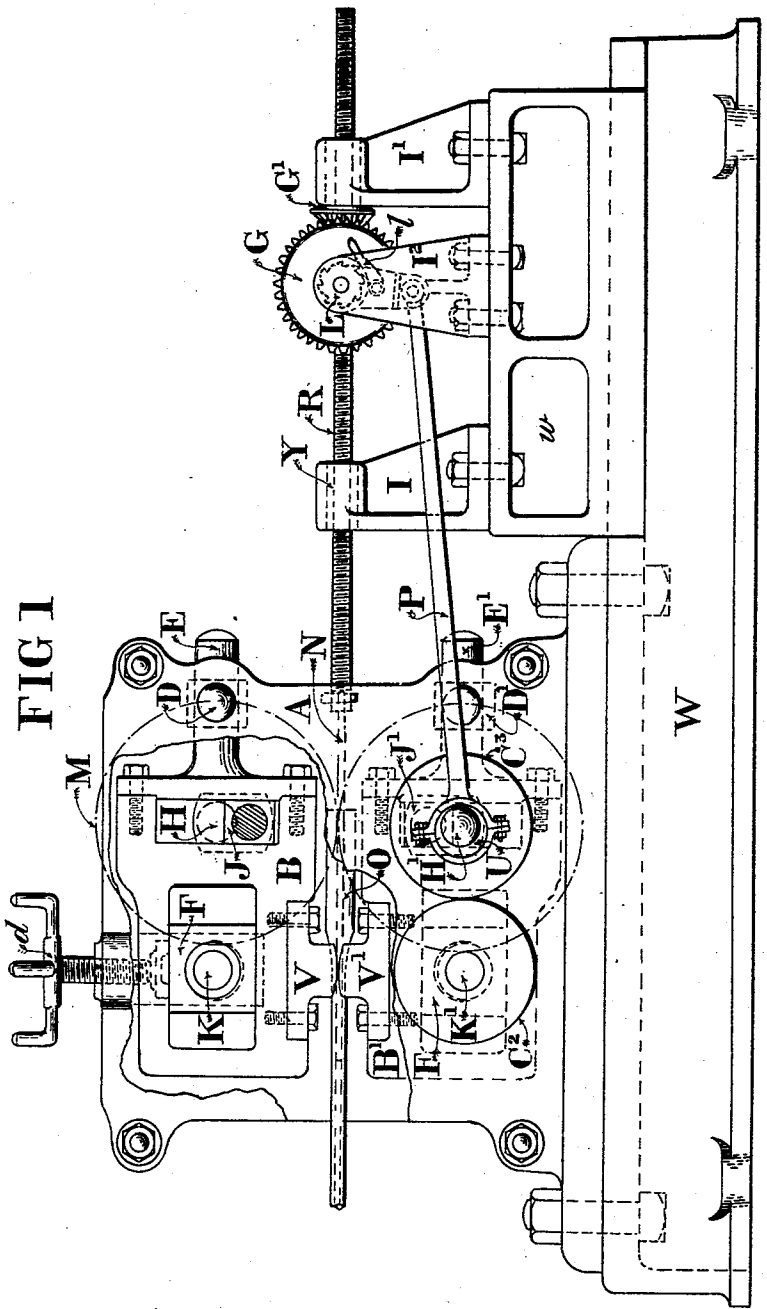
(No Model.) 8 Sheets—Sheet 1.

B. PRICE.

APPARATUS FOR MANUFACTURING METAL TUBES.

No. 570,816. Patented Nov. 3, 1896.

FIG 1



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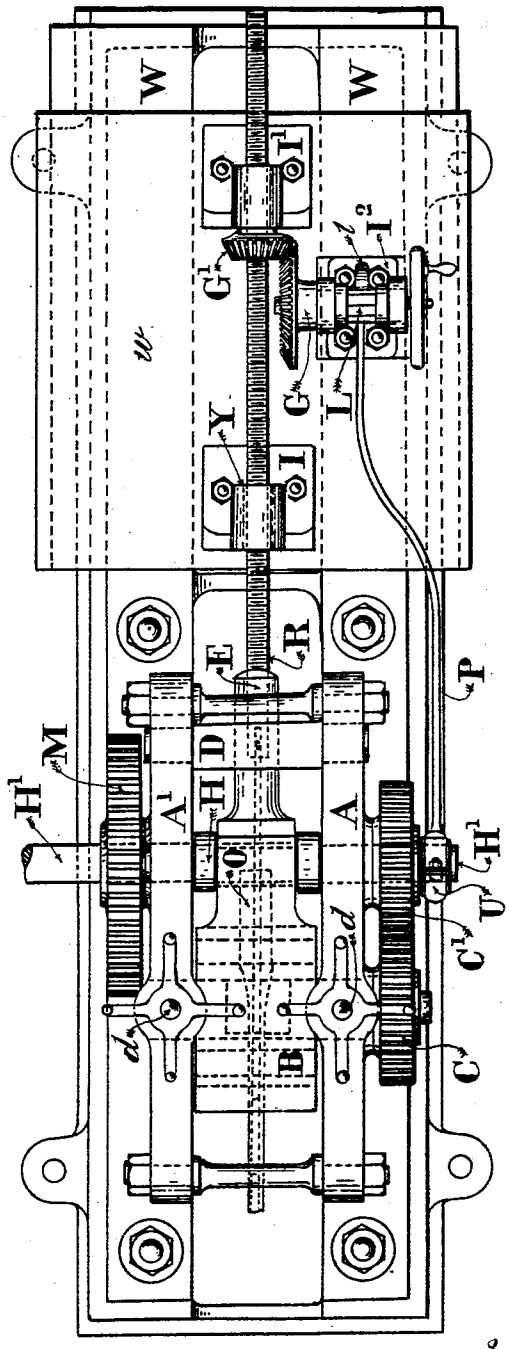
(No Model.) 8 Sheets—Sheet 2.

