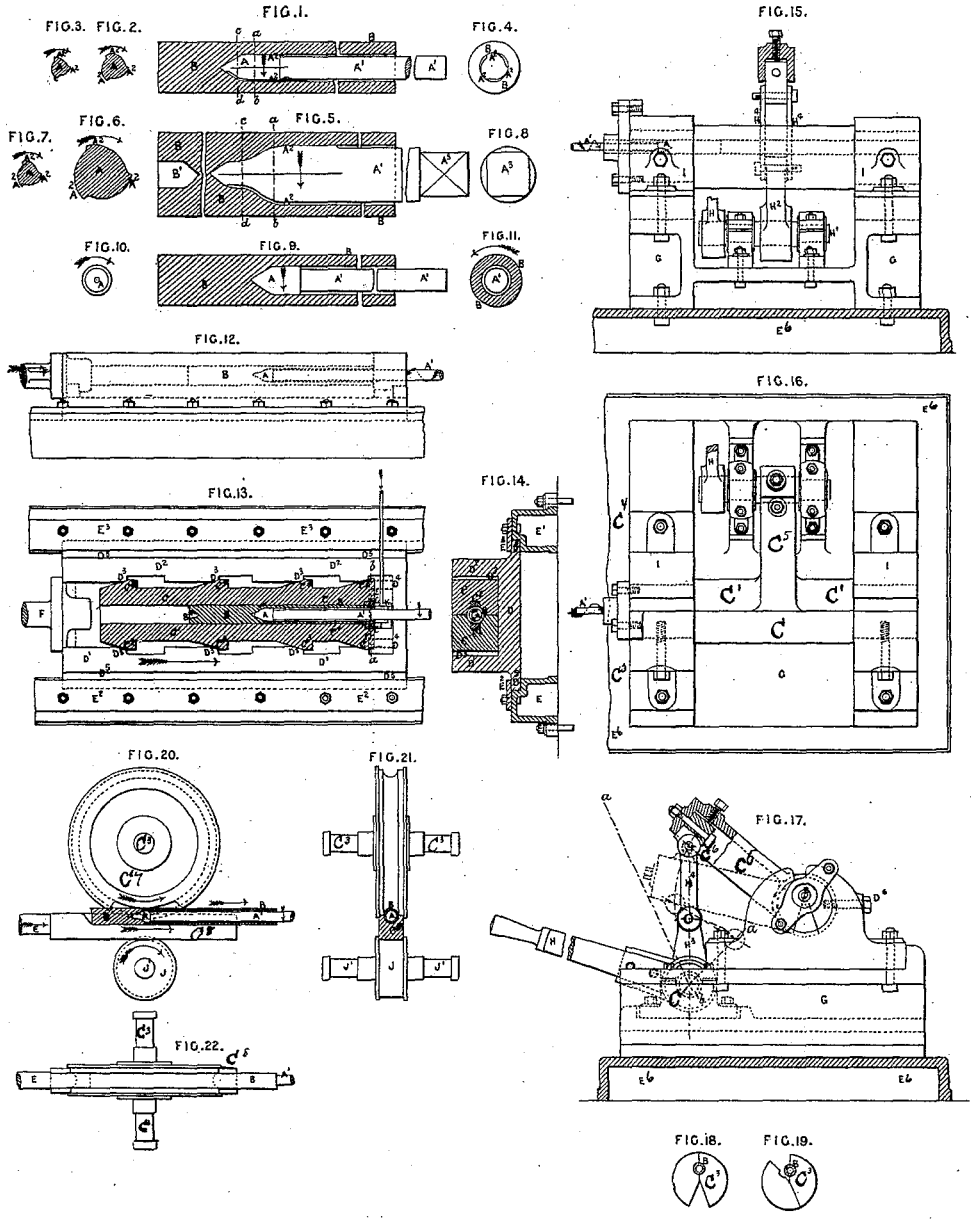
(No Model.) 3 Sheets—Sheet 1.

J. ROBERTSON.

MECHANISM FOR THE MANUFACTURE OF TUBES.

No. 411,109. Patented Sept. 17, 1889.



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(No Model.) 3 Sheets—Sheet 2.

J. ROBERTSON.

MECHANISM FOR THE MANUFACTURE OF TUBES.

No. 411,109. Patented Sept. 17, 1889.

Fig. 31.

