

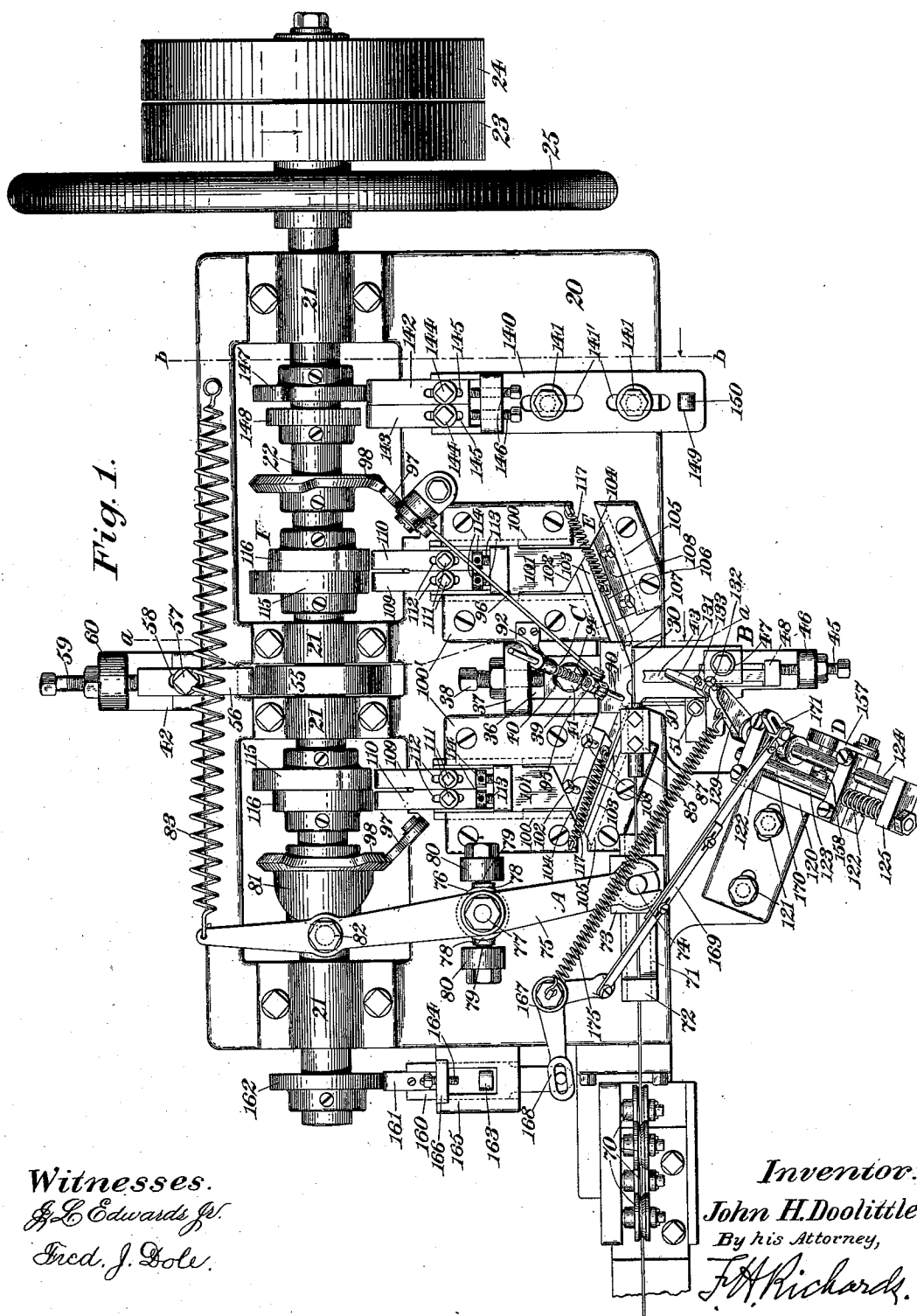
(No Model.)

3 Sheets—Sheet 1.

J. H. DOOLITTLE.
CHAIN MACHINE.

No. 568,749.

Patented Oct. 6, 1896



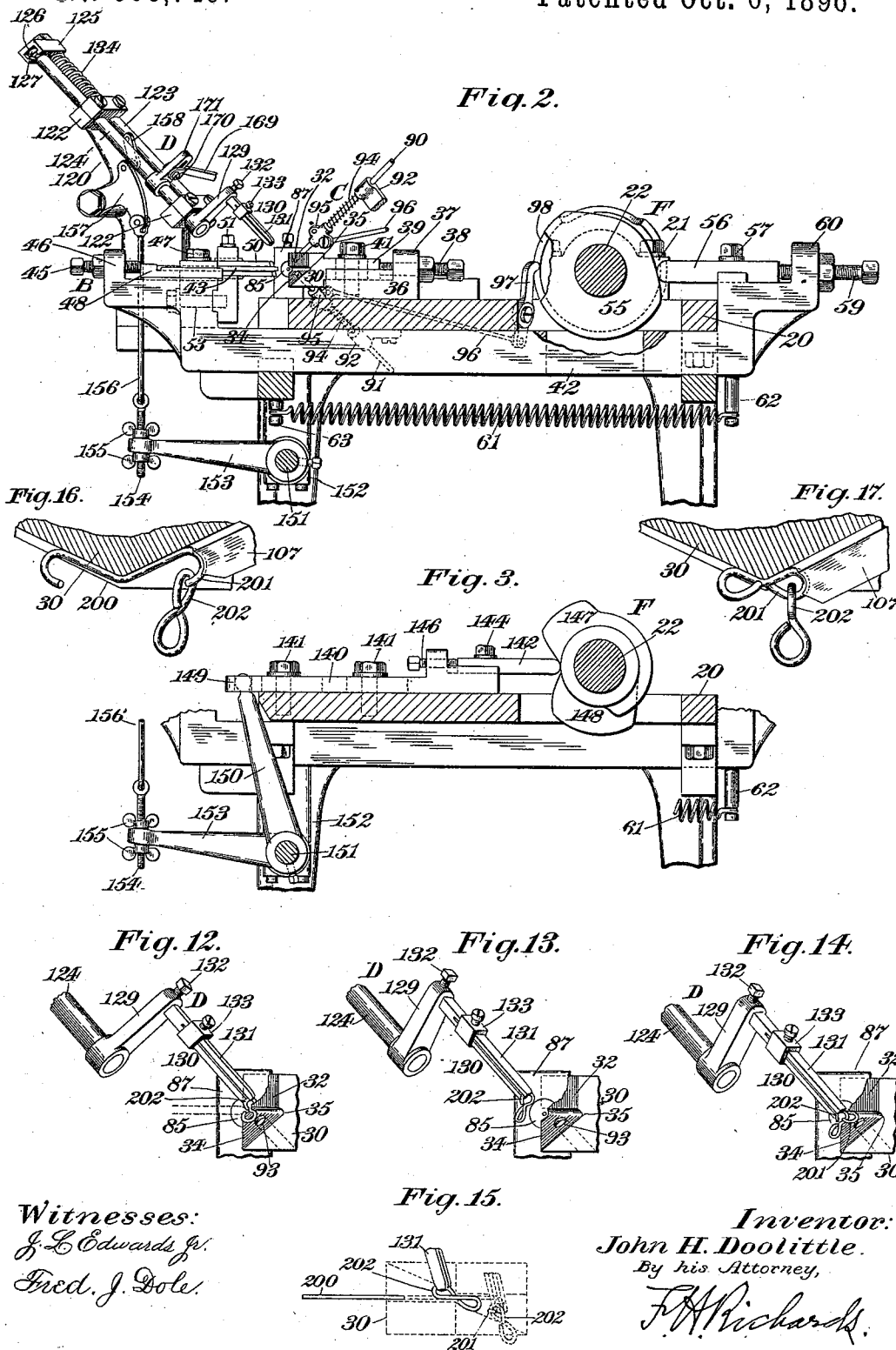
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3 Sheets—Sheet 2.

