F. EGGE.

Manufacture of Sheet-Metal Chains.

No. 202,528. **Patented April 16, 1878.**

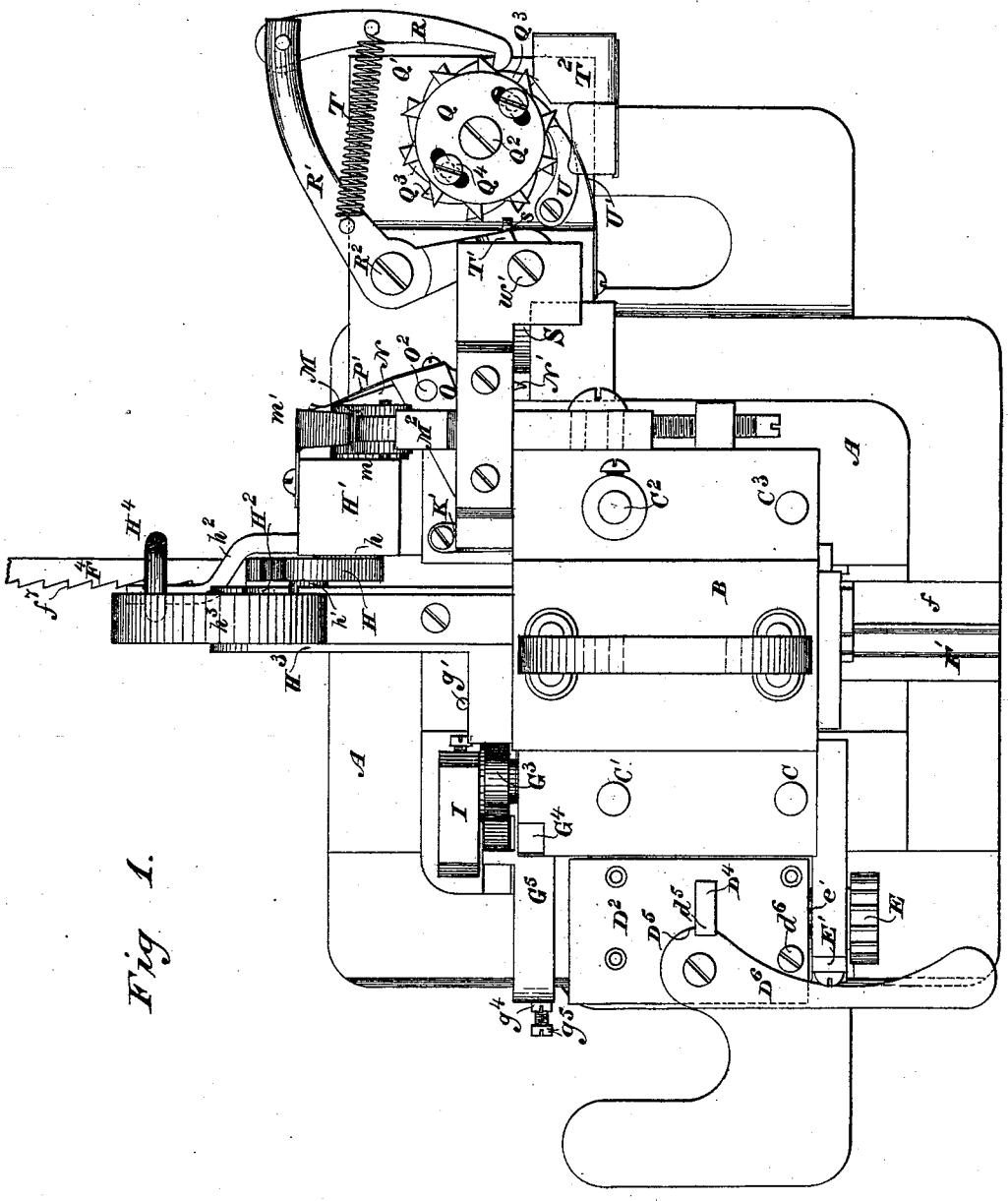

Fig 1.

WITNESSES

Wm A. Skinkle

Geo W Breck

INVENTOR

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By his Attorneys.

Baldwin, Hopkins & Peyton

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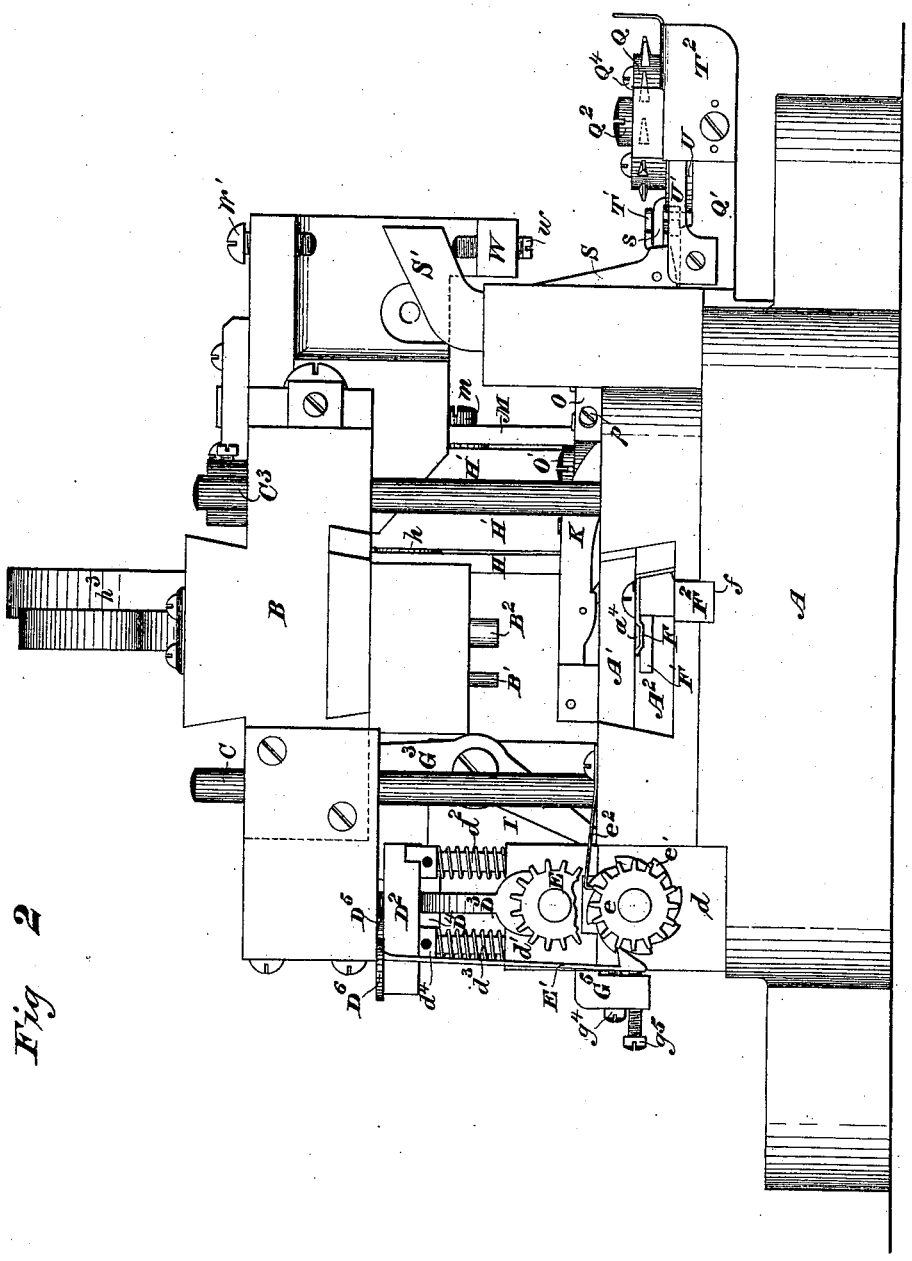

Fig 2

WITNESSES

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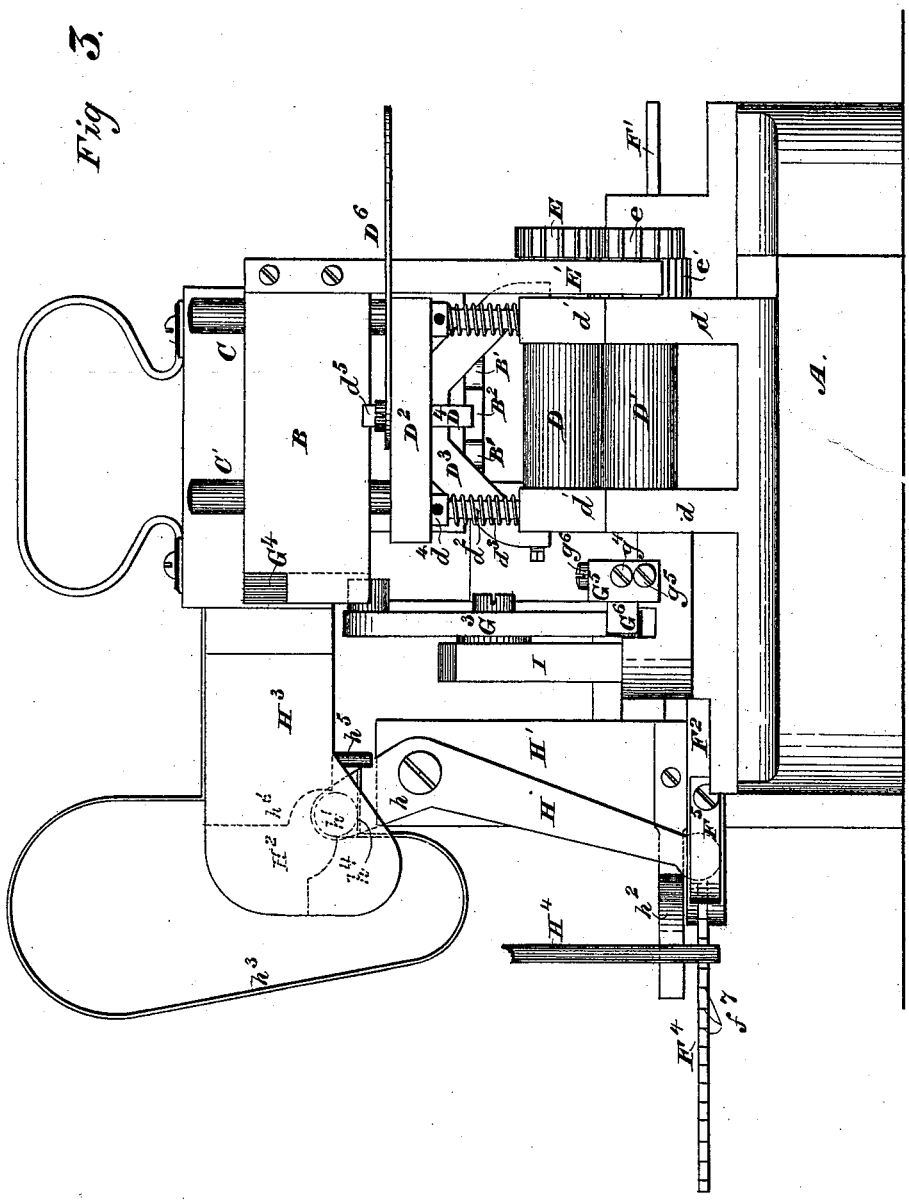
Fig 3.