B. PRICE.

APPARATUS FOR MANUFACTURING METAL TUBES.

No. 570,816. Patented Nov. 3, 1896.

FIG 2



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(No Model.) 3 Sheets—Sheet 3.

B. PRICE.

APPARATUS FOR MANUFACTURING METAL TUBES.

No. 570,816. Patented Nov. 3, 1896.

FIG 4

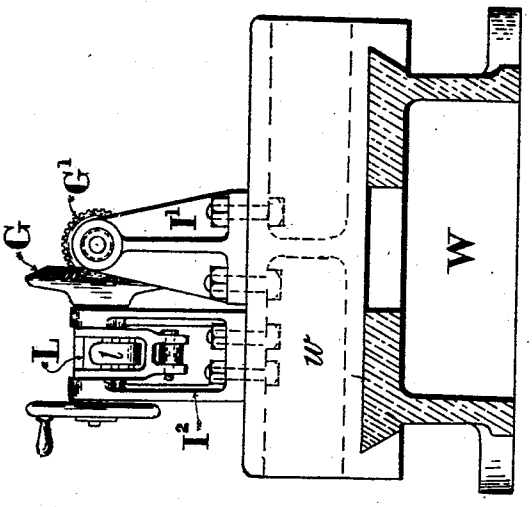
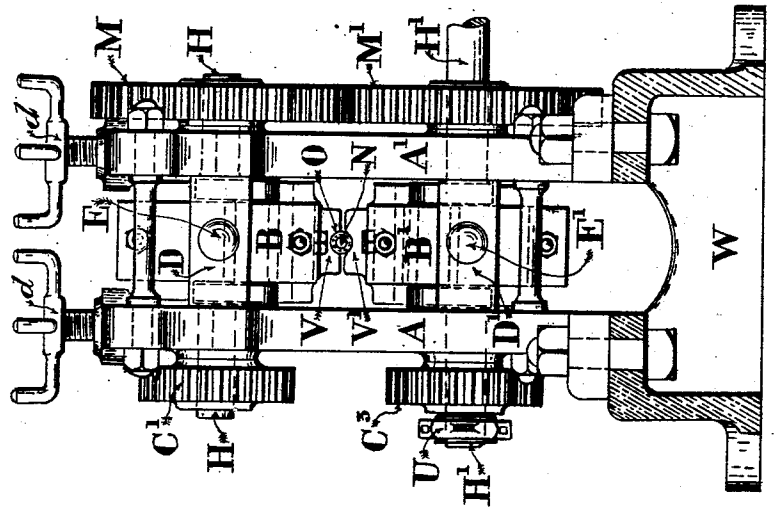


FIG 3



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(No Model.) 8 Sheets—Sheet 4.

B. PRICE.

APPARATUS FOR MANUFACTURING METAL TUBES.

No. 570,816. Patented Nov. 3, 1896.

FIG 6

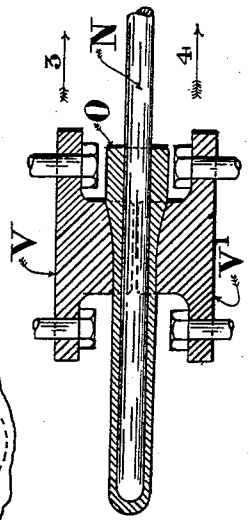


FIG 14

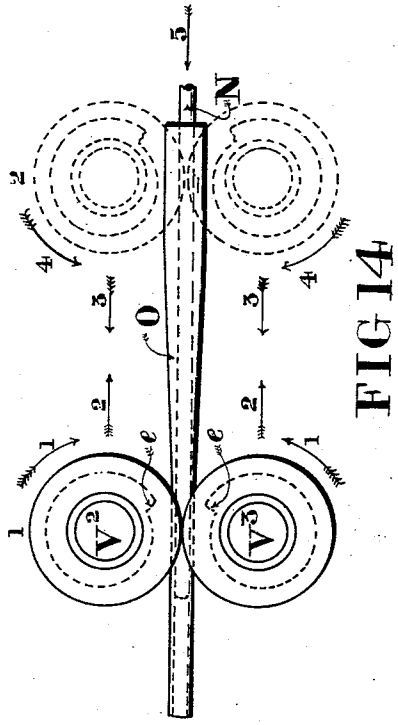


FIG 12

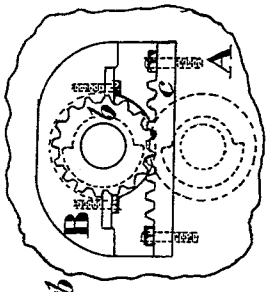


FIG 11

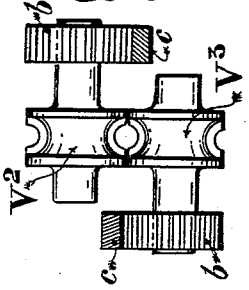


FIG 5

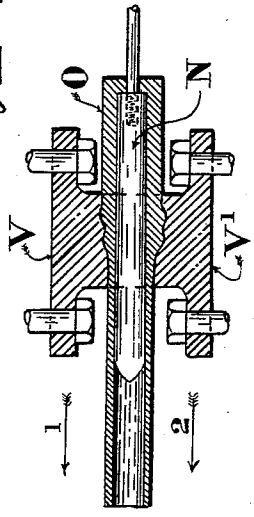
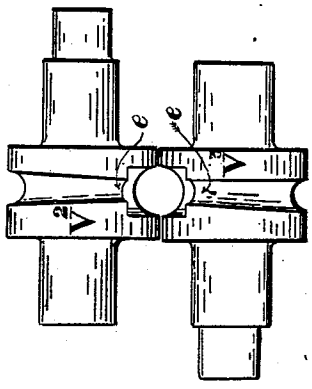


