlying the toe 88 and gravity latch 93 are swung upward by their contact therewith and slide upon, off and below them, when they immediately swing down to horizontal or operative position for subsequent and respective engagement with said toes and latch upon the next rise of the cross-head. Each machine is preferably provided with suitable clutch mechanism, to which reference has been made, for connecting the constantly rotating gear wheel 44 to its supporting shaft, so as to rotate the latter and operate the machine. Any suitable clutch may be employed for this purpose, that here shown preferably comprising one of well known and common construction, conventionally illustrated in Figs. 2, 5 and 18 and consisting of a slidable clutch 100, provided with teeth 101 to engage interlocking teeth or projections 102 on the side of said gear, and rotating said shaft with the latter. The clutch revolving in collar 100^a is moved back and forth on said shaft by a link 103 connected with the vertical arm of a bell crank 104, Fig. 5 and Fig. 18, the horizontal arm of which is, in turn, connected by a vertical link 105, Fig. 7, to an operating lever, by which the machine may be started.

In the straight link machine, see particularly Figs. 1 and 2, this starting lever is in the form of a treadle 106, fulcrumed at 106′ at the right side of the machine and counterbalanced at its rear end, as at 106^b, for normally elevating the link to maintain the clutch in inoperative or disengaged position. In the spiral link forming machine, however, I preferably form the operating lever as a bell crank 106^a (Fig. 7), fulcrumed at the left side of the machine, having its short horizontal arm connected with the vertical link 105, and its vertical arm provided with a handle 106^c presented in convenient position to be grasped by the operator. For normally maintaining the clutch of this machine in inoperative position, it is connected by a light spring 107, Fig. 5, to the left side frame 3. This machine is provided with mechanism for automatically stopping it at the conclusion of the link forming operation and as the cross-head reaches its upper position. For this purpose I preferably provide a pivoted lever 108, best shown in Fig. 6 and Figs. 18 and 20 fulcrumed at 109^a to one of the side frames 3. At its lower end, this lever has a fork 109 embracing said link 103 and bearing by its outer face against a collar on said link. The head of this lever has a yoke 110 engaging the edge of a cam 111, on the crank shaft 40 and comprising a disk having a single tooth or projection with an inclined face 112, at one side or point of its circumference, shown in dotted lines in Fig. 5 and Fig. 18 in full lines. In the rotation of said cam, this tooth engages the side of said yoke and swings it inward to the right, Figs. 5 and 18, causing its forked end, engaging the link collar, to slide outward and simultaneously move the link and actuating the clutch to release the latter from engagement with the constantly rotating gear wheel 44, thus stopping the machine. The pitch or width of this tooth or projection is small and the parts are so timed that the momentum of the moving parts causes the tooth to rotate past or out of engagement with the yoke 110, just as the machine stops, thus permitting the machine to be again started by sliding the movable clutch member into clutching relation with coöperating teeth 102 of the rotary gear 44.

Connected with clutch actuating or operating lever of the spiral link forming machine, is a device for preventing starting the machine until the forward movement of the mandrel after releasing the link has been completed, or which may be independently operated by the operative. In the present instance this device comprises a horizontal lever 113, pivoted at its rear end to a depending arm 114, secured to the cross plate 73 and having a projection or latch 115 at its front end to engage a collar 116 on said link 70 when said mandrel is in rearmost position and which prevents its forward movement until the latch 115 is elevated to disengage said collar. This latch 115 is linked to the inner end of transversely arranged horizontal lever 117 (Figs. 5 and 6), fulcrumed at 117^a to a frame bracket 117^b, a coil spring 118 connecting said end with the lever 113 normally maintaining the latch depressed to cause it to engage the collar as the latter is moved outwardly and is brought in latching position below it. That this latch may not interfere with the reverse movement of the link 70, its inner or rear side has a cam face 119 that is elevated by engagement with said collar 116 as the latter moves inwardly, the spring 118 yielding to permit such elevation.

To provide convenient means for actuat-

ing the lever 117 its outer end extends laterally at the side of the machine immediately below the operating lever 106a. This end of the lever has a tread plate 117x which may be depressed at any time but preferably as soon as a link is released before another bar, 1, can be inserted and the machine started, the depression of said tread end of the lever raising the latch indirectly to release the mandrel so that it may be moved forward. For actuating this lever automatically and simultaneously with the actuation of said clutch in starting the machine, the adjacent side frame 3 has a bracket 132 Fig. 5, formed as a guide for a depressor rod 113. The yoked head of this rod carries roller or other stud 134 in operative engagement with the teeth of a ratchet cam or star wheel 135, which is periodically actuated by the starting and stopping movements of the vertical arm of the operating lever 166a, which carries a pivoted ratchet pawl 136 having a hooked end to engage the teeth of said cam 135. As the starting lever is swung rearward, the latch or pawl 136 moves with it, the hooked end of the latter engaging one of the cam-like teeth or projections of said cam and causing the rotation of the latter through the space of one tooth. By this movement, the tooth in engagement with the roller 134 depresses it and its supporting rod, and as the latter rests by gravity on the tread plate 117x the latter is depressed, to release the mandrel link, so that the latter can be moved forward into link supporting and forming position if said tread plate 117x has not been previously depressed after the removal of a formed link. By this arrangement the machine cannot be started until the mandrel is in link supporting position.