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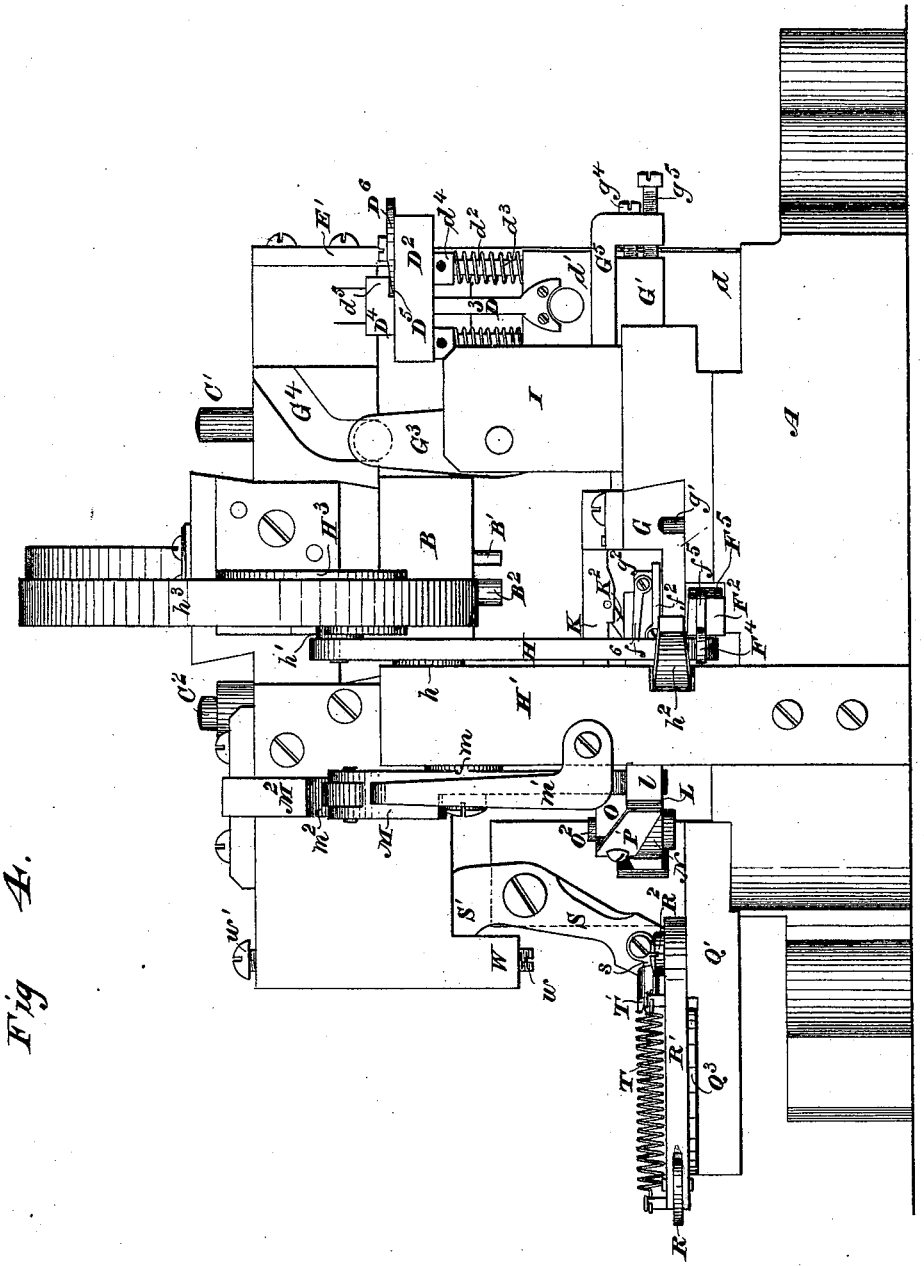

Fig 4.

WITNESSES

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Fig 5.

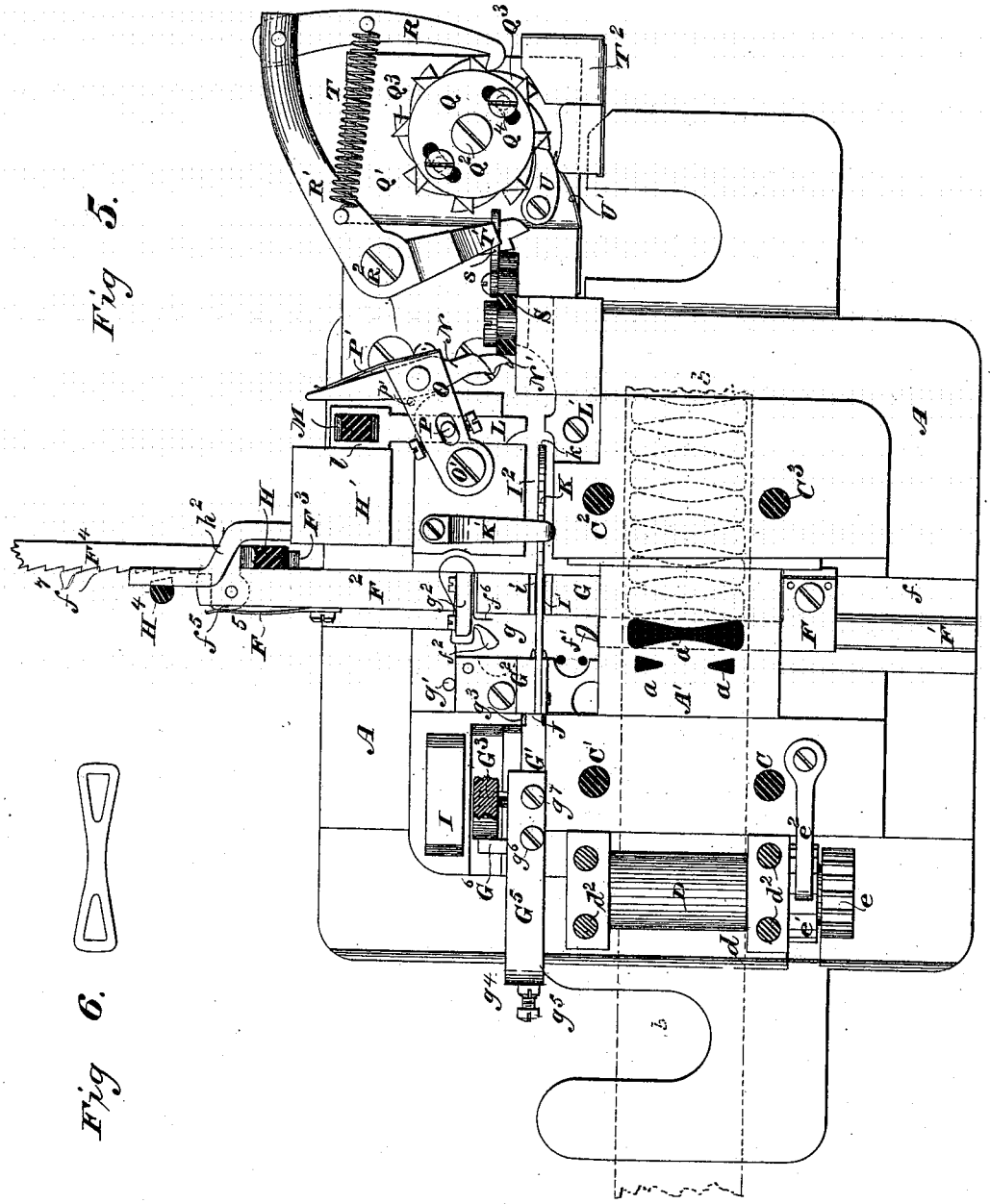

Fig 6.

WITNESSES

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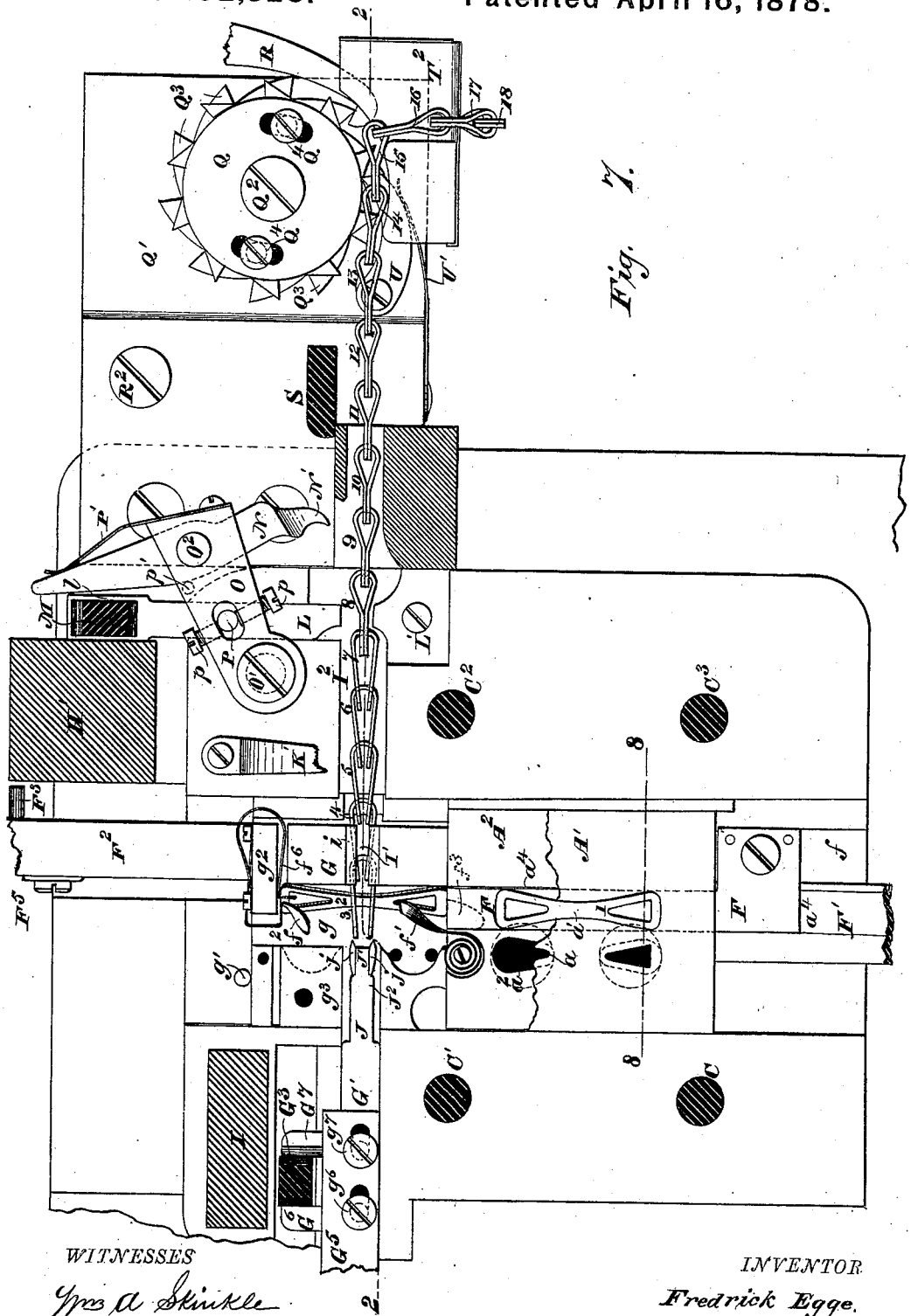
Fig. 1.



WITNESSES

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11 Sheets—Sheet 7.

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Manufacture of Sheet-Metal Chains.

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Fig 8.