FIG 13



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(No Model.) 8 Sheets—Sheet 5.

B. PRICE.

APPARATUS FOR MANUFACTURING METAL TUBES.

No. 570,816. Patented Nov. 3, 1896.

FIG 8

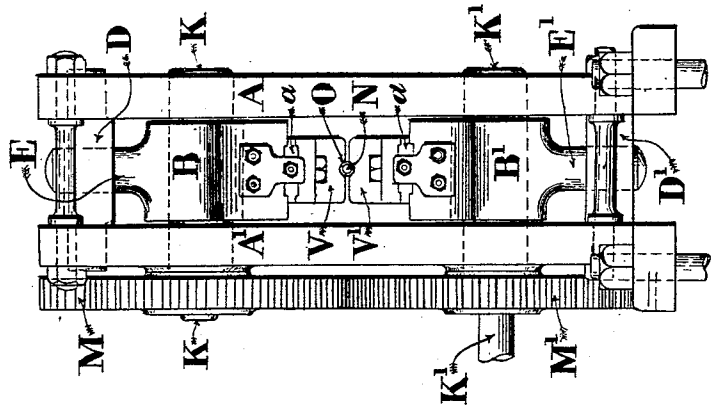
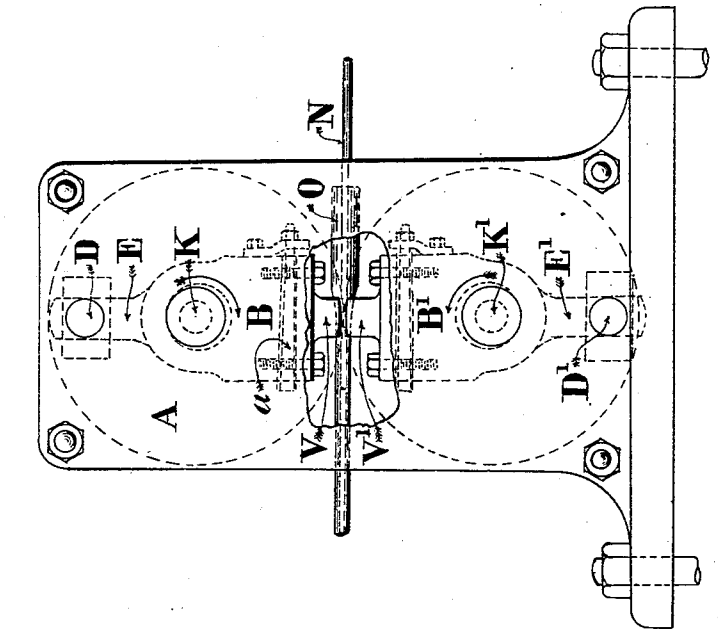


FIG 7



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B. PRICE.

APPARATUS FOR MANUFACTURING METAL TUBES.

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FIG 10

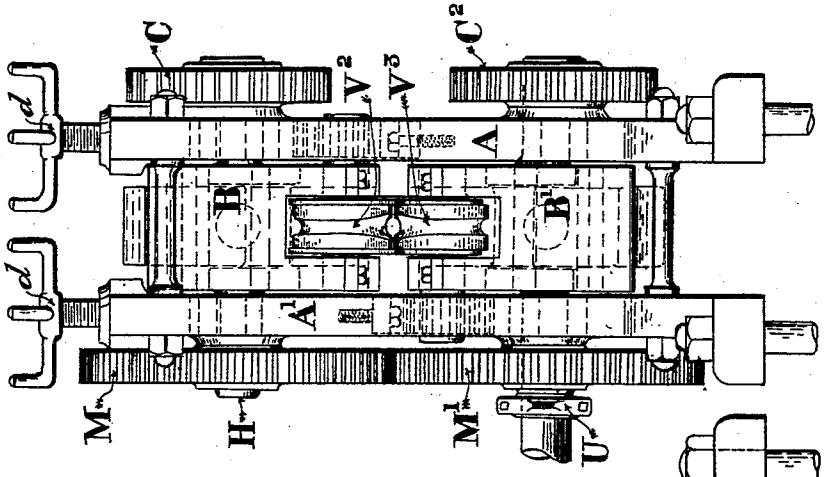
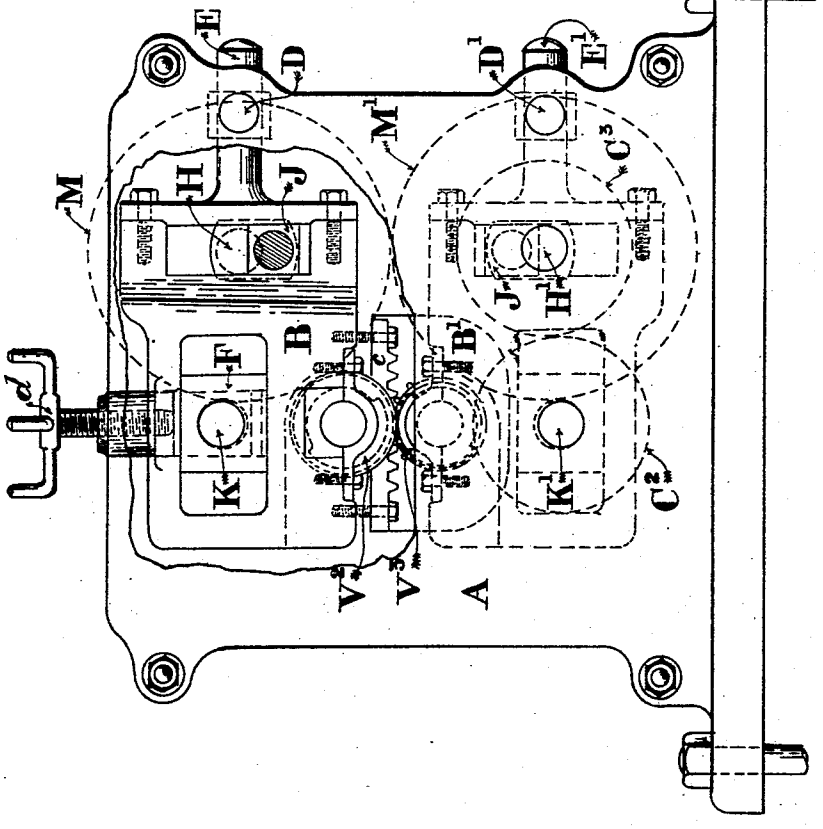


