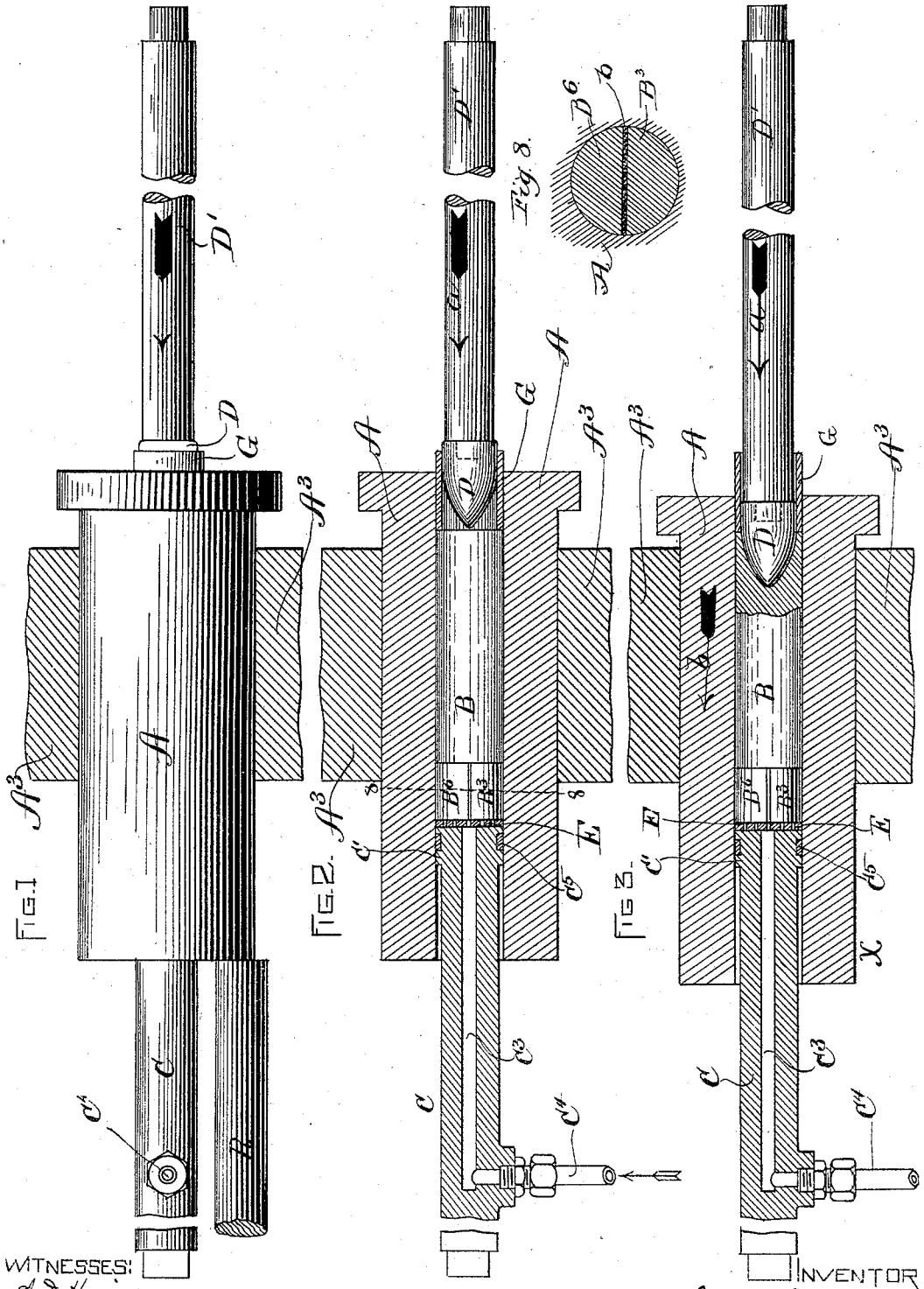
(No Model.) 2 Sheets—Sheet 1.

J. ROBERTSON.

METHOD OF AND APPARATUS FOR SHAPING AND DRAWING METAL TUBES.

No. 493,946. Patented Mar. 21, 1893.



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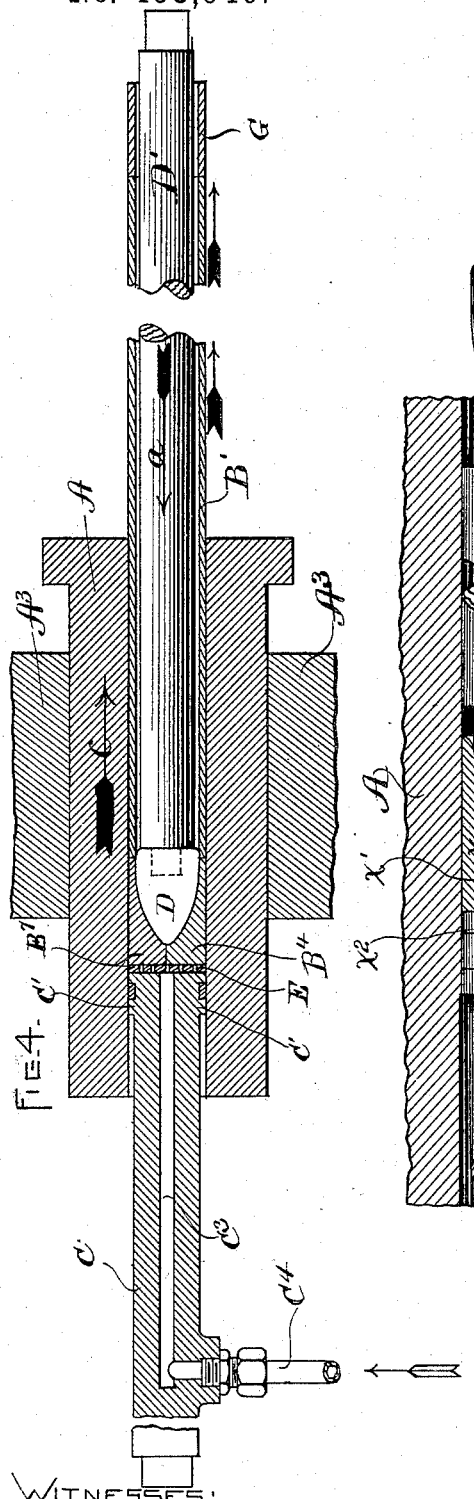