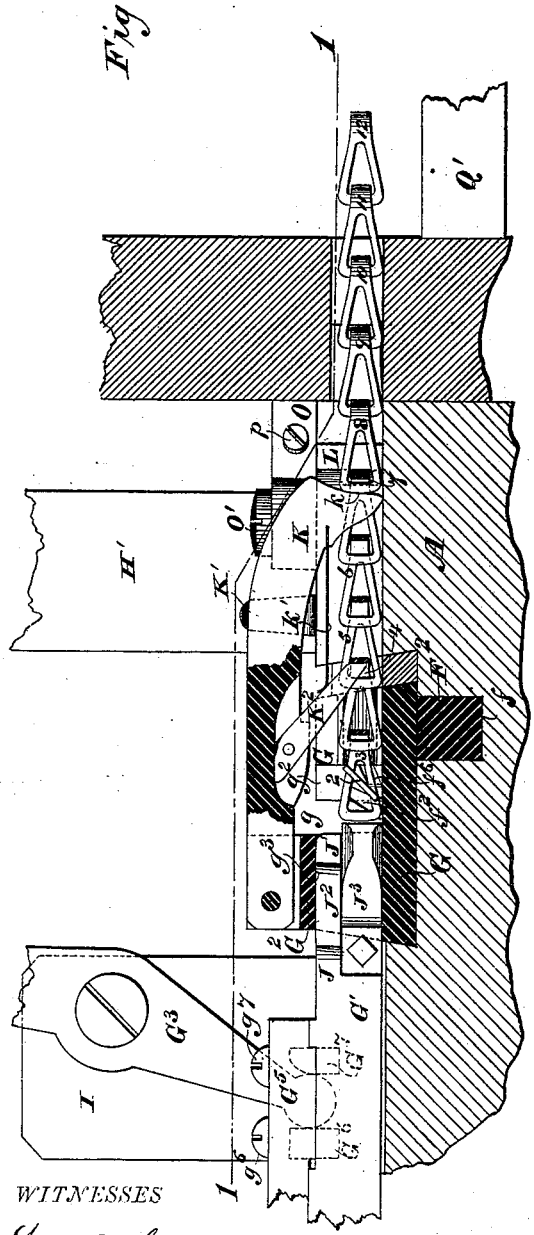
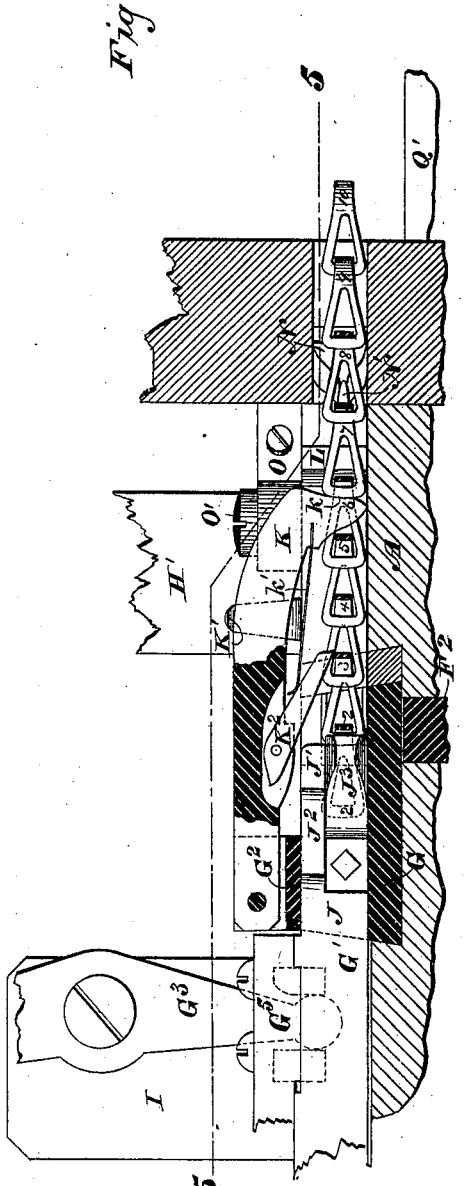


Fig 12.



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11 Sheets—Sheet 8

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Manufacture of Sheet-Metal Chains.

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Fig 9

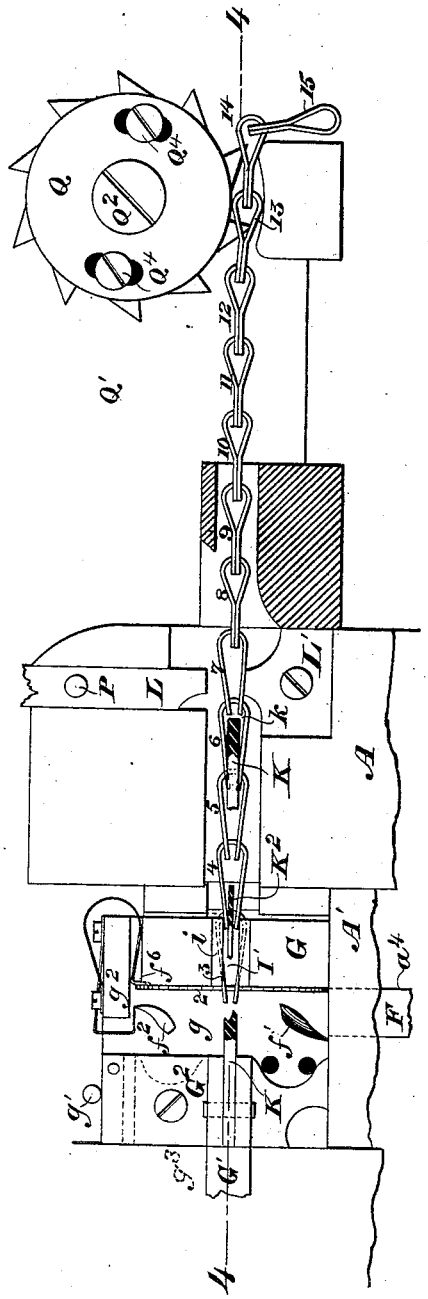
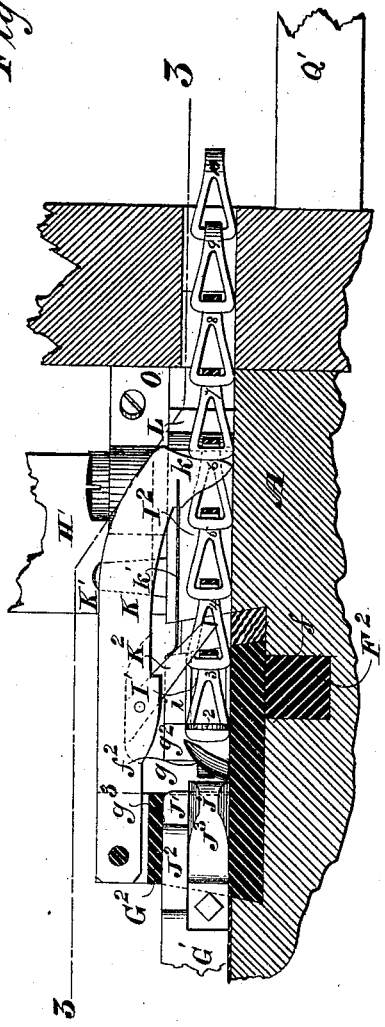


Fig 10.



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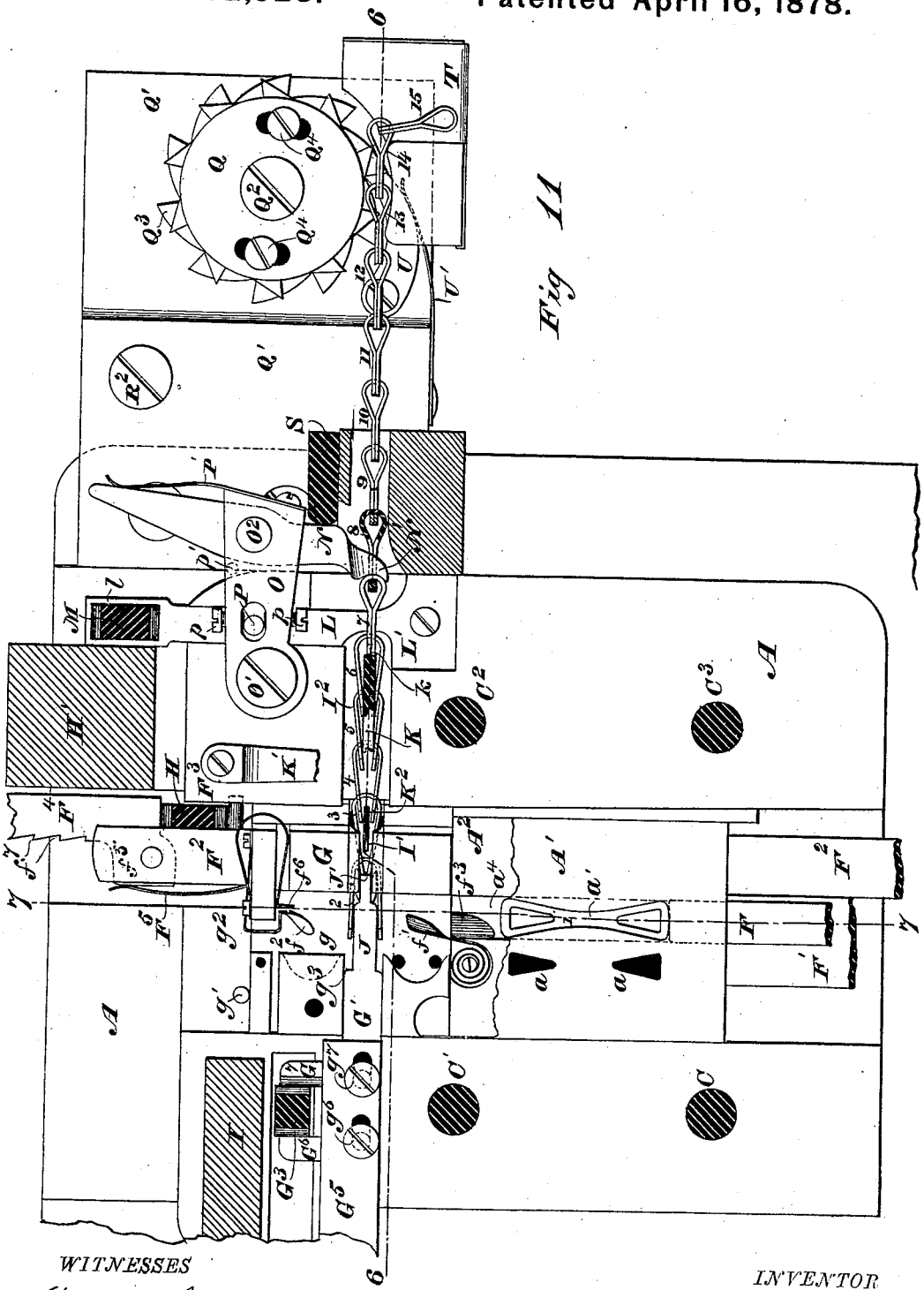

Fig 11

WITNESSES

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Fig 13

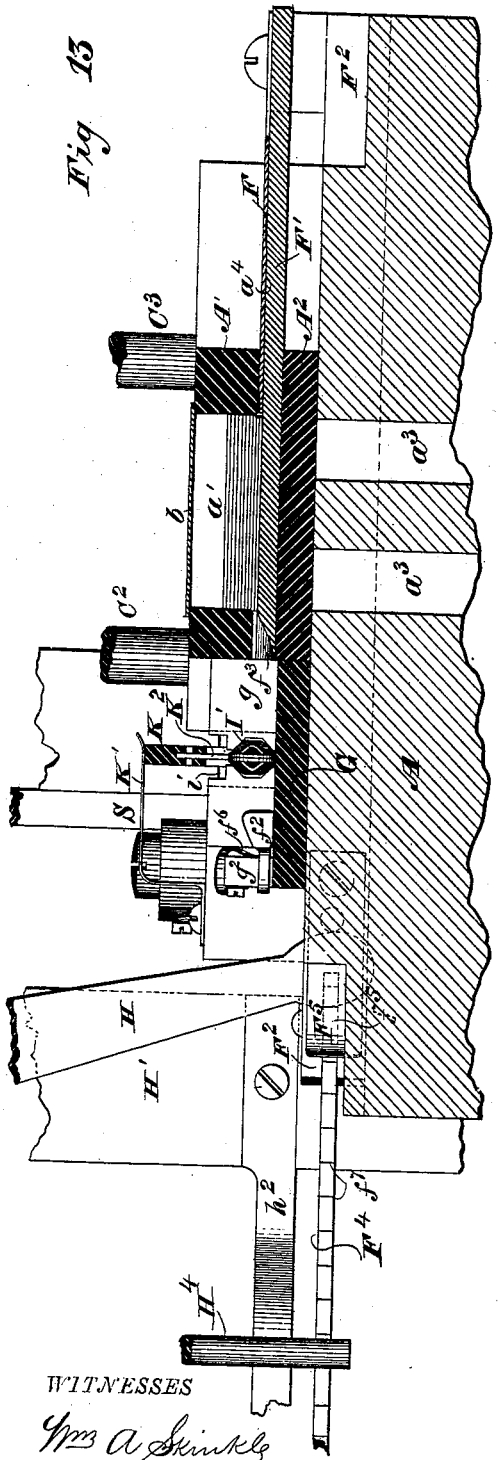

Fig 15.