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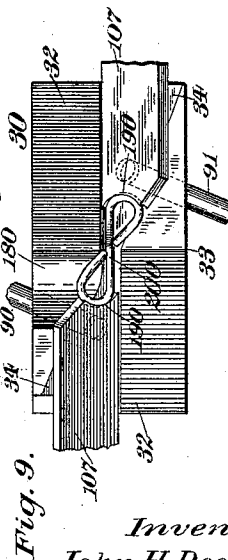
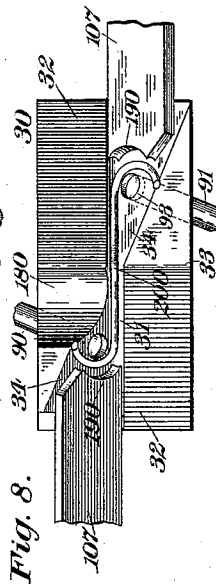
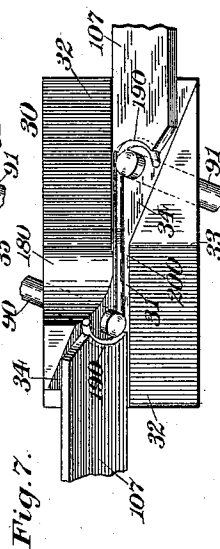
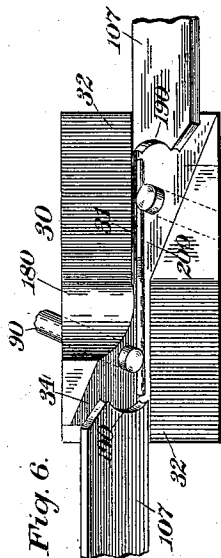
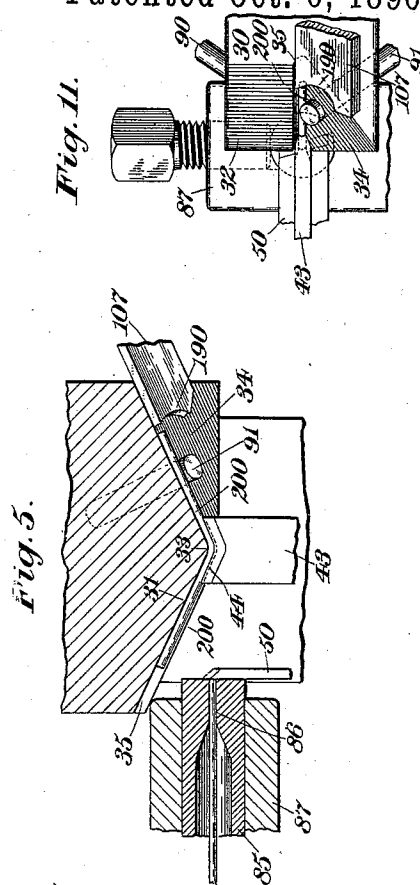
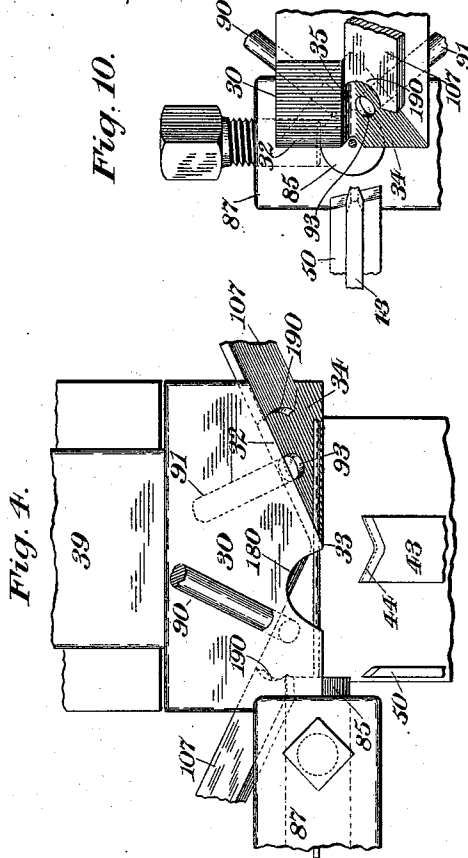
(No Model.)

3 Sheets--Sheet 3.

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CHAIN MACHINE.

No. 568,749.

Patented Oct. 6, 1896.



Witnesses:
B. L. Edwards, Jr.
Fred. J. Dole.

Inventor.
John H. Doolittle.
By his Attorney
F. A. Richards.

UNITED STATES PATENT OFFICE.

JOHN H. DOOLITTLE, OF GREYSTONE, CONNECTICUT.

CHAIN-MACHINE.