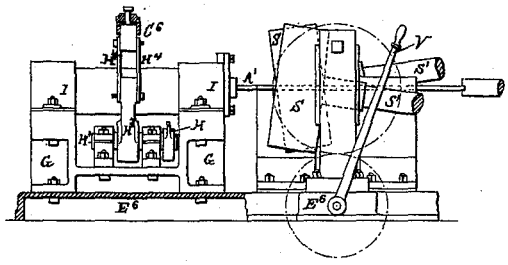


Fig. 32.

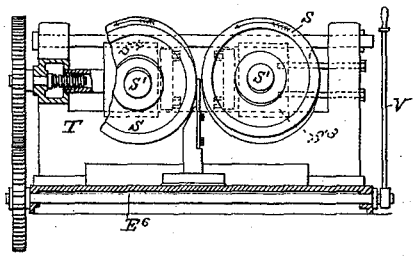


Fig. 24.

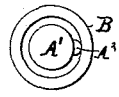


Fig. 33.

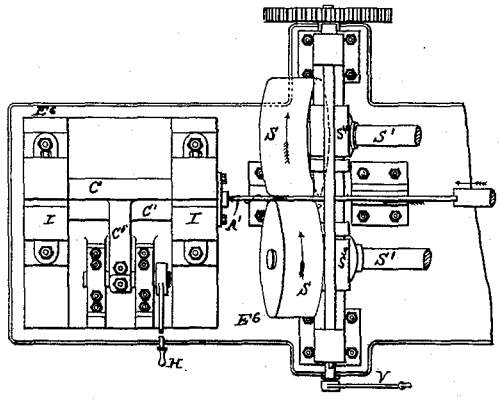
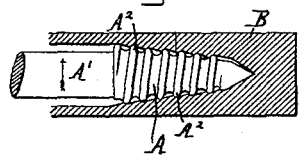


Fig. 23.



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(No Model.) 3 Sheets—Sheet 3.

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MECHANISM FOR THE MANUFACTURE OF TUBES.

No. 411,109. Patented Sept. 17, 1889.

Fig 25.

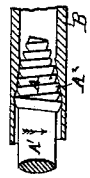

Fig 26.

Fig 29.

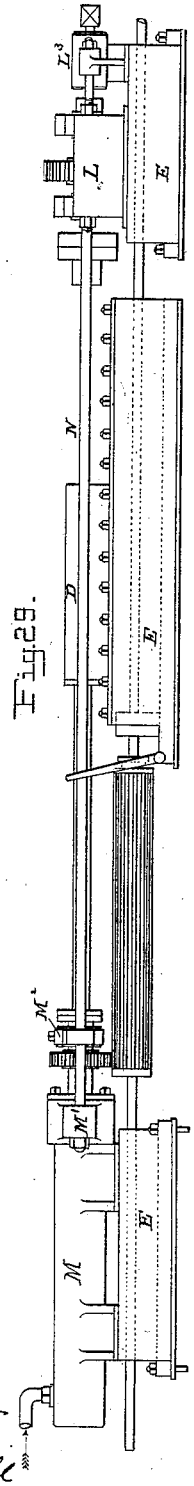

Fig 30.

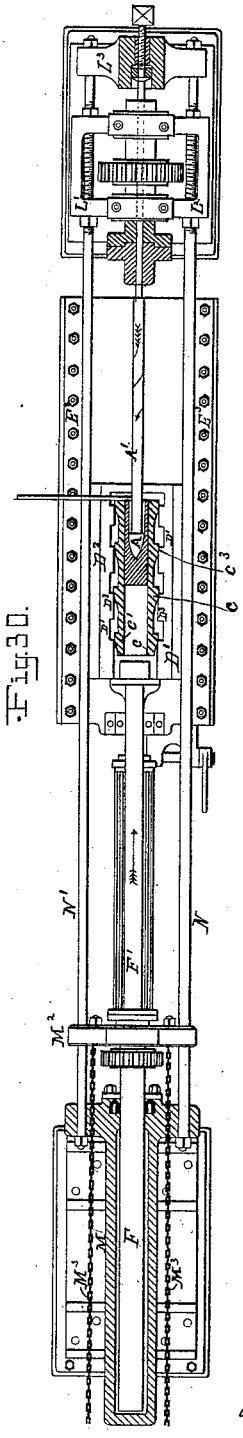

Fig 27.

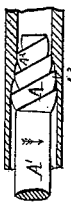

Fig 28.

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UNITED STATES PATENT OFFICE.