FIG 9



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B. PRICE.

APPARATUS FOR MANUFACTURING METAL TUBES.

No. 570,816. Patented Nov. 3, 1896.

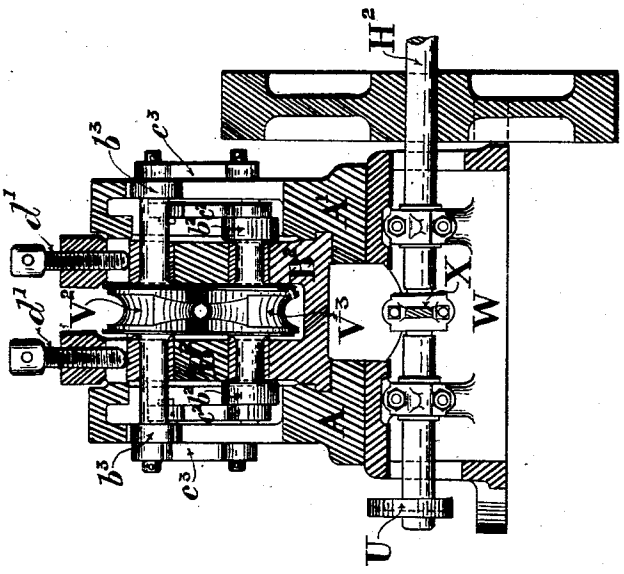

FIG 16.

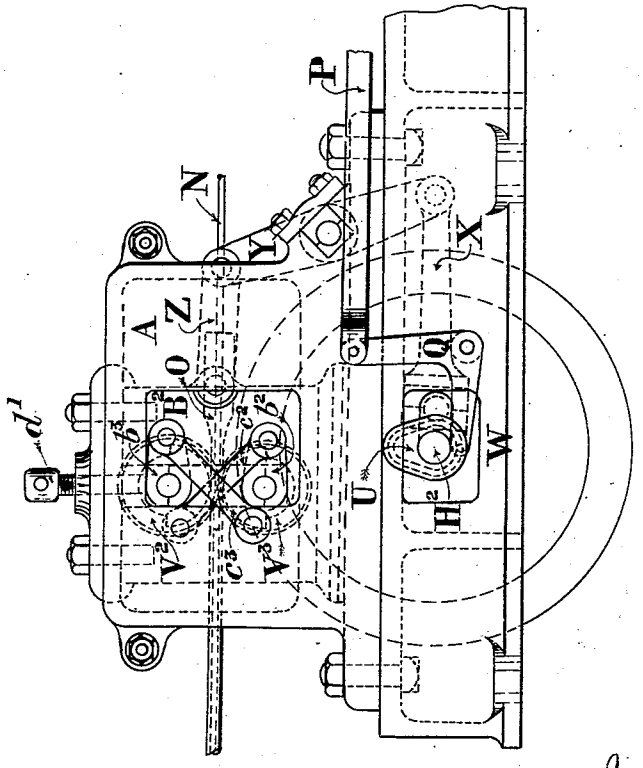

FIG 15.

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B. PRICE.

APPARATUS FOR MANUFACTURING METAL TUBES.

No. 570,816. Patented Nov. 3, 1896.