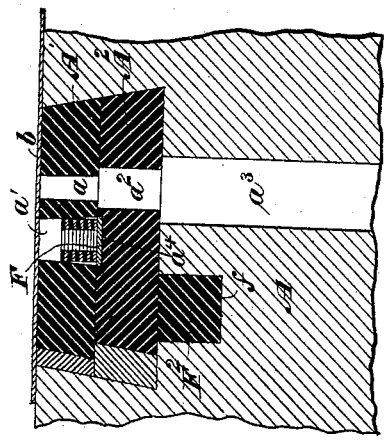

Fig 14.

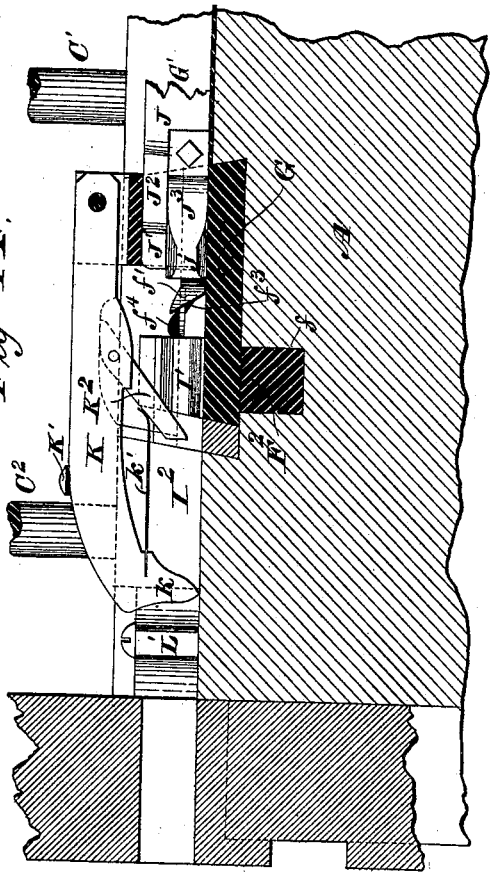

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Fig 16.

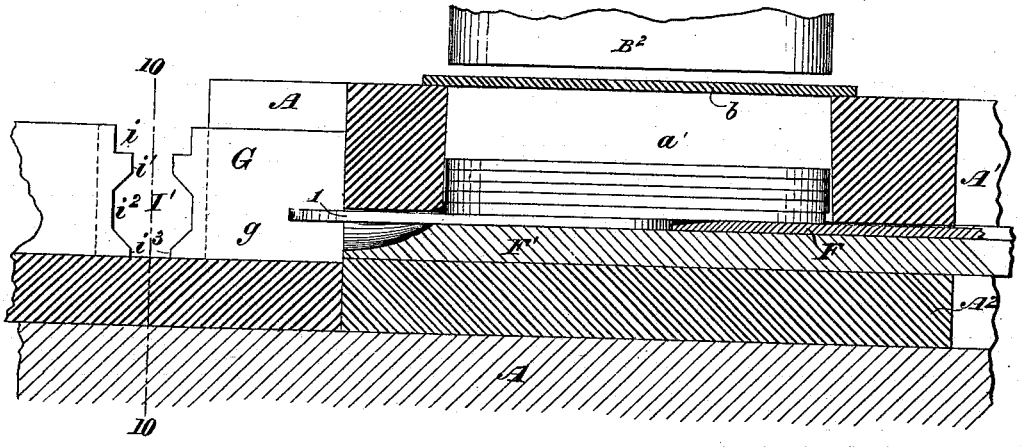


Fig 17

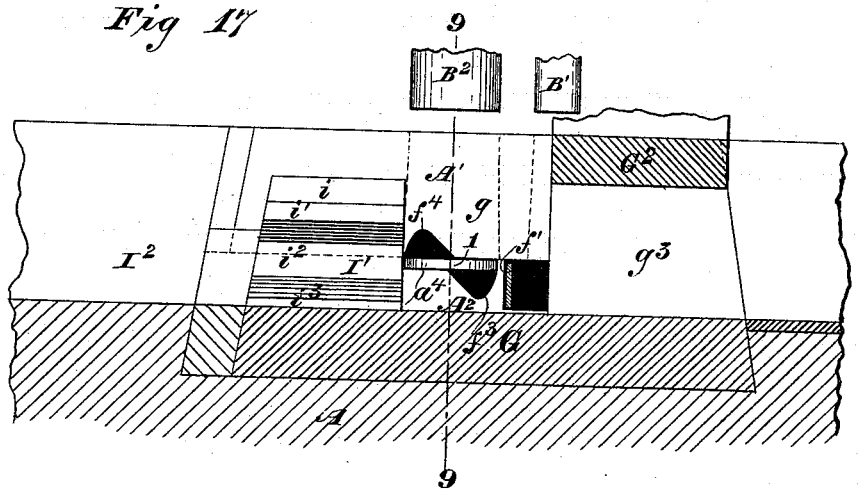


Fig 18

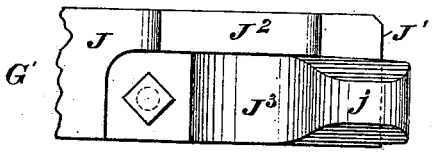
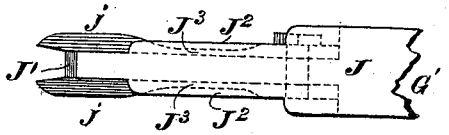


Fig 19.



WITNESSES

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Geo W Breck.

INVENTOR

Fredrick Egge

By his Attorneys,

Baldwin, Hopkins & Peyton.

UNITED STATES PATENT OFFICE.

FREDRICK EGGE, OF BRIDGEPORT, CONNECTICUT, ASSIGNOR TO THE SMITH & EGGE MANUFACTURING COMPANY, OF SAME PLACE.

IMPROVEMENT IN THE MANUFACTURE OF SHEET-METAL CHAINS.

Specification forming part of Letters Patent No. **202,528**, dated April 16, 1878; application filed December 21, 1877.

To all whom it may concern:

Be it known that I, FREDRICK EGGE, of Bridgeport, in the county of Fairfield and State of Connecticut, have invented certain new and useful Improvements in the Art of and Apparatus for Manufacturing Sheet-Metal Chains, of which the following is a specification:

My invention relates to the manufacture of chain from sheet or plate metal links. My objects are rapidly and economically to form the chain, and automatically to produce a strong, neat, and uniformly-finished chain, without welding or riveting, from a sheet or sheets of metal.

My improvements, in the first place, and mainly, consist in a novel art of manufacturing chain, as will hereinafter more fully be set forth, by the connected and successive and repeated operations of continuously-operating mechanism, which first forms the separate flat partially-shaped and unbent links thereof from sheet or plate metal; next, brings these links, one at a time, and in proper position, to a point at which they are to be united with each other; then connects them by looping or bending; and, finally, completely shapes the links, one after another, to form the chain.

My improvements also consist in novel methods of uniting and interlooping or bending the links, and of completely forming or shaping the links and finishing the chain; and, further, in certain novel organizations of mechanisms and in combinations of devices, which will hereinafter first be described, and then specifically be designated by the claims.

The accompanying drawings represent with sufficient fullness those portions or features which it is deemed necessary to show of a suitable organization of mechanism for carrying out my invention, all my improvements or means for carrying them out being illustrated thereby, in connection with an ordinary vertical press.

Some of my improvements obviously, however, may be used without the others; and the invention, in part or parts, be carried out by mechanism differing somewhat from that therein shown and herein described, especially as to details of construction.

Some of the changes which may be made without departure from the spirit and scope of my invention will be mentioned herein, while others more obvious would be suggested to a skillful workman, or one skilled in the art to which my invention pertains, simply by reading this specification and examining the drawings, in which—

Figure 1 is a plan or top view, Fig. 2 a front elevation, Fig. 3 an elevation of left-hand or receiving end, and Fig. 4 a rear elevation, of the machine. Fig. 5 is a plan view of the die block or bed with the "gate" and parts carried thereby removed, and the controlling uprights or guide-posts on which the gate slides in section.

The preceding figures are on a scale somewhat smaller than those which follow, and do not show the chain.

Fig. 6 is a view of one of the flat partially-shaped links, as it is left by the punches and before it is connected with and bent into its place in the chain. Fig. 7 is a plan or top view of the die-bed, partly in section, on the line 1 1 of Fig. 8, with that portion of the mechanism mounted thereon which participates directly in uniting and bending the links and shaping the chain (shown in position) made from the flat partially-shaped unbent links previously punched from the sheet-metal blank or strip; Fig. 8, a vertical longitudinal section of the same on the line 2 2 of Fig. 7. Fig. 9 is a plan view, with portions broken away, and in section, as partly indicated by the line 3 3 of Fig. 10, with the chain and parts lying adjacent thereto similar, as far as shown, to Fig. 7, except that the chain is represented in the position which it is caused to assume immediately before a link is bent and united to the previously and last bent link, which, in Fig. 7, is shown as drawn back or retracted for the passage through its ends of the partially-shaped flat or unbent link; Fig. 10, a vertical longitudinal section on the line 4 4 of Fig. 9. Fig. 11 is a plan view, partly in section, on the line 5 5 of Fig. 12, and generally similar to Figs. 7 and 9, showing the chain and parts operating thereon in the position assumed during the period that a link is compressed endwise to finish it, and at the time the bending

of the last-connected link takes place; Fig. 12, a vertical longitudinal section on the line 6 6 of Fig. 11. Fig. 13 is a vertical transverse section through the dies and bending-block on the line 7 7 of Fig. 11, showing the flat-link feeding devices. Fig. 14 is a vertical longitudinal section through the center of the bending-block on the lines 2 2 of Fig. 7 and 4 4 of Fig. 9, with the chain removed to show more clearly the construction of the parts. Fig. 15 is a vertical transverse section through the dies and bed on the line 8 8 of Fig. 7. Fig. 16 is a vertical transverse section, on an enlarged scale, through the dies and bending-block on the line 9 9 of Fig. 17. Fig. 17 is a vertical longitudinal section, on the same scale, through the center of the bending-block on the line 10 10 of Fig. 16, looking toward the ends of the dies contiguous to the bending-block. Fig. 18 is a side elevation of the bender-head or inner end of the thrust-bar, and Fig. 19 is a plan view of the same.

A die block, frame, or bed, A, of proper construction for use in connection with an ordinary vertical press or punching-machine, is provided beneath the sliding or reciprocating gate or punch-carrier B of such a press. This gate is shown in this instance as sliding upon controlling and guiding uprights, consisting of four posts, C C^1 C^2 C^3, which, for the purpose of compactness and for convenience of illustration, are represented as mounted in the die bed or block A, whereas in practice the guides or warp for the gate form, as usual, part of or rest upon the press-frame upon which the die-block is supported, outside of said block, as is well understood. The die-block is of sufficient size and of the proper shape to support the various working parts of the mechanism; and the gate B, as it is caused to slide up and down, as usual, gives, by suitable actuating devices, the desired movements to these parts, as will hereinafter sufficiently be explained.

The blank sheet, plate, or strip *b*, of proper width and thickness, of brass, copper, German silver, iron, or other suitable metal or alloy, is fed over dies and beneath punches, hereinafter to be described, by suitable feeding mechanism, shown as consisting of two rolls, D D^1, the lower one, D, being supported so as to turn in fixed bearings in standards *d*, supported on the die-bed A, and the upper one, D^1, being self-adjusting to suit the thickness of the blank *b*. This upper roll is mounted in housings or bearings d^1, movable vertically to a limited extent on uprights or guide-posts d^2, secured at their lower ends in the standards *d*, and at their upper ends fitted loosely to a cap-piece or connecting-plate, D^2, into holes or sockets in which the posts project. Expansible or compressed springs d^3 fitting around the posts d^2, bear at the lower ends upon the adjustable boxes d^1, and at the upper ends against shoulders or collars d^4, upon the posts. A yoke, D^3, is connected at its lower ends by its forks or branches with the sliding or adjustable boxes d^1, and terminates at top, or is connected at the juncture of its forks with a short upright bar or central arm, D^4, which passes through an opening in the center of the cap-piece D^2, projects slightly above the cap-piece, and has a hook or nose, d^5, beneath which works an inclined surface or cam, D^5, on the edge of the inner end of a lever, D^6, for raising the upper roll. A stop, d^6, serves to limit the movement of this lever in one direction. When the lever rests against this stop the lower portion of the curved incline or the thinnest portion of the cam is beneath the nose of the central arm of the yoke, and in this position the nose does not touch the lever. The roller D^1 is left free to be forced downward by its springs d^3, to adjust itself properly and bear with sufficient pressure upon the blank. When the feed of the blank is to be stopped, or it is to be removed, or a new blank is to be inserted between the rollers, the lever is swung around to bring the upper portion of its incline or the thickest portion of the cam beneath the nose and lift the upper roller. The posts d^2 are, by preference, provided with screw-threads at and near their lower ends, where they pass into the standards *d*, and with perforations in their collars d^4 for the reception of a rod for turning the posts, which may thus be screwed more or less into the female screws or caps formed in the standards, to increase or lessen the tension of the springs d^3 and properly adjust the cap piece relatively to the yoke and cam-lever. Set-screws may be provided in the cap-piece above the tops of the posts, so as to work through the openings therein, terminating in the sockets for the upper ends of the posts, and bear upon their tops. In this manner, as the posts are lengthened or shortened by screwing them up or down in the standards *d*, the set-screws may correspondingly be manipulated, and thus a firm support of the cap-piece upon the posts at the proper height secured. One of such screws is shown as forming the stop d^6.