JAMES ROBERTSON, OF GLASGOW, COUNTY OF LANARK, SCOTLAND.

MECHANISM FOR THE MANUFACTURE OF TUBES.

SPECIFICATION forming part of Letters Patent No. 411,109, dated September 17, 1889.

Application filed July 7, 1887. Serial No. 243,617. (No model.) Patented in England November 29, 1884, No. 15,752; in Germany September 17, 1885, No. 36,814; in France September 22, 1885, No. 171,280; in Belgium September 22, 1885, No. 70,282, and in Italy August 30, 1886, No. 20,282.

To all whom it may concern:

Be it known that I, JAMES ROBERTSON, a subject of the Queen of Great Britain and Ireland, and residing at Glasgow, county of Lanark, Scotland, have invented certain Improvements in Apparatus for the Manufacture of Metal Tubes, (for which I have obtained British patent, No. 15,752, dated November 29, 1884; French patent, No. 171,280, dated September 22, 1885; Belgian patent, No. 70,282, dated September 22, 1885; German patent, No. 36,814, dated September 17, 1885, and Italian patent, No. 20,282, dated August 30, 1886,) of which the following is a specification.

My invention consists of certain improvements in the construction of mechanism for the manufacture of metal tubes by means of holding dies and a rotating mandrel piercing billets or shells of soft metal and metal such as steel when heated or in a soft state, whether those billets be solid or in the form of shells, as hereinafter described.

Figure 1 in the accompanying drawings is a side external elevation of a sharp-pointed mandrel with its round stem A′ broken off, suitable for piercing solid billets of soft metal and metal such as steel when heated or in a soft state. This form of mandrel is suitable for piercing billets of steel heated to a soft state into "shells" or thick tubes suitable for being pierced by larger mandrels or for being drawn down to thin gages by after-drawing processes, and suitable also for being afterward formed into gun-barrels and like articles. It is shown partly passed through a solid billet of metal B, which is illustrated in section.

The form of the mandrel or acting bulb A is shown in Fig. 2, which is a cross-section at its largest diameter on the line *a b* in Fig. 1, while Fig. 3 is a cross-section near its sharp point on the line *c d*, Fig 1. The stem or after end of the mandrel A′ is shown in end external elevation in Fig. 4, along with the billet B being pierced. The bulb or acting part of the mandrel A has three longitudinal grooves or flutes shown in it, and corresponding high acting edges A^2 A^2 A^2, rounded off to displace or shove aside the metal as the mandrel is rotated, instead of cutting it off, as is done by a sharp drill. These flutes are shallow at the point and made deeper at the larger diameter of the bulb, as seen in Figs. 2 and 3. It is forced through the billet B as it is being rotated, the direction of its rotary motion as it is being forced through the metal being indicated by the arrows placed on the bulb A and stem A′. (Seen in Figs. 1, 2, and 3.) In piercing billets of such metal as copper, brass, and tin in a cold state the mandrel is preferably revolved at a slow speed of about sixten circumferential feet per minute. The intervening flutes between the acting edges are made available for admitting or forcing from the stem end of the mandrel oil or other lubricants to the acting or displacing rounded edges A^2 A^2 A^2 on the bulb-head A. In piercing out billets of metal in a hot state—such as in piercing billets of steel where lubricants cannot well be used—a speed of about two thousand five hundred feet per minute is most suitable to keep the mandrel sufficiently cool in doing its work. Solid bodies immersed in fluid or semi-fluid matters at a high temperature, or in contact with other solid bodies at a higher temperature, do not absorb heat so quickly when in quick circumferential motion as when in a quiescent state—a fact or law in the diffusion of heat so far as I am aware first observed by me—quick motion also being necessary in order to limit the duration of the contact of the mandrel with the hot metal as much as possible. The longitudinal motion of the mandrel as it is rotated in the hot metal should be about a speed of three hundred feet per minute.

Fig. 5 is a side external elevation of a mandrel suitable for piercing solid billets of such metals as copper and alloys of copper in a cold state. The bulb is shown nearly parallel near its point. It is an advantage to bore a center hole with an ordinary drill a short distance into the billet B at its entering end to center the mandrel at starting, and also at the after end, as shown at B′ in the billet B, to keep the mandrel from breaking off portions of the metal in coming out at the after end.

Fig. 6 is a cross-section of the mandrel at the line *a b* in Fig. 5, and Fig. 7 a cross-section at the line *c d* in Fig. 5.