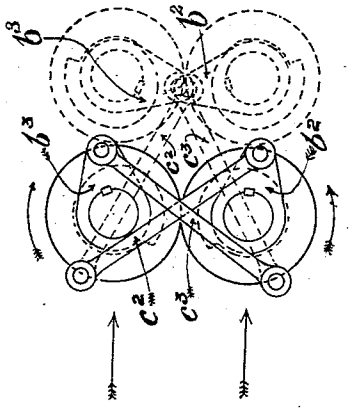

FIG 18

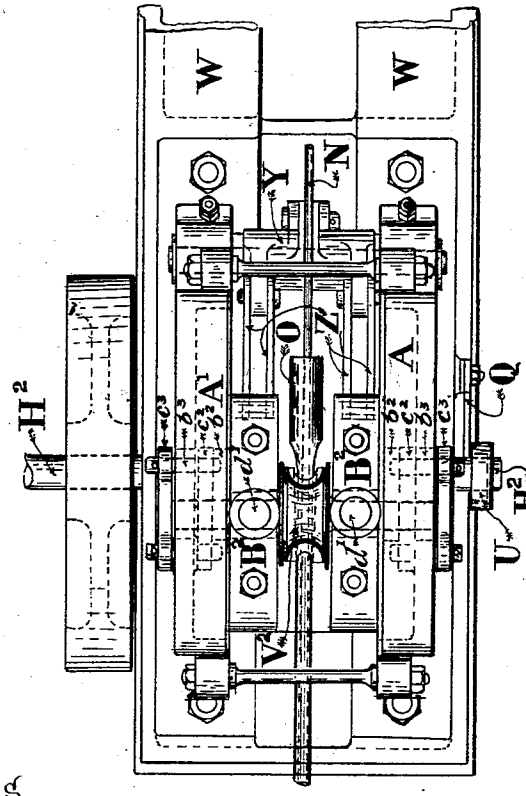

FIG 17

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UNITED STATES PATENT OFFICE.

BENJAMIN PRICE, OF MORRISTON, ENGLAND, ASSIGNOR OF TWO-THIRDS TO RICHARD LAYBOURNE AND CHARLES WILLIAM EARLE MARSH, OF NEWPORT, ENGLAND.

APPARATUS FOR MANUFACTURING METAL TUBES.

SPECIFICATION forming part of Letters Patent No. 570,816, dated November 3, 1896.

Application filed October 19, 1895. Serial No. 566,250. (No model.) Patented in England March 28, 1894, No. 6,283.

To all whom it may concern:

Be it known that I, BENJAMIN PRICE, a subject of the Queen of Great Britain, residing at 38 Crown Street, Morriston, England, have invented certain new and useful Improvements in or Relating to Apparatus for the Manufacture of Metal Tubes, (for which I have received Letters Patent in Great Britain, No. 6,283, dated March 28, 1894,) of which the following is a specification.

My invention has for its object improvements in or relating to apparatus for reducing or drawing out a hollow ingot to a tube of the desired size and thickness of wall during a single passage therethrough and in such a manner that the ingot receives only a step-by-step forward movement during its whole passage between the operating parts, these latter being given a reciprocating motion bodily for this purpose.

For the purposes of my invention I use swages which advantageously have a longitudinally-tapered and transversely-corrugated groove on their operating-faces and secured in any desirable manner to the adjoining faces of two slides mounted in a suitable frame either one above the other or side by side. An arm projects from one of the ends of each of these slides and passes through a block pivoted in the frame in such a manner that the slides may be given a reciprocating motion and at the same time their free ends, near which the swages are secured, caused to approach and recede from one another during their forward and backward movements, respectively. This causes the swages to grip the ingot, which has been previously mounted upon a mandrel of suitable size and length and placed between them during the forward movement of the slides and reduce a portion of this to the desired size and thickness of wall and release said ingot during the backward movement of the slides and allow it to be fed forward a suitable distance and also revolved by the aid of a screw-thread upon the mandrel or by other suitable means.

To give the necessary reciprocating motion to the slides, I form in each of these a slot at right angles to its length, in which slides a block mounted on a crank-shaft journaled in the frame, so that during each complete revolution of said crank-shaft the slide will receive a complete forward and backward movement.

To cause the slides to approach and recede from one another at the proper times, I form a second slot near the free end of each of these parallel with its length, and in each of these slots an eccentric mounted on a shaft journaled in the frame revolves.

The two crank-shafts are advantageously geared together, as also are the two shafts carrying the eccentrics, and these shafts may be driven either separately or together in any suitable manner.

In a modified form of the above-described apparatus the slides, instead of being mounted side by side, may be mounted end to end with the swages on their opposite ends and receive the necessary movement to cause the swages to travel over a portion of the surface of the ingot and gradually approach one another during the forward stroke and to release the ingot during the backward stroke by means of a single eccentric fitting into and revolving in an opening in each of the slides.

Where found desirable, the swages may be replaced by rolls mounted on spindles journaled in the slides and revolved by racks secured to the frame, with which gear spur-wheels mounted eccentrically on the roll-spindles, or in any other suitable manner.

I will now proceed to more fully describe my invention with the aid of the accompanying drawings, which illustrate apparatus according to my present invention, viz:

Figure 1 is a side elevation of the apparatus fitted with swages operated according to my invention and provided with feeding mechanism; Fig. 2, a plan of Fig. 1. Fig. 3 is an end view of Fig. 1 without feeding mechanism. Fig. 4 is an end view of feeding mechanism detached. Fig. 5 is a sectional view of a larger scale of swages having longitudinally-tapered and transversely-corrugated grooves. Fig. 6 is a similar view of swages the grooves in which are not corrugated. Fig. 7 is a view in elevation of the apparatus where the slides are mounted end to end and have the swages mounted on their opposite ends.