The shafts of the feed-rolls D D^1 at one end extend through their bearings and carry meshing gear-wheels E *e*, which are actuated, through means of a ratchet-wheel, e^1, mounted on the shaft of the lower roll D, by a spring-pawl, E′, carried by the reciprocating gate B. Backward movement of the ratchet-wheel e^1 is prevented by a spring-pawl, e^2, is prevented by a spring-pawl, e^2, mounted on the die-bed A. Near the end of each upward movement of the gate the pawl acts on the ratchet to turn the rollers and feed forward the blank to the punches and dies for punching the links from the blank, and in the downward stroke the pawl slips over the surface of the ratchet-wheel.

Punches for cutting eyes or openings, and severing from the blank *b* the flat unbent and partially-shaped links represented by Fig. 6, are carried by the gate B, below which they project, and to which they are properly secured in well-known way. Two punches, or a two-

part punch, B^1, removes the metal to form the wedge-shaped holes or eyes near the enlarged ends of the link, and a punch, B^2, punches the link from the blank. The shapes of the punches and dies used in connection with them correspond, of course, to the shape it is desired to give the link, and will readily be understood from an inspection of the link. The dies over and upon which the blank is fed by the feeding mechanism, and in connection with which the punches operate, are removably secured in the die-bed A in any suitable and customary way, such as by wedging in place. Suitable strippers, as usually employed with blanking-dies, are used (though not shown in the drawings) to prevent the adherence of the blank sheet to the punches as they are retracted. The blank is fed forward between the strippers and the dies. The dies are preferably made in two sections or layers, A^1 A^2, thus horizontally dividing them. The upper section or plate A^1 may be said to constitute the die proper, as it is provided with the cavities or openings a a^1, respectively corresponding in shape and size with the punches B^1 and B^2, and into these openings the punches project when the gate B is at the end of its downward stroke. These openings are of a size at the surface just large enough to receive and fit snugly upon the punches, and receive both the waste pieces punched out of the blanks to form the link eyes or openings and the links. Their walls diverge or expand slightly downward or toward the bottoms of the dies, so that the links and punchings from the eyes of the links are not jammed in the dies or held by frictional contact therein, but drop freely downward. The waste pieces or eye-punchings fall through the openings a^2 in the lower section or supplementary portion A^2 of the die, and thence pass by openings or passages a^3 in the die-bed to any suitable receptacle. The links fall upon each other, with the lower one in a way or recess, a^4, formed by a groove in the under section A^2 of the die. The links are in this way brought in position to be fed forward, one at a time, by suitable means to bring them to the point where they are bent, united together, and formed into a chain. By thus making the dies in sections the accurate formation of the receiver and guideway a^4 for the links is facilitated. I am enabled, with but slight trouble, to nicely fit an intermittingly-actuated push-bar or feeder, F, in this guideway, for moving forward the links at proper intervals, and also enabled to readily so construct the die-section as to facilitate the manipulation of the links to bring them in proper position for bending, &c., as hereinafter described. The bottom of the receiver and guideway is, in this instance, formed by a plate, F^1, removably dovetailed in the lower section of the die, and projecting outward some distance in front to form a support and guide for the feeder F, by which any twisting or springing of the feeder is prevented. In event of clogging of the feedway a^4 by a bad blank, dirt, or rust, &c., this plate F^1 may be drawn out and the obstruction removed, the plate being then replaced and detachably secured by wedging or otherwise, so as to hold it in place to form the bottom of the feedway. This feeder or pushing-finger is mounted upon a sliding bar or reciprocating carrier, F^2, moving in a guide-slot, f, in the die-bed beneath the dies. The links, as they are punched, drop one upon another to the lower part of the link-die or cavity a^1, in which they rest, with the lowermost one supported directly upon the plate F^1 or bottom of the guideway a^4. This way is covered by the upper section of the die, as shown, thus forming it into a channel open only at the ends, and where it is intersected at right angles by the link-die opening or cavity a^1. This link-receiver and feeding-way or channel is made slightly wider than a link. It is also of a depth a little greater than the thickness of a link; or, in other words, the space between the plate F^1 and the under surface of the upper section A^1 of the die is a little more than is absolutely necessary to allow of the link being pushed through the channel.

It is necessary to give the links a quarter-turn to bring them from a position with their sides or broad surfaces horizontal as they reach the feeding-channel to one in which their edges are horizontal and their sides vertical. This turn of each link takes place just previous to the bending of the link to interlock it with a previously-bent one, as hereinafter to be described, and is in part accomplished during the latter part of, and at and immediately after, the completion of the traverse or feeding movement of the link, in this instance by the means and in the manner following: At the inner edge of the die, and at the side of the link-guideway and feeding-channel a^4, is a spring, f^1, coiled in a recess or seat in the lower die-section just at the edge of the channel a^4. Its free end is widened or flattened out, forming a yielding finger, which projects crosswise of the channel and beyond its termination, and intersects the line of travel of the links diagonally and at an inclination to the perpendicular, operating upon them in turn as they are moved forward by their feeding mechanism. The broad end of the spring inclines inward from bottom to top, so that its upper edge projects inward across the path of the links to a greater extent than its lower edge. This spring-finger projects into what I term a "bending-block," G, where the links are engaged with each other and bent. The links pass from the feeding-channel a^4 into a receptacle formed by a recess or chamber, g, in this block, in line with said channel. The bottom of this recess is below the level of the channel, so that the link, upon leaving the channel, drops downward slightly. At the end of the bending-block chamber opposite that into which the spring f^1 projects is another spring, f^2, projecting crosswise of the chamber, so as to intersect the path of travel of the links in

a similar manner. This second spring projects outward into and crosswise of the chamber, both diagonally and at an inclination to the perpendicular, in the same way as the spring f^1. These two springs act on the opposite ends of the link, and give it, by the aid of a third spring, f^6, a partial turn.

Owing to their peculiar shape, arrangement, and inclination, the springs f^1 f^2 bear edgewise and slightly downward upon the link. This action gives the link a tendency to move both horizontally and vertically away from the springs, and, in connection with the spring f^6, results in giving each link the necessary turn.

The spring f^6 serves to support the foremost end of the link while being turned. It is located at the same end of the bending-block chamber as the spring f^2. It is very thin, is bent, as shown by the drawings, projects at its end in the direction of the length of the link, bears edgewise on the bottom of the chamber, and is inclined or beveled from bottom to top, and brought to a point at its extreme end. Near the finish of the feed movement of the link it bears on the under side at one end, and about midway of its width, (or it may be somewhat nearer its edge, opposite that operated upon by the springs f^1 f^2,) upon this spring. The link is in this manner caused with certainty to turn properly—that is, the edge opposite that borne upon by the turning springs is held up as the link is rocked.

To enable the links to be acted upon by the turning springs and facilitate the gradual and proper turning of the links, notches or recesses f^3 f^4 are formed diagonally opposite each other in the bottom and top of the feed-channel, at its delivery end, (and in the upper and lower sections of the dies, respectively,) the recess f^3 being in the inner end and at one side of the bottom of the channel a^4, and the section A^1 of the dies being cut away immediately above this channel or in its top and at the opposite edge. The wide ends of the links are in this manner accommodated, and the turning of each link begins before it entirely leaves the guiding and feed channels, but after it partially enters the bending-block chamber g, and passes at one end into the eye or through the link previously bent in the bending-block, as hereinafter to be described.

Instead of the springs to turn the link, it is obvious that other means adapted to perform the turning operation may be employed. For instance, a swiveling griper or head with clamping-fingers might be so located and automatically operated at intervals as to seize the front end of each link as it is properly advanced into the recessed bending-block, give it the required turn, and then release it.

The push-bar or feeding-finger F is beveled on top at its outer end to reduce its thickness at and near the end, so as to be a little thinner than a link, fits snugly between the sides or vertical walls of its guideway or the feed-channel a^4, and is, except at its end, of about equal thickness with the links. This construction prevents the finger from acting on more than one link at a time.

To prevent jamming, and to facilitate the feeding of the links from the cavity or opening a^1 of the link-die, the bottom edge of the inside surface of the wall of its inner end (or that end next the bending-block) is tapered off or beveled for a short distance, as shown in Fig. 13, and more clearly in the enlarged view, Fig. 16.

The slide-bar F^2, which carries the push-bar or feeding-finger F of the link-feeding mechanism, passes beneath the bending-block, and projects beyond it at its end opposite that to which the finger is detachably secured a sufficient distance to be actuated through suitable connections with the gate B. In this instance the bar is operated by a vibrating lever, H, pivoted at h near its upper end to a support, H^1, projecting upward from the die-bed A. This lever is shown as bent near its upper end, but straight for the remainder and greater portion of its length. It carries at top a roller, h^1, which enters a cam-track or recess, H^2, in an overhanging portion, H^3, of the vertically-sliding gate B. The lower end of the lever works between a stud, F^3, on the bar F^2 and the heel or inner end of a spring-tripping arm or latch, F^4. On the advance stroke of the carrier-bar the lever bears against the heel of the bar F^4, and on the retracting stroke, against the stud F^3. This stud serves also as a stop to limit the movement of the bar F^2. This tripper-bar is pivoted at its heel, so as to be capable of swinging horizontally, by a side projection or lateral lug, f^5, in the forked end of the carrier-bar, and a spring, F^5, secured upon the side of the carrier, bears against this lug. In its normal position the swinging tripper or latch is held straight, or in line with the carrier F^2; but should any obstacle, such as an imperfect link, or dirt, or other foreign clogging matter, interfere with the free forward movement of the slide or carrier, pressure of the lever upon the heel of the tripper at one side of its pivot sufficient to overcome the spring-pressure throws the tripper round sidewise, and leaves the lever free to move to the usual extent without moving the slide-bar, and at once prevents injury to the link-feeding mechanism. At the same time the movement of the gate is arrested, and the machinery stopped, by the disengagement of a hooked or shouldered rod, H^4, which hooks at its lower end under a bent arm, h^2, and is connected above in well-known way with clutch mechanism, which controls the connection between the driving-shaft, through which the gate is moved, and the motive power for revolving the shaft and actuating the press common in such machines, and well understood.

The tripper has ratchet-teeth f^7 upon its edge, which abut, as it swings round, against the hook H^4, and quickly and positively throw it out from the holding-arm h^2, to at once stop the revolution of the driving-shaft

and movement of the gate, and thus avoid damage to the mechanism. After inspection, and removal of the obstacle the tripper is swung back into position, the hook H^4 secured under the arm h^2, and the machinery again starts.

The roller h^1 of the lever for operating the link-feeding mechanism enters upon the horizontal bottom portion of the cam-track H^2 upon the upward movement of the gate and moves the lower portion of the lever outward, to actuate the slide-bar carrying the link-feeding finger. The full outward movement of the lever (by the movement inward of its upper bent end) is imparted to it, however, before the gate reaches the limit of its upward stroke, and causes the end of the feeder or push-bar F to just enter slightly into the chamber of the bending-block. To prevent the cam from continuing to operate upon the lever, its roller must be left free, so as to remain stationary during the remainder of this part of the gate's stroke. It is also desirable to give a quick and uniform movement to the feeder throughout its advance stroke. I accordingly make a portion of the cam-track (the terminus of its horizontal surface, which the roller moves upon during the finish of the outward swing of the lever) yielding, so that after the lever has been given its full outward swing, it remains for awhile in that position, while the gate continues to ascend.