Fig. 8 is an end elevation of the stem, showing the square A^3 for driving the mandrel in the clutch-driver of the working head-stock of the driving-machine. The same letters and figures of reference refer to like parts as used in describing Figs. 1, 2, 3, and 4, and the arrows indicate the direction of motion.

Fig. 9 is an external elevation of a sharp-pointed piercing-mandrel A and stem A′ working in a billet, shown in section and adapted for similar purposes to that described in connection with Figs. 1, 2, 3, and 4, but having a smooth surface in its bulb A.

Fig. 10 shows an end elevation of this form of mandrel from its point, and Fig. 11 is an elevation of the stem and billet of metal being acted upon. With great end pressure exerted on the mandrel while it revolves this form of mandrel answers for piercing short billets of soft metal when it is rotated in either direction. The same letters of reference refer to like parts, as in the foregoing figures.

Fig. 12 is a side elevation, Fig. 13 is a sectional plan, and Fig. 14 a transverse sectional elevation, of a long die, correspondingly suited mainly for holding the billets of metal to be operated upon in a cold state by the mandrels described in connection with the foregoing figures. The long die is formed in halves *c* and *c′* and bored out to a slightly-larger diameter than the billet B to be operated upon, the form and arrangement of this die being shown lengthwise and in section by Fig. 13. A billet B is shown placed in this die to be operated upon, and a mandrel A shown partly passed through the billet similar to that described in connection with Figs. 5 to 8. Each half of this long die *c* and *c′* is provided with a steel grasping-dog c^2. These dogs are fitted into the forward ends of the dies and opposite each other, as seen in cross-section in Fig. 14 and in the sectional plan view, Fig. 13. These dogs are bored out to the same concavity as the internal surface of the die, and are provided with teeth to grasp the billet B, being made to project inward a small distance, so as to grasp the billet firmly when the halves of the dies *c* and *c′* are closed upon the billet. These dogs mainly hold the billet in its position against the end pressure and action of the rotating mandrel. Very great containing force is necessary to hold these two semicircular long dies *c* and *c′* together while a billet of any metal in a cold state—such as a billet of copper—is being forced out into a tube by the action of the mandrel, and to effect this a strong containing-channel casting D is provided, by preference, of steel. The strong side containing-flanges D′ and D^2 of this casting have a series of inclined projections D^3, projecting inward, as seen in Fig. 13, on each side, and the flanges are smoothly slotted out between to the shape shown. The bottom of the containing-channel for the halves of this die is also planed out, so as to have a straight and smooth bed-surface for the two halves *c* and *c′* of the die to lie on. The halves of the die, besides being planed and jointed accurately before they are bored out, are also planed on their under sides, and are provided with a series of inclined surface projections c^3, projecting outward, corresponding to the inwardly-projecting surfaces D^3, formed on the containing-casting D, Fig. 13. It is preferred to have these inclined edges D^3 formed at an angle to the center line of the long die sufficiently acute to hold the halves *c* and *c′* of the long die together by the end pressure of the mandrel A as it is forced through the billet of metal B. In operating with this long die and rotating mandrel A the latter may be rotated and forced through the billet B while the billet remains at rest; or the mandrel A may be rotated only while the billet B in its containing long die is moving forward on the mandrel as the latter is rotated to effect the piercing or expanding or drawing action on the billet. The containing die-block D has formed on its base the bed-flanges D^5 D^5, which are planed and are made to slide in the strong bed-plate castings E and E′. The block D is further secured in its channel in the bed-plate castings E and E′ by the plates E^2 and E^3, Figs. 13 and 14, secured to the base-plate castings by bolts. In moving the long die endwise, as explained, the ram of a hydraulic cylinder is the most suitable, and the hydraulic-ram head F, Figs. 12 and 13, is shown connected to the block D, containing the long die *c* and *c′* with the billet B in it. The mandrel A as it is rotated thus effects the piercing and drawing of the metal billet B, the motions on the mandrel, ram-head, containing-block, and long die being as indicated by the several arrows placed on the same. In piercing solid billets of metal oil or other fluid lubricant is fed in over the stem A′ of the mandrel A to its acting head through the annular oil-holder K and oil-tube K′, placed on the mandrel-stem A′. In drawing out from a shell tallow or other lubricant is filled into the hole previous to its being placed in the die.