SPECIFICATION forming part of Letters Patent No. 568,749, dated October 6, 1896.

Application filed June 1, 1896. Serial No. 593,728. (No model.)

To all whom it may concern:

Be it known that I, JOHN H. DOOLITTLE, a citizen of the United States, residing in Greystone, in the county of Litchfield and State of Connecticut, have invented certain new and useful Improvements in Chain-Machines, of which the following is a specification.

This invention relates to chain-machines, and the object of the invention is to provide an improved machine of this class by means of which each link will be completely formed by two consecutive bending operations and in which both ends of the wire forming the link will be shaped simultaneously at or substantially at right angles to each other.

A further object of the invention is to provide an improved chain-machine in which the completed link will be carried into position and united with its companion uncompleted link when the same has been nearly shaped and during the bending or curling of the loop of such partially-formed link.

A further object of the invention is to provide an improved chain-machine embodying various improvements upon machines of this class heretofore employed, and which machine, as compared with analogous apparatus, will be simple in construction, effective in operation, and durable in use.

In the drawings accompanying and forming part of this specification, Figure 1 is a top view of the improved chain-machine. Fig. 2 is a transverse sectional view thereof, partly in elevation, taken in line *a a*, Fig. 1, looking toward the left. Fig. 3 is also a transverse sectional view taken in line *b b*, Fig. 1, looking toward the left and partly in elevation and partly broken away. Fig. 4 is a top view of a part of the wire-guiding device, the fixed angular die, and the movable or central bending die and cutter, with such movable die and cutter in retracted positions. Fig. 5 is a horizontal transverse sectional view of the device shown in Fig. 4, illustrating the link-blank severed from the wire and bent into angular position relatively to the fixed die by the central bending-die. Fig. 6 is a front or face view of the fixed angular die, the starting-pins, and the loop-benders, such loop-benders being shown in position to engage the link-blank. Fig. 7 is a similar view showing the loop-benders forming the

loops around the starting-pins. Fig. 8 is likewise a similar view showing the formers or starting-pins partially withdrawn and the end or loop benders slightly retracted. Fig. 9 is also a similar view showing the formers or starting-pins entirely withdrawn and the loop-benders in position completing the loops. Fig. 10 is a side view of the device shown in Fig. 4, partly in dotted lines and looking toward the left, with the central bending-die in its retracted position. Fig. 11 is a view similar to Fig. 10 with the formers or starting-pins and the central bending-die in operative position engaging the link-blank. Fig. 12 is a view of a portion of a gripping mechanism in position engaging one of the loops of the completed link. Fig. 13 is a similar view showing the gripping devices slightly retracted to clear the apex of the fixed die and carrying the completed link in position to receive the loop of the next link-blank. Fig. 14 is likewise a similar view showing the gripping device in position holding the completed link with one of its loops in position to have the partially-formed loop of the next link-blank bent or curled therethrough. Fig. 15 is a front view of the fixed angular die, showing the position of the gripping device when it first engages the completed link and the position thereof after it has carried such link into position to have one of the partially-formed loops of the next link-blank bent or curled therethrough. Fig. 16 is a view of a portion of the fixed die and showing the completed link in position to have a loop of the uncompleted or partially-formed link bent or curled therethrough by the loop-bender, and Fig. 17 is a similar view showing the links united.

Similar characters designate like parts in all the figures of the drawings.

In the usual construction of chain-machines it has been the practice to form each loop of the link by separate and independent operations and then by means of a clamping-die to bend the wire and bring the loop at one end of the link to a central position relatively to the loop at the other end thereof, whereas by this improved construction of chain-machine the bend of the wire which brings one loop of the link centrally of the other loop is made before such loops are formed and practically simultaneously with the cutting of the wire

from the stock, after which the loops are simultaneously formed at both ends of the link-blank, thus doing away not only with the final link-shaping operation heretofore used in practice, but also with the separate and independent loop-forming operations, as above set forth, and thereby accomplishing more quickly and in two operations the forming of a link, which heretofore has only been formed in three operations, and thus materially reducing the cost of manufacturing the chain. Moreover, in chain-machines as usually constructed the links are united by feeding the straight link-blank, before the same is bent, through one of the loops of the previously-completed links, whereby throughout all the bending operations of the link-blank the perfected link hangs in the way and is liable to interfere with the operation of the machine, whereas by this improved mechanism the completed link is united to its companion link when the latter is nearly formed by bending or curling one loop thereof through a loop of the previously-perfected link, so that the liability of the completed link to get in the way of the bending-tools is obviated and the rapid action of the machine thereby increased.

This improved chain-machine in the present construction comprises, in a general way, wire-feeding mechanism, (designated generally by A,) link-bending mechanism or means for bending the link-blank, (designated generally by B,) as contradistinguished from the loop or eye bending mechanism, and wire-cutting mechanism operative practically simultaneously with the link-bending mechanism, former mechanism, (designated generally by C,) loop-bending mechanism, (designated generally by E,) link gripping and carrying mechanism, (designated generally by D,) and actuating mechanism (designated generally by F) for such feeding, link bending and cutting, former, loop bending and gripping mechanisms, whereby in the construction shown said mechanisms, with the exception of the cutting mechanism, will be operative consecutively to form a wire blank into a chain-link.

In the preferred form the machine will be constructed substantially as hereinafter shown and described; but it will be understood that the various details of mechanism and the dispositions thereof can be replaced by other mechanisms, differently arranged, if desired, adapted to accomplish the same purpose without departing from the scope of my invention.

In the preferred form thereof herein shown and described the various mechanisms are carried upon a framework or fixture 20, which may be of any suitable construction adapted for the purpose.

Journalled in suitable journal-bearings 21, mounted on the framework 20, is a shaft 22, adapted to carry the cams for actuating the various mechanisms hereinafter set forth,

such shaft having at one end thereof the usual fast and loose pulleys 23 and 24 and the balance-wheel 25, whereby motion is imparted to such shaft from any suitable source of power.

The link-bending mechanism B in the form shown comprises a normally-fixed die or anvil 30, adjustably carried on the framework 20, such die having an angular working face 31, provided with a centrally-disposed groove or slot 35, preferably angular in cross-section and extending longitudinally thereof for the reception of the link-blank in a manner hereinafter set forth. This angular face 31 comprises at each side of its apex 33 a transversely-inclined face 32 and a longitudinally-inclined face 34 in angular relation to such transversely-inclined face 32, the faces of one side of the die being in alternation with the faces at the other side thereof.