Fig. 8 is an end view of Fig. 7. Fig. 9 is a side elevation of the apparatus wherein the swages are replaced by rollers, part of the frame being cut away and one rack and pinion also removed, exposing the top slide with the roller mounted therein. Fig. 10 is an end view in elevation of Fig. 9. Fig. 11 shows the rollers with the pinions attached and geared in the racks detached from apparatus. Fig. 12 is a side elevation of the rollers mounted with their respective pinions in position and shows method of securing the racks to the frame; Fig. 13, a view in elevation of a pair of rollers having the grooves formed in them gradually increasing in depth and width from the point *e* around their peripheries to the same point, where it is broken off by a radial step. Fig. 14 is a view in elevation of the rollers, showing their extreme positions in both directions and a partly-finished tube between them. Fig. 15 is a view in elevation of an apparatus wherein the rollers are contained in one slide only, the rollers in their vibrations to and fro being revolved by means of eccentrics or cranks secured to the roller-spindles and connected by links to the frame. Fig. 16 is a cross-sectional view of Fig. 15. For the sake of clearness the rollers, links, adjusting-screws, and eccentrics or cranks on roller-spindle ends are shown in full. Fig. 17 is a plan of Fig. 15. Fig. 18 is an enlarged diagrammatic view of the swaging-rollers shown in Figs. 15, 16, and 17, being a modification of a part of my apparatus.

Like letters of reference indicate corresponding parts throughout all the figures.

In the apparatus shown in Figs. 1, 2, 3, and 4 two frames A A′ are secured to a base W and have arranged between them two slides B B′, capable of being reciprocated bodily by the revolution of crank-shafts H H′, upon which are mounted blocks J J′, arranged to slide freely in vertical slots in said slides B B′. The slides B B′ are supported at one end by projecting guide-arms E E′, sliding in blocks D D′, pivoted to the frames A A′, while their opposite ends are supported and operated so that they periodically approach and recede from one another by eccentrics working in blocks F and carried on the shafts K K′, journaled in the frames A A′, so that their journals may be adjusted vertically by screws *d*. By using different eccentrics and blocks the amount by which the slides approach and recede from one another may be regulated. The shafts K K′ are geared to the crank-shafts H H′ and the latter geared together by tooth-wheels M M′ and C C′ C^2 C^3, respectively, so that the movement of the slides B B′, together with the swages V V′, which are secured to their opposite faces, is synchronous.

An intermediate base *w* is mounted on the base W, and this supports the mechanism for feeding the mandrel N, on which the ingot to be reduced is mounted between the swages. This feed mechanism consists of a screw-threaded spindle R, capable of being connected at one end to one end of the mandrel carrying the ingot by suitable means and arranged to pass through uprights or brackets I I′.

One of the brackets I contains a nut Y, fitting the spindle R, while the other supports and guides a bevel gear-wheel G′, provided with a feather or key adapted to slide in a long groove or keyway running longitudinally of the screw-spindle R, so as to allow the said spindle to slide either forward or backward through the bevel-gear G′, and thus the complete or partial revolution of the gear-wheel G′ will cause the screw-spindle R to rotate and as a result to advance or retire through the nut Y, according to the direction of revolution of the gear-wheel G′, owing to the fact that the said nut is fixed. With this wheel G′ gears a second bevel gear-wheel G, mounted upon a short spindle journaled in the upper end of a bracket I^2, and upon which spindle is also mounted a ratchet-wheel L, having gearing with it a pawl *l*, carried by a hinged plate connected at its free end to a rod P, whose opposite free end is connected to an eccentric U on one end of the spindle H′.

The forward and rotatory movement of the screw R and mandrel and ingot is thus normally governed by the movement of the parts operating the swages, but when desirable the position of the said screw may be adjusted by the aid of a hand-wheel secured to one end of the shaft carrying the bevel-wheel G.

The cranks, eccentrics, and gearing are of such throw and speeds and are so arranged that the parts are operated in the following manner: The slides B B′ are first moved backward as far as possible toward the feeding mechanism, in which position the swages carried by them are sufficiently wide apart to allow of the forward end of the ingot to be treated being introduced between them. The mandrel on which the ingot has been placed, and on which it is held by the aid of its flanged end or in any other suitable manner, is then connected to the forward end of the screw R and the latter adjusted by the hand-wheel so that ingot and mandrel project slightly between the swages. The whole mechanism is now started by the application of suitable motive power to the crank-shaft H′ and the slides B B′ carried forward and at the same time gradually forced toward one another, the result being that a short length of the ingot is considerably reduced and at the same time drawn out, or, as it were, receives a sliding blow on both sides simultaneously. The slides B B′ and swages V V′, after being forced toward one another to the full extent and while still moving forward, commence to recede from one another, so that by the time they have reached the end of their forward travel they have released the ingot. The slides and swages then complete their return stroke while still held sufficiently wide apart to allow the feed mechanism, which during this return stroke is brought into op-

eration, to feed the ingot and mandrel forward a suitable distance, and at the same time revolve them sufficiently to cause any fins or webs formed to be reduced during the next operation of the swages. This operation is then repeated, the feed forward of the mandrel and the ingot being such that a portion of that part of the latter operated upon during the previous forward stroke, together with a fresh portion, being treated each time, the result being that as the ingot gradually passes beyond the reach of the swages it has been reduced to the same diameter as that of the forward narrowest ends of the grooves in the swages.

After the operation of swaging has been completed the mandrel is extracted from the tube by the aid of a suitable draw-bench, and, if it is desired, the tube then is either cold or hot drawn to finish it.