A spring, h^3, is fastened at one end to the overhanging arm H^3 of the gate, curved, and then bent horizontally at its opposite end to form the yielding termination h^4 of the cam-track H^2, upon which spring portion of the track the roller moves at and near the end of the movement given the lever H on the upstroke of the press. This spring is strong enough to sustain the inconsiderable pressure upon it of the roller during the time the feeding mechanism is being operated, and until the requisite swing has been imparted to the lever; but after this time the spring yields as the gate continues to move upward, and the roller, lever, and slide-bar remain stationary. The end of the spring bears against and is guided, as it yields and again moves back to its normal position, by a stud, h^5, projecting downward from the arm H^3.

When the gate moves downward the spring resumes its normal position to form the terminating portion of the horizontal part of the cam-track, and the portion h^6 of the track acts on the roller to swing the lever backward and inward, to return the slide-bar of the feeding mechanism in position to repeat its forward movement to feed a fresh link to the bending-block. Instead of this spring h^3, having the yielding bent end h^4 to form a portion of the cam-track, it is obvious substitutes for this spring might be employed. For instance, that portion of the track shown as formed by the spring end h^4 might be formed by a yielding block capable of sliding downward to the required extent in guide-grooves, and held up, at the proper time to form the terminating portion of the track, by a spring or springs; or the horizontal portion of the track, or a section of it, might be formed by a pivoted piece held up, when required, by a spring, and allowed to swing down when the roller reaches the end of its inward movement.

By the employment of the spring h^3 h^4, or equivalent devices, it will be seen that a regular movement is imparted to the feeding-finger F, instead of a variable movement, or one slowing up at the end of the advance stroke, such as would be the result of the operation upon the roller h^1 of a vertical track or cam-groove at the termination of the horizontal track. Were the roller operated upon by such a vertical track, a longer time would be required and a larger portion of the upstroke of the press-gate be consumed in giving the requisite movement to the lever, as it would obviously take more time for the roller to traverse in a curved path (long enough to give the requisite movement to the feeder) from the horizontal to the vertical part of the track than to travel in a straight line, and be left in proper position upon the spring at the end of the movement imparted to the lever to occupy the vertical part of the track on the continued upstroke of the gate.

With a press having a gate of longer stroke than the one shown the spring might be dispensed with; or by a change of the lever-fulcrum, so as to bring it nearer the roller, a more rapid feed might be imparted to the flat links, and the spring also omitted, while still leaving time for the subsequent operations on the upstroke of the gate; but I prefer the spring cam-track, even with a press having a gate of longer and ample stroke, as a guard against accident.

The bending-block or receptacle G, into which the flat links are fed from the channel a^4, and in the chamber g of which they are bent or looped together to form the chain, is secured upon the die-bed A, in suitable manner, so as to abut at its receiving end or edge against the die-sections A^1 A^2, with its chamber for the links in line with the feeding-channel, as before explained. The links are turned in their chamber, as already described, and each link, when it enters this chamber, and while flatwise or before turning, is threaded in or passed through the eye or opening of a previously-bent link projecting into the chamber, so as to intersect the path of the flat link, and subsequently linked in place or connected with said bent link by bending or looping.

The description of suitable mechanism by means of which the required operations are performed upon the links in the bending-block comes next in order; but that this part of my invention may more readily be understood, I will state at this point that the difference between the flare of the bottom of the bending-block chamber or link-receptacle and that of the bottom of the feed-channel a^4, which, as before mentioned, is located above the cham-

ber, is equal to half the width of a link at its ends or widest parts. The central and narrowest part of a link is of a width somewhat less than half that of its ends. The eyes or end openings in the links are of the form of an isosceles trangle, or wedge shape, with the short sides of the triangles or wide ends of the openings next the links' ends, and the points or narrow parts of the openings nearest the center or narrow part of the link. The length of these openings, or their area lengthwise of the links, is somewhat greater than the width of the ends or widest parts of the links, and the width of the openings at their widest parts (next the links' ends) is greater than the width of the central or narrowest part of the link. The flat link, Fig. 6, shows this construction clearly. The link ends are preferably rounded, as shown, to facilitate their connection or the threading of the one with another, and the wide ends of the eyes or openings made straight from side to side, to afford a firm square hold and strong bearing of one link of a chain upon another.

To prevent any movement of the bending-block away from the dies, and to hold it in proper position relatively to the finished and partly-finished chain, a stop-pin, g^1, is provided, against which that end of the block farthest from the dies abuts. Instead of a fixed stop-pin, as shown, an adjustable stud, provided with a base, and detachably secured in place by set-screws, might be employed. At the opposite end of the chamber g of the bending-block to that at which the link first enters is a shoulder, g^2, terminating the chamber, and against which the foremost ends of the links abut when they are fed to their proper position in the chamber. The turning-spring f^2, before described, is located close to this shoulder or end of the chamber, as is also the spring f^6. Midway of the length of the bending-block chamber it is intersected by a groove, g^3, which is formed in one of the side walls of the bending-block, and terminates in the chamber at a right angle to it, and with its bottom in the plane of the bottom of the chamber. This groove is opposite to the central part of a link when one has been fully entered into the chamber in position to be bent at the side of the chamber next the wall of the block opposite to that in which this groove is formed.

A link-bender carrier or endwise-reciprocating thrust-bar, G^1, is moved back and forth crosswise of the chamber g. It works in the groove g^3, which serves as a guideway for it, and prevents sidewise and downward movement from its proper path. Upward movement of the thrust-bar is prevented by a cap-piece or cover, G^2, forming the top of the groove. The thrust-bar is actuated by the gate through a vibrating lever, G^3, acted upon by a cam-track, G^4, or recess with inclined walls. This lever is pivoted about its center to an upright, I, on the die-bed A, and carries a roller at its upper end to work on the cam-inclines. The advance stroke of the thrust-bar to bend a link takes place during the latter part of the downward movement of the gate, and its advancing movement commences at the time of the finish, or slightly before the finish, of the retracting-stroke of the finger F of the flat-link feeding mechanism.

The retraction of the thrust-bar takes place on the first part of the upstroke of the gate, and its retrograde stroke has been nearly or quite completed before the forward movement of the feeder F commences, so that the bending-head is out of the way of the link fed into the chamber of the bending-block. At the latter part of the upstroke of the press the pawl E′ operates the feed-rollers to move along the blank b, to have a fresh link served to replace the one first fed to the bending-block and keep up the supply of flat links.

The bender-head or link-bender proper, which will more particularly be described hereinafter, is formed at the outer end of the thrust-bar, and the thrust-bar is detachably and adjustably connected with a clamping-bar or holder, G^5. This holder is formed with a downward projection or bend at its outer end, through which pass two screws g^4 g^5.

The screw g^4 passes through a smooth hole or tap in the end of the holder, and enters a female screw or screw-tap in the end of the thrust-bar. When properly adjusted this screw serves to prevent endwise movement of the thrust-bar, such as could otherwise be produced by a pull. The screw g^5 passes through a female screw or tap in the end of the holder and abuts against the push-bar, thus serving to prevent movement by end thrust or pushing strain.

Adjusting set-screws g^6 g^7 pass through vertical slots in the holder-bar and enter the thrust-bar. These screws serve to draw the bars together. Upon the under side of the holder is a shoulder, which enters a recess in the top of the thrust-bar. The adjustment of the thrust-bar is thus limited, and may properly be gaged.

Lugs G^6 G^7 upon the side of the holder-bar receive between them the lower end of the lever G^3, which, as it is swung in and out, reciprocates the thrust-bar or link-bender, as before explained.

In and extending through the side wall of the bending-block G which forms the boundary of the chamber g on the side opposite that in which the thrust-bar guideway g^3 is formed is a bending channel or recess, I^1, into which the flat links are forced by the thrust-bar and bending-head from the position in which they are left by the feeding mechanism and turning-springs, before described. This bending-cavity I^1, which receives the links as bent, is diametrically opposite the thrust-bar groove g^3. Its bottom is flush with the bottom of the chamber g of the bending-block, or in the horizontal plane of the bottom of this chamber and the bottom of the said groove. It is also in line with a recess or groove, I^2, formed

in the die-bed of the press, to form a guideway traversed by the chain, as will hereinafter be explained. The bending-cavity is formed so as to aid in bending and shaping the link, as will soon be explained, as shown in various figures of the drawings, but more clearly by Figs. 16 and 17. It is open at top, where, in this instance, it is shown as terminating in or intersecting a recess, *i*, in the top surface of the side wall of the bending-block chamber, against the vertical inner side or face of which wall the flat link is presented by its feeding mechanism and adjusting or turning springs. From its top downward for a short distance the cavity-walls are vertical, or nearly so, as at i^1. This vertical portion of the cavity is comparatively narrow and shallow. The width of the cavity at this point—that is, between the ledges constituting the bottom of the top recess i^1—is about four times the thickness of the link, or a little more or less than this. Beneath this narrow portion of the bending-cavity its walls diverge or incline outward toward the central and widest portion i^2 of the cavity, which has vertical walls, and is of a width much greater than that of the top part i^1—say, between two and three times as wide. This central porton of the cavity is to receive and accommodate the enlarged bowed or looped ends of the links, as will be explained at the proper time. From the central widened portion of the cavity it is contracted toward the bottom in the same manner as it is contracted toward the top from the center, and at the bottom i^3 it is narrow, and formed about as at top, except that its bottom does not terminate in an opening. In cross-section the cavity may be said to be somewhat of an octagonal shape. The depth of the cavity from the top edges of its vertical walls i^1 to its bottom is about equal to, or it may be very slightly greater than, the width of a link at its ends or widest portions; or, in other words, a link placed on one edge on the bottom of the cavity will project slightly at its top edge, at its widest part, into the top opening, or between the vertical walls i^1 of the cavity. Only at and very near the ends, however, does the link project into the top portion of the cavity, or that portion between the walls i^1. The link, it should be observed, is inclined, or tapers on its edges from the rounded widened ends both ways, or from both ends toward the narrow central part, which is formed into a rounded bow or loop after being passed through the eyes or end openings of a previously-bent link.

The bender proper, or head J of the thrust bar or carrier G^1, is formed with a wide thin end or point, J^1; is shouldered near its end for a short distance from the top by narrow ribs or side ledges J^2, beneath which, at the sides of the head, are secured spring-plates J^3, the outer ends of which project a little beyond the end J^1 of the bar G^1, and form, on each side thereof, strong lips *j j*, which are sufficiently yielding to prevent their accidental breakage should the link end fail to give, as will be described hereinafter. These springs are detachably secured, near their rear ends, in suitable recesses at the sides of the thrust-bar, and abut firmly at their rear against shoulders thereon. The upper part of the end or thin portion J^1 of the bender-head J works on the advance stroke of the thrust-bar between the top walls i^1 of the bending-cavity I^1, while the spring-lips work in the wide or central portion of the cavity. These lips are shown as beveled on their top and bottom edges, and so formed otherwise as to adapt them to work properly in the cavity. The spring-plates are also shown as recessed or thinned away between the lips and screw which attaches them to the thrust-bar, to give them the requisite spring.

The bending of the flat links in the bending-block is accomplished by the bending-head, in connection with the bending-cavity, in the following manner: The link last bent by the previous advance stroke of the bending-head, and then slightly drawn back by it on the first part of its retracting stroke, in the manner presently to be explained, so as to partially project from the cavity into the chamber *g*, with its sides or broad surfaces vertical and intersecting at right angles the path traversed by the flat links, as shown by Figs. 7 and 8, has the flat link passed or threaded through its eyes or openings by the feeder F, and is partially turned—say, to an angle of about forty-five degrees, as before described. The thrust-bar G^1 is now advanced, bringing the bending-head J against the flat link, the turning of which to bring it flat against the inner side of the wall of the bending-block in which the bending-cavity is formed is first completed by the pull of the chain or previously-connected link, as hereinafter explained (see Fig. 9,) and then, by the continued advance of the bending-head, its lips *j* are caused to embrace the ends of the last-bent link, and its point J to bear against said ends. The flat link is now forced into the bending-cavity and bent or formed into a loop, and thus connected with the previously-bent link.