Fig. 15 is an external elevation, Fig. 16 an external plan, and Fig. 17 an external elevation, partly in section, of a long die suitable for operating on metal billets in a hot state. It is placed on a bed-plate E. The bed-plates for dies of this sort require to be variously shaped, according to the description of gear used to actuate the rotating mandrel. The dies formed in halves C and C′ in this modification are shown bored out eccentrically for billets of a nearly-semicircular form on each half to the same length and same diameter of neck as formed in the counterpart. The central part of the half-die C is also shown of a nearly-semicircular form. The other half-die C′ has formed on it the lever-piece C^5 for be-

ing actuated to open and close the die. Both halves of the die are placed in the strong containing pillow-blocks D^7, which are placed upon the stool-casting G, which is fitted on the bed-plate E^6, the half-die C being secured in these pillow-blocks by the bolts D^6. The other half of this die C′, having its neck the same as the neck of its counterpart, formed about three-sevenths of the circumference of its periphery, allows thereby the half-die C′ to revolve about the seventh part of a circle, as illustrated by Figs. 17, 18, and 19. The lever-piece C^5 of this half-die C′ (shown in section in Fig. 17) at its extreme end has fitted in it the adjustable joint hinge-piece C^6, to which the actuating hand-lever H is connected. This hand-lever H is keyed on an axis H′ and placed in the bush pillow-blocks H^2 and fitted in the stool-castings G, the axis of the lever H being thus left free to revolve by the lever-axis H′. On the center lengthwise of this lever-axis H′ is keyed the cam-lever H^3, Fig. 15, to which are shown coupled by hinge-pins the links H^4 H^4, and which are also coupled, as shown by Figs. 15 and 17, to the adjustable hinge-piece C^6 at the extremity of the lever C^5. The hand-lever H, cam-lever H^3, and link H^4 being in the positions illustrated in Fig. 17, the lever C^5 is raised up as high as its range will allow and the eccentric half-die C′ is closed on its counterpart and the billet B grasped by it, the position of the half-dies in this state being better shown by Fig. 18, in which position the billet is ready for the forward piercing or drawing action of the rotating mandrel A. When the hand-lever H is raised up to the position shown by the dotted line *a b* in Fig. 17, the center line of the cam H^3 assumes the position of the dotted line *c d*, and the top side of the lever C^5 falls down to the position indicated by the dotted lines, causing the oscillating half-die C′ to open out, as shown in end elevation by Fig. 19, at which stage of the process the billet has been pierced and is ready to be removed and a fresh one put in. The dies are again almost instantly closed and secured ready for the action of the mandrel. In piercing steel in a hot state, particularly billets of small diameters, all the operations of placing the billets in the die and of piercing or drawing it must be quickly done to avoid the billet getting overcooled. A guiding bore-piece I (shown in Figs. 15 and 16) guides and enters the mandrel A into the center of the billet B. The diameter of the mandrels for piercing will be most effective ranging only from half an inch to about one inch in diameter and made to rotate at from about ten thousand to twenty thousand revolutions per minute. Means for reaching these high velocities are hereinafter described.

Fig. 20 is a side elevation with the billet in section, Fig. 21 an end elevation, and Fig. 22 a plan, of a long die. The rotating mandrel A is shown entering billet B, which is grasped between the long half-die c^8 and roll half-die c^7 in the proper position for action, the half-die c^8 being shown as moved forward by the hydraulic-ram head F. The motions of the hydraulic ram F, half-die c^8, half-die roll c^7, anti-friction roll J, and billet B being operated upon, and of the rotating mandrel A are all, as indicated by the arrows, placed on these several pieces. An ordinary roll-housing is suitable for this die with under bushes for the necks of the anti-friction roll J′ and top bushes with ordinary adjusting-screws for the necks c^3 of the top roll. In these modifications of the long die described the seat of the billet or shell for making gun-barrels or like articles can be of octagonal or any other form instead of being all formed cylindrically, as shown, and tubular articles may be thus expanded out by the action of the rotating mandrel to any external configuration required.

Fig. 23 is a side elevation, and Fig. 24 an end elevation, of a one-threaded sharp-pointed screw-mandrel A for piercing from the solid, to be employed in combination with holding-ing-dies—such, for instance, as described in connection with Figs. 12 to 19.

In Figs. 25 to 28 I have shown my invention as applied to the manufacture of tubes from shells which may have been produced by piercing solid billets in the manner already described.