In the present construction the means for adjusting the die toward and from the work comprises a slideway 36, having a transverse member 37, carrying an adjusting device in the nature of a screw 38 in position to engage the shank 39 of the die 30, and which shank is guided in said slideway and has an elongated slot 40 for the reception of a clamp device 41, whereby the die is adjustably clamped in position on the framework. Transversely movable in ways of the framework 20 is a slide 42, formed at its front end to support the movable link-blank bender or central die and also to preferably support the cutting-tool. The movable link-blank bender 43 is provided with an angular face 44, corresponding with the angular face 31 of the fixed die 30, whereby it will bend the link-blank 200, Fig. 5, into angular relation relatively to said fixed die. In the form shown the means for adjusting this movable link-blank-bending die comprises a suitable adjusting device, such as a screw 45, carried by an extension 46 of the slide 42, the inner end of which screw engages the end of a slide 48, carrying the movable die 43, which slide 48 and die 43 are clamped on the main slide 42 by a clamp device 47.

The cutting-tool or cutter 50 is herein shown disposed in position on said main slide 42 at the side of the movable link-blank-bending die 43 and secured thereon by a clamp device 51, which permits longitudinal adjustment of the cutter, and which clamping device and cutter are transversely adjustable relatively to the main slide 42 by means of a slot and clamping device 53, Fig. 2, whereby the length of the link-blank to be cut can be regulated. As a means for actuating this main slide 42, and thereby reciprocating the bending-die 43 and the cutter 50, a cam 55 is fixedly secured on the shaft 22 and engages a suitable follower 56, adjustably carried on the rear end of the main slide 42, and which follower is clamped in position by a clamping device 57, extending through an elongated slot 58 of the follower, and is adjust-

able by means of a suitable adjusting device, such as a screw 59, carried by an extension 60 of said slide 42. On the rotation of the cam 55 the slide will be actuated to thereby
 5 draw the movable bending-die 43 into engagement with the link-blank 200 to bend the same into angular engagement with the face 31 of the fixed die 30, such slide being moved in the opposite direction, after the actuating-
 10 face of the cam has passed the follower, by means of a coiled spring 61, having one end thereof secured to a stud or pin 62, fixed in the slide 42, and its opposite end also secured to a stud or pin 63, fixed in the framework 20,
 15 whereby such spring will actuate the slide to thereby move the link-blank-bending die 43 away from the fixed die 30.

Any suitable mechanism may be used for feeding the stock—preferably wire—into position to be operated on; but in the form shown this feeding mechanism may have as one part thereof the usual guide and straightening rolls 70, supported upon a part of the framework, if desired. The feeding mechanism proper, however, comprises in one form thereof a suitable dovetailed slideway 71, forming a part of or fixedly secured on the framework 20, and which guideway is shown having an extension 72 at one end thereof,
 30 having an aperture for guiding the wire. On this guideway a sliding member 73, having a dovetailed recess, is mounted, the upper face of which member 73 is provided with a wire-engaging face. This sliding member has an upwardly-extending stud or pin 74, having an aperture communicating with the wire-engaging face of said slide member and through which aperture the wire is fed.

The means for clamping the wire on the slidable member 73 and for moving said member longitudinally of its slideway 71 comprises in this construction a bifurcated lever 75, having its furcated end engaging the stud or pin 74 and pivotally secured for horizontal and vertical movements on the framework 20.
 45 In the form shown this lever 75 is pivotally secured on a member 76 by means of a pivot-pin and nut 77, whereby it is horizontally movable on such pivot-pin. This member 76 is provided with conical recesses or bearings 78, adapted to receive conical pivots or journals 79, mounted on suitable extensions 80, formed on or fixedly secured to the framework, whereby such lever is movable vertically to clamp and release the wire in order to feed the same to the machine. One means for actuating this lever 75 comprises a suitable cam 81, mounted on the rotary shaft 22 and provided with a pair of cam-faces, one of
 60 which engages said lever beneath the same to thereby raise and lower it to clamp and release the wire, while the other cam-face engages a suitable roller 82, pivotally secured to the lever 75, whereby said lever is actuated
 65 in one horizontal direction to move the slidable member 73 longitudinally of the slideway 71 to thereby feed the wire, said lever

being actuated in the opposite direction to reclamp the wire after each feed thereof by means of a spring, such as a spiral spring 83, 70 having one end secured to the lever and the other end to the framework.

In order to guide the free end of the wire or work and hold the same firmly in position to be severed by the cutter 50, a tubular guide device 85, having a central bore 86, is clamped in position in a holder 87, secured to the framework, (see Fig. 5,) and has one end in position adjacent to the plane of movement of the cutter, whereby the work will be supported while being severed. This guide device is adjustable in its holder to correspond with the transverse adjustment of the cutter hereinbefore set forth.

The formers, around which the ends of the 85 wire blank are shaped and which in the present construction comprise a pair of rods 90 and 91, are shown one, as 90, supported on top of the framework and the other, as 91, beneath the same and operable in diagonally 90 opposite directions, the planes of movement thereof intersecting each other. In the preferred form shown one end of each of these rods 90 and 91 is mounted in a suitable sleeve 92, fixedly secured to the framework 20, 95 (shown one above and the other below the same,) the working ends of said rods sliding in apertures 93, extending through the longitudinally-inclined faces 34 of the fixed die 30 and projecting beyond such faces at certain periods in the operation of the machine, whereby one former will be moved into position above one end of the link-blank and the other below the opposite end of said link-blank and at an inclination corresponding with the inclination of such longitudinally-inclined faces 34. As one means for actuating these formers into position each rod is provided with a spiral spring 94, encircling the same intermediate of its guide-sleeve 92, and a clamping-collar 95, fixedly secured to the rod, whereby the springs will force the working ends of the rods above the longitudinally-inclined faces 34 of the fixed die 30, and thus permit the ends of the link-blank 200 to be partially formed around the same by the loop-bending mechanism herein-
 105 after set forth. In order, however, to withdraw these rods after the loops are partially formed in the link and to also hold the same retracted during the link-bending operation, each former is pivotally connected to one end of an actuating-rod 96 by means of its clamping-collar 95, the opposite end of which actuating-rod 96 is pivotally connected to one end 125 of an oscillatory lever 97, pivotally secured to the frame in position to have its opposite end engaged by a suitable cam 98, mounted on the rotary shaft 22, whereby when the actuating-faces of such cams are in engagement 130 with the ends of the levers 97 the former-rods will be withdrawn from their working positions and held against movement until such actuating-faces release the ends of said le-

vers 97, when the springs 94 will force the former-rods into position to permit the ends of the link-blank to be shaped around the same.