It should be noticed that the ends of a link thus bent into a U shape have a tendency to separate or spring apart.

Should the lips *j* of the bending-head abut against instead of embrace the ends of the bent link when first coming in contact with them on the advance stroke, these ends will, nevertheless, soon be inclosed by the lips, which should be slightly beveled in the inner sides of their ends; for the link, when forced into the bending cavity has its ends brought nearer together by their contact with the walls of the narrow top and bottom portions i^1 i^2 of the cavity, and the lips are thus caused with certainty to embrace the link ends and bear against the link to be bent while the point J^1 bears upon the ends of the already-bent link embraced by the lips.

The narrow portion of the link, at the point where it is doubled or bent, does not come

against the narrow top and bottom parts of the cavity, but occupies the central enlarged portion thereof, and the link consequently is not crowded together injuriously at this part.

On the retraction of the bending-head at the return stroke of the thrust-bar, the link just bent is drawn back crosswise of the chamber, and with its sides vertical to the position shown in Figs. 7 and 8, by frictional contact of its ends with the spring-lips, or rather by the griping or clamping of the link ends on the springs. This leaves the eyes or openings in the last bent link in position to receive the flat link next fed forward into the bending-block chamber.

It is obvious that, should anything get between the ends of the bent link, the breakage of the lips *j* (which would, if they were rigid, be the result of forcing them over these ends) is avoided by the yielding of the lips to accommodate themselves to the increased distance apart of the link ends, or their failure to yield properly.

On the finish of the upward movement of the gate B the connected and partially-finished, as well as the finished, links of the chain are fed forward a short distance in a path at right angles to that traversed by the flat links. This feed of the chain takes place just after a flat link has been threaded with or passed through the eyes or openings of a previously-bent link, and the pull of the chain leaves the flat link resting on edge in the bending-block, or flatwise against the wall of the side of the bending-chamber, in position to be forced into the bending-cavity by the bending-head, as before described.

The connected links, both finished and partially formed, of the chain pass by the recess or channel I^2 to the feeding mechanism, which operates intermittingly to give the necessary pull upon the connected links, and carries forward the finished chain.

The partially-finished connected links are thus brought in turn to be operated upon by suitable devices (soon to be described) for first compressing the links sidewise to bring their ends close together, finish the bending of them, and properly form their loops or bows, and then to upset, compress, or crush the links endwise to destroy the separating spring of the metal and the tendency of the links to open or spread at and near their ends.

During the time that a link is being finished its retrograde movement is prevented by a stop or holder, formed by a loosely-swinging arm, K, shown as pivoted at one end to the cover or cap-piece G^2 of the thrust-bar guide-way g^3, and provided at its opposite end with a nose, *k*, which fits in the loop or between the sides of one link, and serves as a firm support for the ends of the link next in advance. This arm moves vertically directly over the chain-way I^2, and is borne upon by a spring, K^1, the pressure of which gives a tendency to the arm to assume and occupy the position clearly shown in Figs. 8, 10, and 12. The rear edge of the nose is made thin, so that it may descend into the link-loop or between the link's sides, and its end or bearing-face is so formed as to afford a firm support for the ends of the link to be finished and resist end thrust thereof. As the chain is fed forward the links behind the nose in turn act upon its curved or inclined rear edge and lift it, the spring K^1 yielding to allow of the proper upward movement of the arm. A short swinging arm or pawl, K^2, is pivoted at one end to the arm K, and swings in the plane of movement thereof. This pawl serves as a stop to gage the retrograde movement of the last-formed link as it is drawn back by the griper-lips of the bending-head, as before explained. It is borne upon by a spring, *k'*, attached at one end to the arm K. On the forward movement of the chain and interlooped links the pawl is moved upward by the contact therewith of the links, and slides over them, its spring yielding to allow of this movement; and upon the return movement of the links, when drawn back by the bender-head, the pawl at the proper time drops between the sides or into the loop of a link, releases the one last bent from the spring-lips *j*, and holds it against too great rearward movement by abutting against the bent end of next to the last link, (see Fig. 8,) stopping it and the last link in the proper position to have the flat link threaded in the eyes of the last-bent link, as already explained. Obviously the bender might be so operated as to force a link into the bending-cavity just far enough to bring the bent link in the exact position for the threading through its eyes of the next flat link, and any withdrawal or retrograde movement of the link be prevented by a suitable stop, so constructed and operated as not to require the slight backward movement necessary to cause the pawl K^2 to act.

The pressing together of the link ends and formation of the bow (see Fig. 11) is accomplished by a reciprocating compressor-bar, L, operating in connection with a supporting block or anvil, L'. The anvil is located on one side of the path of the chain, and the bar moves toward and against the link from the opposite side, being guided and supported in its movements in a recess in the die-bed. The link, during this operation, is held in the proper position by the nose *k*. The compressor-bar is operated by the gate B during the first part of its downstroke through suitable connections, which, in this instance, consist of a vertical vibrating lever, M, pivoted at *m* to a standard, H^1, of the die-bed A. The lower end of the lever is connected with the reciprocating compressor by a slot or loop, *l*, at its outer end. A strong spring, m^1, secured at one end to the standard H^1, bears at its opposite end upon the lever above its pivot. The tendency of the lever, owing to the pressure of this spring, is to swing inward at top and outward at bottom, to retract the compressor-bar. A projecting portion, M^2, on the gate operates upon the upper end of the lever to rock it outward

and throw in its lower end to advance the compressor. A cam or incline, m^2, against which the lever is forced inward at top by the spring, and which serves to rock it, as above described, admits of the retraction of the compressor a little before the completion of the upstroke of the gate, and at this moment the feed or pull of the chain takes place.

The upsetting of the links by compressing or slightly crushing them endwise, to finish them and destroy the tendency of the links to separate or spring apart at their ends, takes place at the finish of the downward stroke of the gate. Mechanism for accomplishing the result desired is shown in this instance as consisting of a swinging arm or compressor-lever, N, having a curved nose or bill-hook, N′, at its end, which is shaped to fit snugly around the head or loop of a link. (See Fig. 11.)

This compressor-lever has the movement imparted to it necessary to bring it into its operative position and retract it from the gate through connections with the endwise-moving bar L, for compressing the links sidewise at their ends. A swing-arm or carrier, O, for the compressor-lever is pivoted at its inner end O^1 to the die-bed, and the lever is supported by a pivot, O^2, at the opposite end of the arm. A stud, P, on the bar L works in an elongated slot in the carrier, and set-screws *p p*, working in the carrier at each side of the slot, and bearing at their inner ends against, or nearly against, the stud in the slot, serve to adjust the carrier to regulate the movements of the compressor-lever, should it be necessary to do so, as well as to compensate wear.

A spring, P^1, secured at one end to the outer end of the carrier O, bears at its opposite end against the rear or outer end of the compressor-lever with a tendency to keep the lever against a stop, *p′*, on the carrier until its nose enters the eyes of the link immediately in advance of the link being acted upon by the reciprocating or sidewise compressor L, and rests against the bow end of the link held by said bar against the anvil. At this time the link to be compressed is supported at the opposite end by the nose *k* of the holder or swinging arm K, as before described. In its normal position the compressing-lever bears against this stop; but when its nose N′ is advanced or forced against the link in upsetting, the lever moves slightly away from the stop, its spring yielding to enable it to do so. The main function of this spring is to hold the lever with its nose in the proper position for adjustment in the eyes or end openings of a link previous to the time that the crushing force is exerted upon the link. Soon after the commencement of the downward movement of the gate the compressing-lever begins to swing inward, and this movement continues.

Near the finish of the downward movement of the gate the compressor-lever is struck near its nose by a moving part of the mechanism, (soon to be described,) and the compression of the link endwise to complete it takes place, and the link is finished at the end of the downstroke of the gate. The compressing-lever is withdrawn near the finish of the upward stroke of the gate.

The chain-feeding mechanism, which is operated through connections with the gate at the end of its upstroke, is shown as consisting of a sprocket-wheel, Q, the teeth of which are ratchet-shaped or straight on one edge, so as to act on the chain by entering the link eyes or openings to draw it forward as the wheel is revolved, and inclined on the other edge, which sprocket-wheel is mounted on a bracket or projecting portion, Q^1, of the die-bed, and is intermittingly and partially revolved at intervals about its axis Q^2 by means of a ratchet-wheel, Q^3, revolving about the same axis, and to which the sprocket-wheel is adjustably attached by set-screws Q^4, passing through elongated slots in the sprocket-wheel and engaging with the ratchet. This ratchet is engaged by a pawl, R, and operated at the proper time through means of a bell-crank or elbow-lever, R^1, and a vertically-vibrating lever, S. The bell-crank lever swings horizontally on a pivot, R^2, secured to the die-bed or bracket Q^1 thereof, and at its outer end is pin-jointed to the pawl R. A spring, T, connected at its opposite ends to the lever and pawl, respectively, keeps the pawl up to its work. A detent hook or pawl, U, engages with the ratchet, to prevent injurious backward movement thereof. This detent is borne against by a spring, U^1, to keep it up to the ratchet.

The lower end of the lever S moves close to or bears against the inner side or edge of the short arm or inner end of the elbow-lever; and a hook, *s*, pivoted to the lower end of the actuating-lever S, engages the inner end of the elbow-lever. As the lever S is vibrated to move it inward at its lower end the lever R^1 is drawn after it by the hook *s*, the accidental vertical displacement of which is prevented by the overhanging lip or lug T^1 on the elbow-lever. On the reverse or outward movement of the lever S, its end, bearing directly against the elbow-lever, moves it correspondingly. This latter movement causes the feed-wheel 2 to partially rotate by the operation of the pawl R upon the ratchet Q^3, while the movement imparted to the pawl at the time the hook *s* is operated moves the pawl forward for a repetition of this feeding movement. The chain, as it is drawn out by the feeding mechanism, passes, by way of a suitable channel or deflecting-guide, T^2, to a proper receptacle beneath the die-bed of the press.

The lever S is bent or provided with an inclined arm, S′, at its upper end, and this arm is struck at and just before the end of the upstroke of the gate B by an adjustable screw or stud, *w*, on a short inwardly-projecting arm or lug, W, carried by the gate, and the lever thus vibrated. On the downstroke this arm W moves close to or in contact with the outer edge of the lever, and starts to move it

in the direction opposite that in which it is moved by the stud *w* on the top of the arm W, or by the contact of the top of this arm with the lever, in event of the stud *w* being omitted. The complete inward swing of the lower end of the lever S is given at the end of the downstroke of the gate by an adjustable screw or stud acting on the top S′ of this lever, and carried by an overhanging projection, similar to W. The lower end of the lever S, on its inward swing, strikes the bill-hook N′, or the compressing-lever N, near the nose, and forces the nose against the link, to be upset or compressed endwise, as before fully explained.

To aid in the description of the operation of the mechanism, the links will be numbered from 1 to 18, as in Fig. 7, the link numbered 1 being the flat link, at the bottom of the link-die or opening a^1, and that numbered 18 being the most advanced of the links in the finished chain, and shown as leaving the machine.

In view of the description already given of the operations of the respective parts of the machine, a general description of the operation will be sufficient.

If the machine is to be worked for the first time, it will be necessary to provide a section of chain and partially-formed links sufficient to extend from the bending-block to the feed-wheel, as in Figs. 7, 9, and 11. Such a section may be made by hand, and the links may be stamped out by the machine by disengaging the feeder bar or finger F and then starting the machine, to form the required number of flat links, which may be removed from time to time until the necessary number has been secured. A number of links are left in the lower portion of the link-die, (see Figs. 13 and 15,) so that the weight upon the lower one will keep it in proper position to be operated upon by the finger of the flat-link-feeding mechanism. This finger being readjusted in position, the section of chain and bent and partially-formed links placed in position in the machine, and the machine started, the manufacture of the chain progresses automatically and continuously by the intermittent, connected, successive, and repeated operations of blank-feeding-mechanism, the punches, the flat-link-feeding mechanism, the link-turning devices, the bowing or partial-bending and retracting mechanism, the sidewise and endwise compressing devices, and the chain-feeding mechanism.

Supposing the working parts of the machine, as prepared for starting, to occupy the positions shown in Fig. 7, when the gate is very near the end of the upstroke—say, at seven-eighths of its upward movement—the parts first operated as the machine starts are the blank-feeding rollers and the chain-feeding wheel Q.