As the movement of the counterbalance lever 48, Fig. 1, causes the suspended weights to swing or oscillate with the lower arm of said lever, and which is undesirable, in the spiral link forming machine (Figs. 5–7), I provide means for preventing this movement and which may be applied to the straight link machine. As here shown, these means preferably comprise a standard 120, having guide pulleys 121, 122, at its head and foot respectively, which receive the strands of a rope or wire 123, leading from the end of the counterbalance lever under the lower pulley 122, then over the upper pulley 121 and at its lower hanging end is connected to the counterbalance or weights 49. This arrangement permits oscillatory movement of the end of the counterbalance lever, but does not transmit it to said weights, which only move vertically.

To prevent the belt 124, Fig. 5, driven from a convenient source of power, from slipping on the belt pulley 47, I have provided an improved belt tightening device, herein shown as a roller 125 adapted to engage the belt and provided with end flanges 126 to prevent lateral movement thereon. This roller is mounted on arms 127 of a horizontal rock shaft 128, Figs. 5 and 7, suitably supported in vertical brackets 129 at the head of the side frames 3, said arms being secured to said shaft exterior to the adjacent left frame 3 (Fig. 5). At its opposite end and exterior to the opposite or right side frame 3, said rock shaft has a depending arm 130, to the eyed end 131 of which suitable means are attached for depressing it, and through said rock shaft, to depress the belt roller 125 upon the belt 124 to deflect it transversely to the direction of its movement and thus take up all slack and prevent it from slipping.

My invention provides simple, compact and efficient machines for bending metal bars or rods into desired shape, the present invention showing means for bending bars to form either straight or spiral links and preferably by a vertical movement, though obviously my invention is not limited to the specific use herein described. The provision of a machine of this type provided with cam plates and a matrix or mandrel with means, such as bending rollers, guided by said cam plates to bend the metal bar around the matrix, I believe to be new and original with me, as is also the provision of a series of mandrels or formers and interchangeable cam plates adapted for different sizes and shapes of links or other metal forms.

By causing the machine to work automatically when started and to stop automatically at the conclusion of the bending operation, the attention of but a single operative is required to feed the bars and start the machine, resulting obviously in a saving of labor and reduction in the cost of manufacture. Moreover, the machine produces an absolutely uniform product, each form being a duplicate or copy of another, and when employed in forming links, giving thereto an invariable oval or elliptical shape.

My invention obviously is not limited to the particular embodiment herein selected for purposes of illustration only, nor to the specific details of construction and arrangement, it being understood that the same may be varied or modified within wide limits without departing from the spirit and scope thereof.

I claim—

1. In a machine of the type described, a mandrel having a spiral peripheral groove and adapted to form a support for the metal bar to be bent, bending rollers operatively mounted relative to said mandrel at opposite sides of its bar supporting portion, and means for imparting simultaneous longitudinal and lateral bending movement to said

rollers and relative to their length to cause them to engage said bar and bend it into said groove to form a spiral link.

2. In a machine of the type described, a mandrel adapted to form a support for the metal bar to be bent, bending rollers operatively mounted relative to said mandrel at opposite sides of its bar supporting portion, operatively controlled means for imparting simultaneous longitudinal and lateral bending movement to said rollers and relative to their length to cause them to engage said bar and bend it to form a spiral link, and means actuated by said operative controlled means for effecting subsequent and relative movement between the link thus formed and the mandrel on which it is supported for displacing and releasing said link at the conclusion of the bending operation.

3. In a machine of the type described, a cam plate having an opening, a former or mandrel supported therein and on which the metal bar to be bent is centrally supported, means guided by said cam plate for engaging the bar thus supported and bending its arms around said mandrel, and means operable at the conclusion of said bending operation for effecting relative displacement of said mandrel and the bar supported thereon to release the latter and permit its removal from the machine.