5 The end-bending or loop-shaping mechanism E in one construction thereof herein shown comprises two sets of slides operative by means of cams and springs and adapted to carry a pair of bending-tools, one operative
10 at each end of the wire link, and each set of which bending means preferably comprises suitable guideways 100 and 100', formed on or fixedly secured to the framework 20, and in the ways of which a slide 101, having a
15 beveled or angular face 102, is adapted to slide. Disposed at an angle to such slide 101 is an auxiliary slide or tool-carrier 103, also having a beveled or angular face 104 in engagement with the beveled face 102 of the
20 slide 101, and which slide or tool-carrier is movable in suitable ways 105, formed on or secured to the framework 20, and one side of which ways may be formed, if desired, by the end of the way 100'. Each of these auxiliary
25 slides or tool-carriers is provided with an inclined recess 106, adapted to receive a bending-tool 107, clamped therein by clamping devices 108, and each of which bending-tools has a transversely-curved face 190 and is
30 preferably supported by such slides 103 at the same angle of inclination as the inclination of the longitudinally-inclined faces 34 of the fixed die 30, whereby the said bending-tools are supported substantially at right angles
35 to each other, and thus the loops of the link will be formed at right angles to each other. In the construction shown these bending-tools 107 engage a link-blank, one tool at each end thereof, to bend the same around the
40 formers, one loop in a substantially upward direction and the other in a substantially downward direction, Figs. 7, 8, and 9.

It will be understood, however, that by substituting a fixed die having faces 34 of different longitudinal inclinations from those herein shown, and by disposing the bending-tools
45 to correspond with such inclinations, the loops may be formed in any desired angular relation relatively to each other rather than at right angles, as shown.

As one means for actuating the slides or tool-carriers 103, and thereby the bending-tools, each slide 101 is provided with a pair of followers 109 and 110, adjustably attached thereto
55 by means of clamping devices 111, extending through elongated slots 112 therein, said followers being adjustable by suitable adjusting devices—such as screws 113 and nuts 114—thereon. These followers are adapted to be
60 alternately operated by a pair of cams 115 and 116, mounted on the shaft 22, whereby the benders are actuated into position to engage the link-blank 200, in a manner herein-after set forth.

65 As a means for retracting the slides or tool-carriers 103, and thereby also holding the followers in engagement with their respective

cams, a suitable spring, such as a spiral spring 117, is connected to each slide, one end thereof being secured to the slide and the opposite end thereof to the framework or other desired place on the machine. In the
70 operation of these slides 101 and 103 the followers 110 are first actuated by the cams 116, whereby the tools 107 are simultaneously operated into position partially to bend the
75 loops around the formers 90 and 91, Figs. 6 and 7. The bending-tools are then slightly retracted, Fig. 8, after the actuating-faces of the cams 116 release the followers 110, by
80 means of their springs 117, during which time the formers 90 and 91 are withdrawn, Fig. 8, by their cams 98. The pair of followers 109 is then engaged by the pair of companion
85 cams 115, whereby the bending-tools 107 by means of the same slides 101 and 103 are actuated into position to complete the partially-formed loops, Fig. 9, after which the bending-tools 107 are retracted into their inoperative
90 positions by their springs 117.

In the present construction each loop-bender is shown having movements of varying lengths, that movement thereof which completes the loop being somewhat longer
95 than that which starts the loop. It will be understood, however, that the lengths of movement of the benders may be otherwise modified by mere mechanical changes in the construction of the device.

After the link has been completely formed
100 the gripping mechanism is actuated into position to grip the same and carry it into position with one loop 202 thereof in the path of the bending or curling of one of the loops 201 of the next link-blank 200 for the purpose of
105 putting the links together.

It will be understood that any suitable gripping mechanism adapted for this purpose may be used; but in one preferred form thereof
110 herein shown this mechanism comprises a suitable gripping device supported for longitudinal and oscillatory movement and means for actuating the same, whereby it will be operated into position to engage the link, then
115 rocked into position to carry the same substantially centrally of one-half of the next link-blank 200, in order to permit at the proper time one of the partially-formed loops 201 of said blank to be bent or curled through
120 a loop 202 of the completed link to thereby connect said links together, and then actuated into its normal inoperative position. In the present construction this gripping mechanism is supported on the framework 20 by means
125 of a suitable bracket 120, adjustably clamped thereto by clamping devices 121, and which bracket 120 is provided with a pair of laterally-extending arms 122 in alignment with
130 each other and so disposed that they are inclined relatively to the work or wire. Mounted within these arms 122 is a pair of rods or shafts 123 and 124, one of which, as 123, has secured thereto a head 125, having a longitudinally-dovetailed recess 126 therein. The

companion shaft 124 has an annular head 127 movably secured in said recessed head 125, and which shaft is provided adjacent to its opposite or lower end with an arm 129, adapted to receive the gripper or gripping device 130, which in the form shown comprises a bifurcated member 131, having two fingers in the nature of spring-jaws and removably clamped in position in said arm 129 by a clamping device 132, and which bifurcated member carries a clamping-collar 133, whereby the tension of said fingers may be regulated. As one means for holding said gripping device 130 in its normal inoperative position and for retracting the same at certain periods in the operation of the machine, a spiral spring 134 is secured intermediate of the upper supporting-arm 122 and the shaft-head 125. One means of actuating this gripping device 130 into position to grasp a completed link comprises a suitable slide 140, adjustably supported on the framework 20 by means of clamping devices 141, extending through elongated slots 141' of said slide, and which slide 140 carries a pair of followers 142 and 143, adjustably secured thereto by clamping devices 144, likewise extending through elongated slots 145 and adjustable by means of adjusting devices, such as screws 146, and which followers are adapted to be engaged by a pair of cams 147 and 148, mounted on the shaft 22. This slide 140 is provided at its forward end with an opening 149, in which is inserted one end of a lever 150, the opposite end of which is fixedly mounted on a shaft 151, journaled in a suitable hanger 152, carried by the framework 20. Fixedly secured adjacent to the opposite end of said shaft 151 is a second lever 153, which thus forms, with the lever 150, a bell-crank-actuating device.