By an inspection of Figs. 7 and 8 it will be seen that the link 3 projects quite a distance into the chamber *g* of the bending-block, with link 2 threaded through its eyes and partially turned; and that there are considerable spaces between the bowed or bent ends of links 4, 5, and 6, and the eyes of the links, through which they are, respectively, passed, and with which they are interlooped, this spacing being caused by the tendency of the partially-formed links to spring open at their wide or eye ends, and slide upon the curved inner sides of the loops or bows of the links with which they are respectively connected. The ends of link 4 are held much nearer the bow end of link 3, as the ends of link 4 are somewhat compressed in the narrow top and bottom of the bending-cavity I′, and prevented from springing apart and sliding in link 3. At the time of starting the machine, link 8 occupies the position at which, in the regular order of operation, it would have been compressed sidewise by the bar L against the anvil L′, to give it the proper shape, as well as have been upset or compressed endwise by the bill-hook N′, to leave it ready to be moved forward to make room for link 7.

Toward the end of the upstroke, or during the last eighth part of the upward movement of the gate, the pawl R is caused to move the chain-feeding sprocket-wheel R a portion of a revolution equal to a distance slightly greater than one tooth, drawing the chain forward a little more than the length of a link, and to the position shown by Figs. 9 and 10. The flat link 2 is thus brought by the pull of the chain against the vertical wall of the chamber *g* of the bending-block G, and link 3 drawn into the bending-cavity, except at its ends. This movement of the link 3 a distance less than its length does not compensate entirely for the shortening of the chain by the draw of the feeding mechanism, which, as before remarked moved the chain and partially-formed links forward, between the sprocket-wheel and bending-block. The additional compensation for this shortening of the chain to allow it to be fed forward a distance a little greater than the length of a link is, however, provided for by the stretching of links 4, 5, 6, and 7, the tension on the links being sufficient to overcome the resistance offered by the spring of the links, and cause the ends of the respective links to approach each other near enough to slide in the bows of the links with which they are connected and assume the positions shown in Figs. 9 and 10. The nose *k* of the swinging-arm or holding-dog K now drops behind the ends of link 7. The tension on the chain produced by the spring of the link ends, and consequent tendency of the partially-formed links to lap or draw upon each other, will give the chain and links a slight retrograde movement, which is checked by the nose *k* of the dog K. On the beginning of the downward movement of the gate, and during about the first eighth part of this downward movement, no change occurs in any of the parts which act directly upon the chain or connected links. As the gate descends, and by the time it has completed about one-fourth part of its downstroke, the compressor-bar L and the bill-hook N′ have

advanced part of the distance traversed by them toward the chain, and the push-bar or flat-link feeder F is on its retracting movement. As the gate continues to descend, and by about the time it has reached about three-eighths of its downstroke, the compressor L will have been advanced its full stroke, and will have driven the sides of the ends of link 7 together against the anvil L′, (see Fig. 11,) and the bill-hook or nose of the end compressor N will have entered the eyes or openings in the ends of link 8 and rest behind the bow of link 7, ready to push or crush the bow when pressure is produced by the lever S.

The curving or bowing of the sides of a link by the compressor L and the endwise compressing of the link by the compressor N shorten the link somewhat. To accommodate this shortening of the chain between the feeding-wheel and nose *k* of the dog, a slight slack, checked by the detent U, is allowed.

It should be noticed that slack is provided for in two parts of the chain, and partially-formed chain—namely, between the bending-block and nose *k*, and between the compressors and feeding-wheel.

At about one-half of the downstroke the thrust-bar or reciprocating carrier G^1 of the link-bender will begin to advance across the chamber *g* of the bending-block. The flat-link feeder F will have reached the limit of its outward or retracting movement shortly after the completion of one-half of the downstroke of the gate—say, when five-eighths of this downward movement has been accomplished. At about the completion of three-fourths of the downward stroke of the gate, the flat-link bender-head will have been advanced far enough to bring its point or solid end J^1 against the projecting ends of link 3, which occupies the bending-cavity I^1, with link 2 passed or threaded through its eyes or end openings, as shown by Figs. 9 and 10.

The spring-lips *j j* of the bender-head embrace the ends of the link 3 and hold them properly up to the bender-head point. The bender continues to advance, and by the time the gate has moved down to about seven-eighths of its stroke the head or point J^1 and the yielding lips *j* will have been projected partly into the bending-recess, forcing the ends of link 3 back into this recess and bending or folding link 2 at its center, where it is held in the eyes or end openings of link 3. During the completion of the downstroke the bender continues to advance, and its head is projected some distance into the bending-cavity; and by the time the downstroke is finished, as in Figs. 11 and 12, the bending or folding operation performed by the bender, in connection with the bending-cavity, is completed, and the bow end of link 3 has been pushed to a point slightly beyond the lower end of the pawl K^2. During the time that the bender is forcing the link 3 into and through the bending-cavity link 7 is firmly held between the compressor L and anvil L′; and, to accommodate for the increased length of the connected and partially-formed links by the addition of the newly-bent link, the links are crowded together or lapped at their connected eye ends and bows, as shown in Figs. 11 and 12.

The natural spring of the links would partly accommodate for the increased length by the new link, (it being borne in mind that the connected links had been stretched by the feeding-wheel, while the link 2 was lying flat against the wall of the bending-block, and before this link had been closed upon and forced into the bending cavity;) but there is still room for crowding them together to a greater extent after the natural spring is taken up, admitting of the addition of the new link between the bending-chamber and anvil. During the last part of the downstroke of the gate the bill-hook N′ of the end compressor is operated upon by the lever S and forced against the bow end of link 7 while this link is held against the anvil L′ by the side-compressor, (see Figs. 11 and 12,) and the bow of the link is thus given an upsetting or crushing squeeze. The spring of the link ends is thus changed to cause them to bear against each other, instead of tending to separate them. While the lever S is advancing against the bill-hook, it also operates upon the pawl R to advance its end beyond the tooth of the ratchet Q^3, next that one last engaged by it, so as to be ready to cause the sprocket-wheel to repeat the pull on the chain at the proper time. At the finish of the downstroke a flat link is punched from the blank, and at the same time the eyes are punched from the blank for the next link. Upon the starting of the upstroke, and during the first eighth part of this movement of the gate, the bender-carrier or thrust-bar G^1 commences to withdraw to retract the bender-head, slightly drawing back with it the link 2. At the same time the lever S, being released from the pressure upon its top of the stud *w′* and free to rock, the spring P′ of the compressor-lever N will rock it slightly away from the bow of the link against which it has just operated, and leave it ready to be swung back by the bar L. When the gate has reached about one-fourth the way of its upward movement the bender-head will have been entirely withdrawn from the bending-cavity, bringing with it the ends of link 2 and leaving its eyes or end openings in position in line with the flat-link feedway a^4 to receive a flat link. The further retracting or retrograde movement of the link 2 is prevented by the bow of the link 3 coming in contact with the holding-pawl K^2. When this pawl assumes this position, (see Fig. 8), the eyes or end openings of link 2 are just in the proper position to be threaded by the flat link next fed forward. As the gate moves upward, the thrust-bar continues to draw back the bender-head until, soon after the completion of one-half of the upstroke of the gate—say, at five-eighths of this upward movement—the bender-head has

been retracted across the chamber *g* of the bending-block to its starting-point. At this time the push-finger F begins to move forward link 1, and shortly before the end of the upstroke—say, at seven-eighths of the upward movement of the gate—the flat-link feeder will have advanced to its full movement. During this time the compressor-bar L will have been retracted and the bill-hook lever swung back, leaving all the parts in the position occupied at starting, and ready to repeat the operation described.

I claim as of my own invention—

1. The hereinbefore-described improvement in the art of manufacturing chain from sheet metal by machinery, which improvement consists in forming the partially-shaped flat links from a plate, bringing these links (flatwise or with their broad surfaces horizontal) to the point at which they are to be connected with each other, successively threading the separate flat links through the eyes of previously-bent and partially-formed links, (the broad surfaces of which are vertical or at right angles to the sides of the flat links,) turning the flat links, bending them to interloop and unite them with the previously-bent links, and subsequently completely shaping the links and forming the finished chain, substantially as set forth.

2. As an improvement in the art of manufacturing chain from sheet metal by machinery, the hereinbefore-described method of automatically adjusting a flat link in a previously-bent link preparatory to bending, which consists in feeding forward the flat link endwise, threading it through the eyes of the bent link intersecting its line of travel at right angles, and turning it as it is fed along after its forward widened end has passed through said eyes, substantially as set forth.

3. As an improvement in the art of manufacturing chain from sheet metal by machinery, the hereinbefore-described method of connecting and uniting the links, which consists in feeding forward the flat and partially-shaped links flatwise or with their broad surfaces horizontal in a path intersected at right angles by that traversed by the previously-connected links, threading the flat links successively through the eyes of the previously bent and united links, the broad surfaces of which are vertical and at right angles to the sides of the flat links, giving a partial turn to the flat links, and then bending them at their middles to respectively unite them with the previously bent and united links, substantially as set forth.

4. As an improvement in the art of manufacturing chain from sheet metal by machinery, the hereinbefore-described method of completely forming and finishing the bent interlooped links, which consists in intermittingly feeding forward the links, compressing them sidewise, and then upsetting or compressing them endwise, substantially as set forth.

5. The combination, substantially as hereinbefore set forth, of the blank-feeding rolls, the yoke connected with the adjustable bearings of the upper roll, and the cam-lever for actuating the yoke.

6. The combination of the flat-link-feeding mechanism, the chambered bending-block, and link-turning devices, substantially such as described.

7. The dies formed in sections and having a feed-channel for the flat links, recessed at the top and bottom of its inner end to facilitate the turning of the link, substantially as set forth.

8. The combination, substantially as hereinbefore set forth, of the punches, the dies, the flat-link-feeding mechanism, the chambered bending-block, to which the links are delivered from the feedway or channel, which is recessed at its inner end, and the turning-springs, which operate upon the link and begin to turn it when its rear end reaches the recesses in the guideway, as specified.

9. The bending-block provided with the bending-cavity, having narrow top and bottom portions and a wide central portion, in combination with a bender, substantially as and for the purpose specified.

10. The combination of the reciprocating bender and the chambered bending-block, having a bending-cavity with a wide central part and contracted top and bottom portions in its wall, into which the bender-head is projected to bend the flat links and connect them with the previously-bent links, substantially as hereinbefore set forth.

11. The combination of a bending cavity or die and the bending-head, provided with spring-lips, as described, whereby it is adapted to engage the ends of a previously-bent link on the advance stroke and withdraw the last bent link on the retraction of the bender, substantially as set forth.

12. The combination of the reciprocating carrier-bar of the flat-link-feeding mechanism, the lever for reciprocating the bar, and the spring tripping-arm, pivoted to the bar and operated upon by the lever, substantially as and for the purpose set forth.

13. The combination, substantially as hereinbefore set forth, of the bending-block provided with a bending-cavity, the bender which forces a link into said cavity and then partially withdraws it, and a stop or pawl, K^2, for releasing the link from the bender-head to limit its retrograde movement and leave it in position to receive the next link through its eyes.

14. The combination, substantially as hereinbefore set forth, of a nose, N′, the stationary anvil located on one side of the way traversed by the chain, and the compressor operating from the opposite side of said way, to compress the links sidewise at their flat ends and form the bows.

15. The combination, substantially as hereinbefore set forth, of the chain-feeding mechanism and a swinging arm or pawl, K, pro-

vided with a nose to engage the links and hold them in turn in proper position to be compressed after being fed forward.

16. The combination, substantially as hereinbefore set forth, of a self-adjusting arm or pawl, K, having a nose to engage the links as fed forward, the compressor acting against the sides of the links, and the compressor for upsetting or compressing the links endwise.

17. The combination, substantially as hereinbefore set forth, of mechanism for intermittingly feeding forward the chain and connected links, swinging arms or pawls K K^2, to limit retrograde movement of the links, the bending-head, the sidewise compressor, and the endwise compressor.

In testimony whereof I have hereunto subscribed my name.

FREDRICK EGGE.

Witnesses:

WARREN H. DAY,

WM. E. DISBROW.