Instead of arranging the slides B B′ side by side, as above described, these may be placed end to end, as shown in Figs. 7 and 8, the compound reciprocating motion of said slides being effected in this case solely by eccentrics K K′, the shafts of which are geared together by gear-wheels M M′, aided by the blocks D D′, pivoted to the frames A A′ and having arms E E′, projecting from said slides, working through them.

The process of forming tubes in this machine is similar to that above described, although in this case the swages V V′ are preferably made with plain grooves in their operating-surfaces and so operated that they give the ingot the sliding blow during their backward travel, as indicated by arrows 3 and 4 in Fig. 6, instead of during the forward stroke, as above described and indicated by arrows 1 and 2 in Fig. 5.

When found desirable, the swages may be replaced by one or more pairs of rolls, preferably, but not necessarily, of that type in which the grooves in the peripheries thereof gradually increase in depth and width, as shown in Figs. 13 and 14, from a point *e*, at which point the groove is broken by a radial step or gap. Such an arrangement is shown in Figs. 9 and 10.

The construction of the apparatus generally is similar to that already described, Figs. 1, 2, 3, and 4, with the addition of racks *c c*, with which gear pinions *b b* on the axes of the rollers V^2 V^3, Figs. 11 and 12, which replace the swages, so as to revolve said rollers during their backward and forward travel and retaining them in their proper relative positions.

The rollers are operated in the same manner as the swages, the pinions *b b* being mounted eccentrically to allow of this, and are so arranged that as they are moved forward the opening between them gradually diminishes and so reduces the diameter of the ingot. Where it is not desired to relieve the ingot O from the action of the rollers on the return stroke, the wheels C C′ C^2 C^3 will not be required, and the rolls will accordingly roll backward and forward on the ingot, reducing it in cross-section at each stroke as it is fed forward. The tube as it is elongated extends beyond the action of the rollers and from that point forward becomes concentric and of a uniform diameter.

The grooves in the rolls, if desired, may be modified by making a portion of the smaller part thereof concentric for the purpose of smoothing the tube after being reduced to its smaller diameter, while in some cases the rollers may each have two or even more grooves in them to enable them to operate upon two or more ingots simultaneously.

In Figs. 15, 16, and 17 a modification is shown in which a pair of rollers are journaled in one slide B^2 only. The rack and pinion is also replaced by the links C^2 C^3 and eccentrics or cranks b^2 b^3, said eccentrics or cranks being secured to or formed on the roller-spindle ends, while the links have one end connected to pins in the frames A A′, the other end connected to the eccentrics or cranks b^2 b^3, so as to form jointed ends. The slide B^2 is reciprocated between the frames A A′ by the crank-shaft H^2 through the connecting-rod X, the rocker Y, and the links Z, and the links c^2 c^3 and eccentrics or cranks b^2 b^3 are so brought into play and cause the rolls to partially revolve as they travel on the ingot placed between them, but beyond this partial revolution no other movement is given to the roll-axes by said links C^2 C^3 and eccentrics b^2 b^3, as will be seen from the diagram, Fig. 18, as said eccentrics are so arranged that they allow of sufficient play between the roll-axes and the ends of the links that the former may travel in a straight line independently of the curved path through which the ends of said links move.

The feeding mechanism, which is preferably, but not necessarily, the same as that already described and shown in Figs. 1 and 2, is actuated by the cam U through the bell-crank Q and the rod P. The rollers V^2 V^3 are adjusted as to the distance between them by the screws *d′ d′*.

In some cases the ingot, instead of being fed forward when the swages or rollers are at their extreme backward position, may be fed forward when the rollers are at their forward movement, or it may be turned only when the rollers are at their extreme forward position, or turned and advanced both when the rollers are at the extreme backward and forward position, in which latter case the ingot may be acted upon and reduced and elongated both during the backward and forward movements of the rolls.

The last-mentioned method of working is illustrated in Fig. 14. At 2 the rolls are shown in dotted lines in their extreme backward position, where the opening between them is sufficiently large to allow of the ingot being turned and advanced. As the rolls are caused to travel forward in the direction of

the arrows 3 3 and revolve in the direction of the arrows 4 4 they act upon the ingot and reduce and elongate it until they reach their utmost forward position. (Shown at 1 in full lines.) At this point the ingot may be again turned and advanced, so that as the rolls return in the direction of the arrows 2 2 (revolving in the direction of the arrows 1 1) they will again be caused to operate on the ingot and further compress and elongate it.

The above being my said invention, I wish it to be understood that the arrangements for actuating the slides, swages, rolls, and feed mechanism may be modified without departure from the essential features of my said invention.

I am aware that the method of reducing a hollow ingot to a tube by rolls with tapering or plain grooves to which a reciprocating or alternating motion is given whereby the reduction of the ingot is effectedby a series of motions or steps and in sections or portions, as distinguished from continuous rolling through dies, is not broadly new. Such a method is described in Ritchie's British patent, No. 13,054, of 1850, and in Brooman's British patent, No. 1,105, of 1856, and I make no claim thereto.

What I claim is—

1. In an apparatus for the manufacture of metal tubes from hollow ingots, the combination with a pair of swages mounted in a frame; means for reciprocating said swages longitudinally of said frame, and means for causing said swages to approach and to recede from each other simultaneously; of means for holding the ingot while being operated upon; and means for intermittently advancing and turning said ingot, substantially as described.