Secured to the outer end of the lever 153 is an adjusting device comprising a screw-rod 154 and thumb-nuts 155. The upper end of this screw-rod 154 is connected by a suitable rod 156 with one end of an oscillatory lever 157, pivotally secured to the bracket 120. The opposite end of this oscillatory lever 157 is connected by means of a link 158 to the shaft 123, whereby on the actuation of said slide 140, by means of the cams 147 and 148, in a manner hereinafter set forth, such gripping device 130 will be actuated into position to grasp a completed link. As one means for imparting a rocking movement to said gripping device to thereby carry the completed link from its formative position into the loop bending or curling path of the next link-blank a slide 160 is mounted on the framework in a slideway 165 thereof and is provided with a follower 161, adapted to be engaged by a cam 162, fixedly mounted on the shaft 22. This slide is provided with a suitable stop device 163, adapted to abut against an adjusting device 164, carried by an extension 166 of such slideway 165, whereby the movement of said slide is limited. A bell-crank lever 167 is pivotally secured to the framework and has

one end 168 thereof in engagement with said slide, the opposite end of said lever 167 being pivotally secured to one end of a connecting-rod 169, herein shown as composed of two members adjustably clamped together, whereby the length thereof can be regulated to thereby limit the rocking movement of the gripping device, the opposite end of said connecting-rod 169 being provided with a bifurcated bracket 170, pivotally secured thereto, and which bracket is also pivotally attached to an elongated slotted arm 171, mounted on the rock-shaft 124, whereby on the actuation of said cam 162 the slide 160 will be operated to move the bell-crank lever 167 in one direction and by means of the connecting-rod 169 thereby rock the shaft 124 and its gripping device 130 into position substantially centrally of the length of one-half of a link-blank 200. As a means for retracting the gripping device from such position a suitable spring, such as a spiral spring 175, has one end secured to the gripping-device arm 129 and the other end to the framework, or, as herein shown, to the pivot of the bell-crank lever 167, whereby, when the gripping device is retracted, the bell-crank lever 167 actuates the slide 160, and thereby the follower, into position to be engaged by the working face of the cam 162.

It will be understood that other connecting means, as well as various dispositions thereof, could be used for actuating the gripping device in place of that herein shown and described.

In the operation of this improved chain-machine at each forward movement of the feeding mechanism, comprising the clamping-lever 75 and its actuating-cam 81, a part of the wire sufficient to form a link is fed with the center of its longitudinal length adjacent to the apex of the angular face of the fixed die 30, at which time the main slide 42, by means of the actuating-cam 55, is moved forward to thereby permit the cutter to sever a link-blank 200 from the stock, and which link-blank, simultaneously with the severing thereof, is engaged by the movable link-bender 43 and bent around the angular faces of the fixed die 30, whereby it will rest in the groove 35, and thus the link-blank is not only given its first bend, but the ends thereof are thereby moved out of the way of the work or stock to permit the loop-benders to operate thereon. The formers 90 and 91, by means of their springs 94, are then moved into position, one below and one above the wire, to permit the loops to be properly started. The loop-benders 107, by means of the cams 116 and slides 101 and 103, are then moved into position to engage the ends of the link-blank 200 and partially bend such ends around the formers 90 and 91, after which said benders are slightly retracted by means of their springs 117, and during which retraction the formers 90 and 91 are withdrawn by the actuating-cams 98 and the loop-benders then again moved into

position to reengage the partially-completed loops by means of the actuating-cams 115 and the same slides 101 and 103, whereby the loops are completely formed, after which said loop-benders are completely retracted by means of their springs 117. The gripping device 130, by means of its cam 147, slide 140, and intermediate mechanism, is then actuated into position to engage the link at any desired place, (herein shown, however, as centrally of one of the loops, Figs. 13 and 15,) such engagement being permitted by having one of the straight faces of the fixed angular die cut away, as at 180, Fig. 6, and at which time the link-blank-bending die 43 releases the completed link, having firmly held it in position against the angular face of the fixed die 30 throughout the loop-forming operation. The gripping device is then retracted slightly in order to clear the apex of the fixed die 30, and which retraction is permitted by the actuating-face of the cam 147 releasing the follower 142, whereby the spring 134 slightly retracts such gripping device, which is then rocked to the opposite side of the apex of the die 30 by means of its cam 162, slide 160, and intermediate mechanism. The gripping device is then moved into position, by means of the cam 148, follower 143, and slide 140, to carry the formed link, with one of its loops, as 202, substantially centrally of one-half of the nearly-formed link, whereby said loop 202 will be in position in the path through which the end 201 of the partially-formed loop will be bent or curled as the bending-tool completes its loop-forming operation, Figs. 16 and 17, said blank 200 being fed, cut, bent, and the loops thereof partially formed while the gripping device is carrying the previously-formed and completed link into position to have one of the loops of the next link bent or curled there-through, whereby when the perfected link is in position, as above set forth, the partially-formed end or loop 201 will enter and be bent or curled through the loop 202 during the completion of the loop-forming operation, and thereby unite the links to form a chain. Substantially simultaneously with the last loop-bending operation, which partially withdraws the completed link from the gripping device, said gripper is retracted by means of its spring 134, which is permitted to operate by the actuating-face of the cam 148 releasing the follower 143 of the slide 140, whereby the gripping device is withdrawn into its longitudinal inoperative position and is then rocked by means of its spring 175 into its normal inoperative position in readiness to be moved to engage a loop of the last completed link and carry the same forward, as set forth, and during which time the bending operations are being repeated in the manner above set forth to thereby form a chain of any desired length.

It will be understood that the ends of the loop-benders may be provided with any desired degree of curvature, either extending

substantially the entire width of the end thereof, as herein shown, or only partially, as may be desired.

I do not claim, broadly, the use of bending-tools for forming the links of chains, as I am aware that similar tools have long been used for this purpose.

Having described my invention, I claim—

1. A chain-machine having supporting means for the link-blank, said machine comprising reciprocatory, obliquely-disposed benders movable toward and from each other and arranged and constructed to engage the ends of a link-blank to form thereon, during the reciprocative movements of said benders, loops substantially at right angles to each other; and means for actuating said benders.