4. In a machine of the type described, a pair of vertical cam plates arranged one in front of the other, a supporting former or mandrel mounted between them, a pair of bending rollers mounted to reciprocate between said cam plates and at opposite sides of said former, and means for reciprocating said rollers, each of said cam plates having a pair of curvilinear slots arranged on opposite sides of said former and parallel or conforming to the contour of the adjacent peripheral portions thereof and in which said rollers are also slidably mounted, thereby to guide the bending movement thereof, the opposed lateral portions of said cam plates adjacent said slots having forwardly and rearwarly inclined roller engaging faces to move said rollers longitudinally of their length to effect opposite lateral movement of the arms of the bar or rod supported on said former and simultaneously with the curvilinear vertical movement, said former having a peripheral groove the portions of which adjacent to said cam plates are parallel to the inclined faces of their roller directing faces.

5. In a machine of the type described, a mandrel or former on which the bar or rod to be bent is supported, bending rollers having means for moving them to bend the bar around said mandrel, and auxiliary means for imparting to said rollers a movement transversely to the plane of their travel to effect similar bending of the arms of said bar.

6. In a machine of the type described, a bar support comprising a former around which the bar is to be shaped, bar bending members each mounted in operative relation thereto for simultaneous lateral and longitudinal movements relative to its length, and means simultaneously to impart such movement to each of said members for correspondingly and simultaneously bending said bar.

7. In a machine of the type described, a pair of cam plates each provided with a pair of curvilinear slots and a pair of cam surfaces, one inclined rearwardly from the top of the plate and the other forwardly, the opposed surfaces on the two plates being parallel, a mandrel supported between said plates and between the slots of each plate, a vertically movable crosshead having a pair of bending rollers, and guiding pins on which said rollers are mounted, said pins traveling in said slots and causing said rollers to move between said plates and in conformity to the curvature of said slots for bending, for producing a predetermined bending movement.

8. In a machine of the type described, the combination of bending means and coöperating work supporting former with means to effect work displacing movement thereof to effect release of the work, and means for preventing said movement until the conclusion of the bending operation.

9. In a machine of the type described, the combination of a work supporting former having means to effect work displacing movement thereof to effect release of the work, and including a pivoted latch, a trip rod operably connected with said former, means normally to lock said latch in latching position, and means carried by said crosshead for effecting release of said locking mechanism and said latch.

10. In a machine of the type described, the combination of bending means and a coöperating work supporting former with means to effect work displacing movement thereof to effect release of the work, means for holding said former in inoperative or work releasing position and means adapted to be operated by the operative at will, or automatically, by said machine, for effecting return of said former to work supporting position.

11. In a machine of the type described, a former adapted to support a bar of metal to be bent and around which it is to be shaped, an adjustable gage at the side of the machine to engage the inserted end of said bar for centering it on said former, means for movably mounting said gage to permit it to move with the work during the bending

operation and for releasing the same, and means for bending the supported bar and effecting releasing movement of said gage.

12. In a machine of the type described, a former on which the bar is to be supported and bent, means coöperating therewith for bending said bar and a swinging gage pivoted intermediate its ends at one side of the machine, said gage having counter-balance means normally to hold it in gaging relation with one end of said bar and an inclined abutting face for positioning the scarfed end of said bar.

13. In a metal bending machine, a pair of separated cam plates having opposed cam surfaces, a former arranged between them on which the work is to be supported and bent and bending devices movable between and directed by said cam surfaces for bending the work around the former.

14. In a metal bending machine, a pair of cam plates, each having a plurality of curvilinear slots and an inclined cam face, said faces being opposed to one another, movable work bending members operatingly mounted in said slots between said cam surfaces, to be guided and moved thereby.

15. In a machine of the type described, a pair of separated cam plates, each provided with inclined cam or wedge surfaces on their opposing halves, a mandrel supported between said plates having a spiral forming groove, the portions of which adjacent said cam surfaces have the same inclination as the adjacent wedge faces of said plates, and bending devices engaging said surfaces and guided thereby with means for operating the same.

16. In a metal bending machine, a pair of separated cam plates each provided with wedge or inclined faces on each lateral half, a work supporting mandrel between said cam plates, and movable work bending devices adapted to play between said plates and guided by said faces for shaping the work around said mandrel.

17. In a metal bending machine, a mandrel or former adapted to receive the work, a reciprocatory cross-head having bending devices operably related to said mandrel for shaping the work around said mandrel, means for reciprocating said cross-head, and means operated by said cross-head for effecting relative movement between the mandrel and the work thereon at the conclusion of the bending operation and to displace or eject the latter.

18. In a metal bending machine, a mandrel or former adapted to receive the work, a reciprocatory cross-head having bending devices operably related to said mandrel for shaping the work around said mandrel, means for reciprocating said cross-head, and means operated by said cross-head for effecting relative movement between the mandrel and the work thereon at the conclusion of the bending operation and to displace or eject the latter, said means including mechanism positively to prevent said relative movement during the bending movement.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

HENRY E. PARMENTER.

Witnesses:

ROBERT H. KAMMLER,

SIDNEY F. SMITH.