2. In an apparatus for the manufacture of metal tubes from hollow ingots, the combination with a pair of swages mounted in a frame; means for reciprocating said swages simultaneously in the direction of the length of the ingot; and means for causing said swages to simultaneously approach and recede from each other; of a mandrel for holding the ingot, a screw and means for advancing and retiring the same, whereby said ingot is simultaneously fed forward and turned, substantially as described.

3. In an apparatus for the manufacture of metal tubes from hollow ingots, the combination with a pair of swages mounted in a frame, and each having a tapering groove on its operating-face; means for reciprocating said swages longitudinally of said frame and means for causing said swages to approach and to recede from each other simultaneously; of means for holding the ingot while being operated upon; and means for simultaneously advancing and turning said ingot, substantially as described.

4. In an apparatus for the manufacture of metal tubes from hollow ingots, the combination with a pair of swages mounted in a frame, and each having a tapering groove on its operating-face; means for reciprocating said swages simultaneously in the direction of the length of the ingot, and means for causing said swages to simultaneously approach or recede from each other; of a mandrel for holding the ingot while being operated upon; a screw, and means for turning said screw whereby said ingot is simultaneously fed forward and turned, substantially as and for the purposes described.

5. In an apparatus for the manufacture of metal tubes from hollow ingots, the combination with a pair of slides mounted in a frame; swaging devices mounted in the opposite faces of said slides; means for reciprocating said slides simultaneously, and means for causing said slides to approach and recede from each other simultaneously; of means for holding the ingot while being operated upon; and means for simultaneously feeding forward and turning said ingot, substantially as and for the purposes described.

6. In an apparatus for the manufacture of metal tubes from hollow ingots, the combination with a pair of slides mounted in a suitable frame; swaging devices mounted upon the opposite faces of said slides, said slides each having an elongated slot therein at right angles to its length; sliding blocks working in said slots; crank-shafts journaled in said frame and rotating in said sliding blocks, and means for simultaneously rotating said crank-shafts and thereby reciprocating said slides simultaneously; and means for causing said slides to approach and to recede from each other simultaneously; of means for holding the ingot while being operated upon by said swages; and means for simultaneously advancing and turning said ingot, substantially as and for the purposes described.

7. In an apparatus for the manufacture of metal tubes from hollow ingots, the combination with a pair of slides mounted in a suitable frame and having swaging devices mounted upon the opposite faces thereof; a pair of crank-shafts journaled in said frame; a block mounted upon each of said crank-shafts and working in a slot in each of said slides at right angles to the length thereof, and adapted to impart a reciprocating motion to said slide; means for rotating said crank-shafts simultaneously; another pair of shafts journaled in said frame; an eccentric on each of said shafts; a block mounted upon each eccentric, and working in slots in the said slides and adapted to cause said slides to approach and recede from each other; and means for simultaneously rotating said shafts; of means for holding the ingot while being operated upon; and means for simultaneously advancing and turning said ingot, substantially as and for the purposes described.

8. In an apparatus for the manufacture of metal tubes from hollow ingots, the combination with a pair of swages and means for simultaneously operating the same mounted in

a suitable frame; of a mandrel for holding the ingot; a screw attached to the rear end of said mandrel; brackets supporting said screw, one of said brackets being screw-threaded, and the other of said brackets being provided with a smooth hole therethrough; a gear-wheel splined upon said screw and journaled in said latter bracket; and means for rotating said gear-wheel, substantially as and for the purposes described.

9. In an apparatus for the manufacture of metal tubes from hollow ingots, the combination with a pair of swages and means for simultaneously operating the same mounted in a suitable frame; of a mandrel for holding the ingot; a screw attached to the rear end of said mandrel; brackets supporting said screw, one of said brackets being screw-threaded and the other of said brackets being provided with a smooth hole therethrough; a gear-wheel splined upon said screw and journaled in said latter bracket; another gear-wheel mounted upon suitable supports and meshing with the first gear-wheel; a ratchet and pawl connected with said second gear-wheel; a rod operating said ratchet and pawl; and means for operating said rod, substantially as and for the purposes described.

10. In an apparatus for the manufacture of metal tubes from hollow ingots, the combination with a pair of slides mounted in a frame; of curved swaging devices each mounted on a shaft or axle journaled in the said slides; means for reciprocating said slides simultaneously, means for causing said curved swaging devices to rotate on their said axes in said slides; means for holding the ingot while being operated upon; and means for intermittently feeding forward and turning said ingot substantially as and for the purposes described.

11. In apparatus for the manufacture of metal tubes from hollow ingots, the combination with a slide mounted in a frame; of curved swaging devices each mounted on a shaft or axle journaled in said slide; curved swaging-surfaces on each said device eccentric to the axis on which said device turns; means for reciprocating said slide; means for causing a partial revolution of said shafts or axles and thereby causing said curved swaging devices to simultaneously and equally rotate on their said axes respectively in said slide; means for holding said ingot and means for intermittently advancing and turning said ingot, substantially as and for the purposes described.

12. In apparatus for the manufacture of metal tubes from hollow ingots, the combination with a slide mounted in a frame, of curved swaging devices each mounted on a shaft or axle journaled in the said slide; curved swaging-surfaces on said devices eccentric to said axes; means for causing the said swaging devices mounted on their respective shafts or axles to reciprocate parallel with the longitudinal axis of the said ingot; and means for causing a partial revolution of said shafts or axles and thereby causing said curved swaging devices to simultaneously and equally rotate on their said axes, respectively in said slide, substantially as and for the purposes described.

BENJAMIN PRICE.

Witnesses:
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