2. A chain-machine comprising supporting means for the link-blank; two sets of slides, each set thereof consisting of a pair of slides disposed at an angle to each other; means for actuating the slides; and loop-benders carried by one slide of each set and operative simultaneously to form loops on the ends of the link-blank.

3. A chain-machine comprising supporting means for the link-blank; two sets of slides, each set consisting of a pair of slides disposed at an angle to each other; cam mechanism for actuating the slides in one direction; springs for actuating the slides in the opposite direction; and loop-benders carried by one slide of each set and operative simultaneously to engage the ends of the link-blank to form the loops.

4. A chain-machine comprising supporting means for the link-blank; two sets of slides, each set consisting of a pair of slides disposed at an angle to each other and one slide of each set having a pair of adjustable followers; two sets of cam mechanisms, each set comprising a pair of cams, one for each follower, whereby the followers of each set will be engaged alternately; means for retracting said slides; and loop-benders carried by said slides.

5. A chain-machine having supporting means for the link-blank, said machine having loop-bending mechanism embodying two sets of slides, each set comprising a pair of followers and a loop-bender and mechanism for operating the followers of each set alternately to thereby impart to each loop-bender intermittent movements.

6. A chain-machine having supporting means for the link-blank, said machine having a pair of loop-benders operative simultaneously to form loops in the ends of a link-blank; means for actuating said loop-benders toward each other to start the loops; means for retracting said benders slightly; and means for actuating said benders toward each other to completely form the loops.

7. A chain-machine having supporting means for the link-blank; a pair of loop-formers movable in diagonally opposite directions and in planes oblique to a horizontal

plane; means for actuating said formers; and means for bending the ends of the links around said formers.

8. A chain-machine having supporting means for the link-blank a pair of formers disposed at an angle to each other and having movements in diagonally opposite directions whereby their planes of movement intersect each other, means for actuating said formers and means for bending the ends of the links around said formers.

9. A chain-machine having supporting means for the link-blank a pair of formers comprising a pair of rods movable in diagonally opposite directions; means for actuating said formers in one direction; cam mechanism for actuating said formers in the opposite direction and means for bending the ends of the links around said formers.

10. A chain-machine having supporting means for the link-blanks a pair of formers comprising rods movable in diagonally opposite directions; a spring on each of said formers for moving the same into operative position; cam mechanism for withdrawing and holding said formers withdrawn from their operative positions during a certain period in the operation of the machine and means for bending the ends of the links around said formers.

11. A chain-machine having a support; a pair of formers, one mounted above and the other below said support and movable in diagonally opposite directions; means for moving said formers into their operative positions; means for withdrawing and holding said formers withdrawn from their operative positions during a certain period in the operation of the machine, said means comprising levers pivotally connected to said support; rods connecting said formers and levers; cam mechanism operatively engaging said levers during a predetermined period in the operation of the machine and means for bending the ends of the links around said formers.

12. A chain-machine including as an element a normally-fixed die with an angular working face having at each side of its apex a transversely-inclined face and a longitudinally-inclined face in angular relation to such transversely-inclined face.

13. A chain-machine including as an element a normally-fixed die with an angular face provided with a centrally-disposed groove or slot extending longitudinally thereof, said angular face having at each side of its apex a transversely-inclined and a longitudinally-inclined portion in angular relation to such transversely-inclined face.

14. A chain-machine comprising a frame; a normally-fixed, adjustable die thereon having an angular face comprising at each side of its apex a transversely-inclined portion and a longitudinally-inclined portion disposed in angular relation relatively to each other; a movable link-blank bender carried by said frame and having an angular face

corresponding with one part of the angular face of the fixed die; and means for actuating said link-blank bender toward and away from said fixed die.

15. A chain-machine comprising a frame; a normally-fixed, adjustable die thereon having an angular face comprising on each side of its apex a transversely-inclined and a longitudinally-inclined portion disposed in angular relation relatively to each other; a slide on said frame; a link-blank bender carried by said slide and having an angular face corresponding with one part of the angular face of the fixed die; cam mechanism for actuating said slide and thereby the link-blank bender toward the fixed die; and means for actuating said slide and thereby moving said link-blank bender away from said die.

16. A chain-machine comprising a frame; a normally-fixed, adjustable die thereon having an angular face comprising on each side of its apex a transversely and a longitudinally inclined face disposed in angular relation relatively to each other, the faces at one side of the apex being in alternation with the faces at the opposite side thereof; a slide on said framework; an adjustable link-blank bender carried by said slide and having an angular face corresponding with one part of the angular face of the fixed die; and means for actuating said link-blank bender toward and from said die.

17. A chain-machine comprising a frame, a normally-fixed adjustable die thereon having an angular face; a slide on said frame; an adjustable link-blank bender carried by said slide and having an angular face corresponding with the angular face of the fixed die; a cutter supported on said slide and longitudinally and transversely adjustable thereon; and means for actuating said link-blank bender and cutter toward and from said fixed die to practically simultaneously sever the link-blank from the wire and bend the same into angular relation relatively to the fixed die.

18. A chain-machine comprising a gripping device; means for actuating said gripping device toward the link and embodying a slide having a pair of followers; cam mechanism for engaging said followers alternately; connecting mechanism between said slide and gripping device; mechanism for rocking said gripping device intermediate of the actuation of the followers; and means for retracting said gripping device.

19. A chain-machine comprising a frame; a die normally fixed thereon and having an angular face; a gripping device disposed in front of the angular face of said die; means for actuating said gripping device toward said die at one side of its apex; means for retracting the same to a point beyond its apex; means for rocking said gripping device to the opposite side of its apex; and means for again actuating said gripping device toward said die at such side of its apex.

20. A chain-machine comprising gripping mechanism consisting of a pair of shafts and a gripping device secured to one of said shafts; a slide having a pair of followers secured thereto; cam mechanism for actuating said followers alternately; connecting mechanism between said slide and one of the shafts for actuating said gripping device; a second slide having a follower; cam mechanism engaging said follower; connecting mechanism between said slide and gripping device for rocking said device; and means for retracting said gripping device at certain periods in the operation of the machine.

21. A chain-machine comprising mechanism for bending a link-blank centrally of its longitudinal length; reciprocatory loop-bending mechanism for engaging the ends of such bent link-blank and simultaneously forming during its reciprocative movement loops thereon; and means for actuating such bending mechanism.