Fig. 25 is a side elevation, and Fig. 26 an end elevation, of a rotating mandrel with the bulb having one spiral thread with rounded acting edges A^2. This mandrel is illustrated as being rotated and forced into the shell, and it is shown how the acting edges take hold of the metal and roll or spin waves of metal before them, causing the thick shell to flow into a thin tube, each successive acting edge causing a portion of the metal to flow down before it. The directions of motion are indicated by the arrows.

Fig. 27 is a side elevation, and Fig. 28 an end view, of a similar mandrel A, but with two threads.

Fig. 29 is a side elevation, and Fig. 30 is a plan view, partly in section, of an improved arrangement of draw-bench, illustrating a convenient means for actuating these mandrels. The mandrel A, which is shown in position for action, is as described in connection with Figs. 5 to 8, and the long die *c* (shown applied) is as described in connection with Figs. 12 to 14, and the same letters of reference are used for the same parts. A strong revolving headstock L is shown applied for driving the mandrel A, but as this is very similar to an ordinary hollow spindle-lathe main head-stock it is unnecessary to describe it, other than is done by sectioning some of the parts, as shown in Fig. 30. On the bed-plate E is placed a strong hydraulic cylinder M for giving longitudinal motion with great pressure to its ram F, and the ram-head rod F′ is shown carried from the ram F to the containing-block D of the long die *c*. The hydraulic cylinder M is

shown provided with the rod-snugs M′, to which are secured the tie-rods N and N′, extending through the head-stock casting at L′ and L^2, and through the head-stock back center bridge L^3, being secured by separate screw-nuts. As shown applied in Figs. 29 and 30, the head-stock spindle gives motion to the mandrel A. The motion of the latter and of the die *c* and hydraulic ram F are as indicated by the arrows. A balance-weight may be used for the backing-stroke of the hydraulic cylinder, and this movement is effected through the bush cross-head M^2 by the two chains M^3 M^3, which may be attached to a separate hydraulic-cylinder ram or a balance-weight, or otherwise, as is usually done for similar purposes.

Fig. 31 is a side elevation of a long die similar to that described in connection with Figs. 15 to 19, and combined with means for operating the mandrel. Fig. 32 is a plan view, and Fig. 33 is a transverse section of the same. I have shown this long die as mounted on a bed-plate E along with an arrangement of screw-roll or frictional screwing-rolls S S for driving the high-speed mandrel. In piercing billets of steel in a hot state, as already referred to, a very high rotative speed is required with means for quick starting and stopping, and for small bores of about half an inch in diameter a speed about from twelve to eighteen thousand revolutions per minute is necessary. These rolls S S are keyed on shafts S′ S′, which may be driven by any suitable gear, and they are set in bush-bearings S^3 S^4 in a strong housing T, Fig. 32, containing both these bush-bearings. The bearing S^4 is adjustable by the gear shown for grasping firmly the stem A′ of the mandrel to give it motion quickly, and to release or stop the motion as quickly by the gear and hand-lever V. The diagrams sufficiently explain this gear. The long die C shown is the same as that described in connection with Figs. 15 to 19, and the same letters of reference and numerals refer to like parts. For small diameters of mandrels acting on soft metals the driving frictional grasp of the screw-rolls will give sufficient piercing force; but for large sizes a hydraulic or steam ram F, analogous to the helve of a steam-hammer applied, as shown, to the end of the stem A′ of the mandrel, may be used to increase or assist the forward motion of the rotating mandrel.

I claim as my invention—

1. The herein-described mechanism for forming tubes, comprising long holding-dies for firmly grasping the metal to be operated on, in combination with a rotating mandrel for piercing the metal as it is held in the dies, and means, substantially as described, for applying end pressure to force the mandrel into the metal, all substantially as set forth.

2. The herein-described rotary mandrel for forming tubes by piercing billets, said mandrel having grooves with rounded acting edges to displace the metal as the mandrel is rotated and forced into the billet, substantially as specified.

3. The combination of a rotating grooved mandrel having rounded acting edges for forming tubes by piercing billets of metal with long holding-dies for firmly grasping the metal to be operated on, and means, substantially as set forth, for applying end pressure to force the mandrel into the metal, all substantially as described.

4. The combination of a rotating mandrel for forming tubes by piercing billets of metal with a pair of long half-dies for firmly grasping the metal to be operated on, and a ram to force the dies with the billet up to the rotating mandrel, all substantially as described.

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

JAMES ROBERTSON.

Witnesses:

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