22. A chain-machine comprising mechanism adapted to feed a predetermined length of wire; a cutter; mechanism operative to bend a link-blank centrally of its longitudinal length; reciprocatory loop-bending mechanism operative to simultaneously engage the ends of such bent link-blank and during its reciprocative movement form loops thereon substantially at right angles to each other; and means for actuating such feeding and bending mechanisms.

23. A chain-machine comprising mechanism operative to bend a link-blank centrally of its length into angular position; former mechanism operative to permit the loops to be partially shaped around the same and embodying means for withdrawing said mechanism at a predetermined period in the operation of the machine, loop-bending mechanism operative to engage the ends of the link-blank and simultaneously form the loops, and embodying means for actuating said mechanism, to partially form the loops to then retract the same to permit the withdrawal of the former mechanism, and to then actuate said loop-bending mechanism into position to re-engage the partially-formed loops to complete the same.

24. A chain-machine comprising bending mechanism operative to bend a link-blank centrally of its length; former mechanism embodying formers having their planes of movement intersecting each other; loop-bending mechanism operative simultaneously to engage the ends of the link-blank to form loops therein substantially at right angles to each other; and means for actuating said mechanisms.

25. A chain-machine comprising bending mechanism operative to bend a link-blank centrally of its length; former mechanism embodying formers having their planes of movement intersecting each other; loop-bending mechanism operative simultaneously to en-

gage the ends of the link-blank to form loops therein substantially at right angles to each other; cam mechanism for actuating all of said mechanisms in one direction; and means for actuating said mechanisms in the opposite direction.

26. A chain-machine comprising bending mechanism operative to engage a link-blank and bend the same centrally of its length; former mechanism embodying formers operative simultaneously, one to engage the link-blank above one end thereof and the other below the other end thereof; loop-bending mechanism embodying a pair of loop-benders operative to engage the ends of the link-blank, and each of said benders having intermittent movements of varying lengths; and means for actuating said mechanisms.

27. A chain-machine comprising bending mechanism operative to bend a link-blank centrally of its length into angular position; former mechanism; loop-bending mechanism operative simultaneously to engage the ends of the link-blank; gripping mechanism operative to engage one of the loops of the completed link at one side of its apex and carry said link into the path of the partially-formed loop of the next link-blank; and means for actuating said mechanisms.

28. A chain-machine comprising cutting mechanism and bending mechanism operative to practically simultaneously sever a link-blank of a predetermined length and bend the same into angular position centrally of its length; former mechanism; loop-bending mechanism operative to engage the ends of said bent link-blank and simultaneously form the loops thereof substantially at right angles to each other; and means for actuating such mechanisms.

29. A chain-machine comprising cutting and bending mechanisms operative to sever a link-blank from the stock and bend the same into angular position centrally of its length; former mechanism embodying formers operative in diagonally opposite directions, whereby the planes of movement thereof intersect each other; loop-bending mechanism operative to engage the ends of the bent link-blank and simultaneously form the loops thereon substantially at right angles to each other; gripping mechanism operative to engage the completed link and carry the same into the link bending or curling path of the wire blank; and means for actuating said mechanisms.

30. A chain-machine comprising feeding mechanism operative to feed the wire a predetermined length; cutting and bending mechanism operative to sever a link-blank and bend the same into angular position centrally of its length; former mechanism embodying formers operative in diagonally opposite directions; loop-bending mechanism operative at an angle to the feed of the wire to engage the ends of said link-blank to simul-

taneously form the loops thereon; gripping mechanism; and means for actuating said mechanisms.

31. A chain-machine comprising link-bending mechanism embodying a normally-fixed die having an angular face at each side of its apex with transversely and longitudinally inclined portions; former mechanism embodying formers having their working ends extending through said fixed die and projecting at the longitudinally-inclined faces thereof; and means for actuating said mechanisms.

32. A chain-machine comprising link-bending mechanism embodying a normally-fixed die having an angular face at each side of its apex with transversely and longitudinally inclined portions; former mechanism embodying formers having their working ends extending through said fixed die and projecting at the longitudinally-inclined faces thereof; loop-bending mechanism embodying loop-benders disposed at the same inclination as the longitudinally-inclined portions of the fixed die; and means for actuating said mechanisms.

33. A chain-machine comprising bending mechanism embodying a normally-fixed die having an angular face comprising on each side of its apex transversely and longitudinally inclined portions disposed in angular relation relatively to each other, and a movable link-blank bender; feeding mechanism operative to feed the link-blank a predetermined length, whereby it will be fed in a horizontal plane substantially in parallelism with the horizontal plane of the points of juncture of the longitudinally and transversely inclined portions of the die, and whereby also that part of the link-blank which is to form the link has the center of its length adjacent to the apex of said angular-faced die; and means for actuating the link-blank bender to thereby bend said link-blank centrally of its length into angular relation relatively to said die.

34. A chain-machine having bending mechanism comprising a normally-fixed die with an angular face and a movable link-bender;

feeding mechanism operative to feed the work a predetermined length, whereby that part thereof which is to form the link has the center of its length adjacent to the apex of said die; means for actuating the link-bender, to bend said link-wire centrally of its length into angular position relatively to said die; loop-bending mechanism operative to engage the ends of said bent link-blank and simultaneously form the loops thereon; and means for actuating said loop-bending mechanism.

35. A chain-machine comprising feed mechanism operative to feed a wire a predetermined length; means for simultaneously bending or curling the ends of the link-blank into loops; and means for carrying a completed link into the loop bending or curling path of the next link-blank, whereby the links are united to form a chain by bending or curling a partially-formed loop of the uncompleted link-blank through a loop of the completed link.

36. A chain-machine comprising feeding mechanism operable to feed a wire a predetermined length; means for bending the link-blank centrally of its length; means for bending or curling the ends of the link-blank into loops; and means for carrying a completed link into the loop bending or curling path of the next link-blank, whereby the links are united to form a chain by bending or curling a partially-formed loop of the uncompleted link-blank through a loop of the completed link.

37. A chain-machine embodying means for bending or curling the end of a link-blank into a loop and means for carrying a completed link into position to have its loop in the path of bending or curling of said link-blank, whereby the link and link-blank are united by bending or curling the partially-formed loop of such blank through the loop of the completed link.

JOHN H. DOOLITTLE.

Witnesses:

PORTER L. WOOD,
EMELINE DOOLITTLE.