FIG. 4.

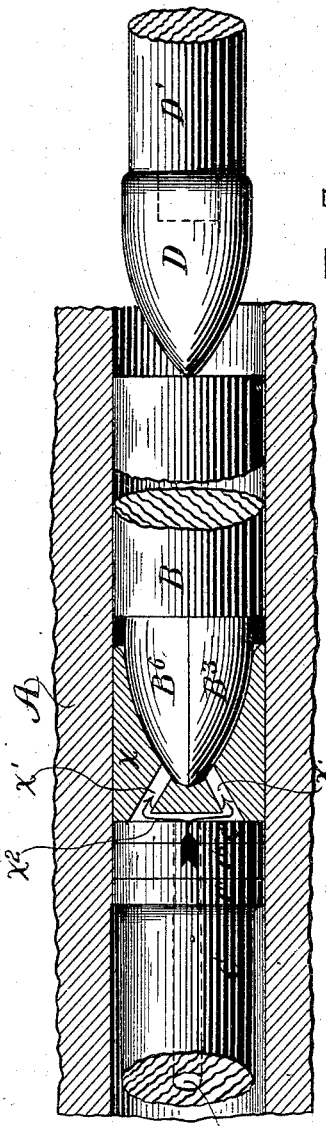

FIG. 5.

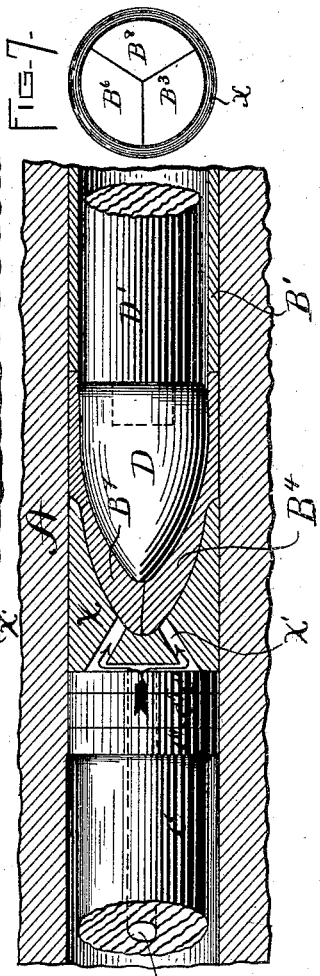

FIG. 6.

FIG. 7.

WITNESSES:
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UNITED STATES PATENT OFFICE.

JAMES ROBERTSON, OF MANCHESTER, ENGLAND.

METHOD OF AND APPARATUS FOR SHAPING AND DRAWING METAL TUBES.

SPECIFICATION forming part of Letters Patent No. 493,946, dated March 21, 1893.

Application filed July 15, 1892. Serial No. 440,152. (No model.) Patented in England July 6, 1891, No. 11,436.

To all whom it may concern:

Be it known that I, JAMES ROBERTSON, a subject of the Queen of Great Britain, residing at Manchester, England, have invented certain new and useful Improvements in the Method of and Apparatus for Shaping and Drawing Metal Tubes, (for which British Letters Patent No. 11,436, dated July 6, 1891, have been granted me,) of which the following is a specification.

This invention has for its object, first, to enable a billet of metal, rendered soft and viscid by heat, to be pierced, and thus converted into a tube, with the minimum of resistance by friction and with the minimum strain and wear of the necessary operative parts.

The invention also has for its object to provide for the ready disengagement of the tube-forming mandrel from the completed tube at the end of the piercing and tube-forming operation, and, further, to protect the mandrel from that injury which might result to it if, at the end of its forward stroke, it were left enveloped in a cap composed of the metal of the rear end of the billet.

The invention consists, first, in the apparatus comprising a metal holding cylinder or die having a cylindrical bore or passage extending through it from end to end, said die being movable in the direction of the length of its bore in both directions, a fixed head or stem-rod formed to enter the rear end of the die and to support the rear end of a billet therein, and a movable mandrel formed to enter the forward end of the die and to exert pressure upon the forward end of the billet, thereby first compressing the billet longitudinally and then causing the metal of the billet to exude between it and the wall of the die in the form of a tube, the freedom of the die to move endwise enabling it to move with the metal of the billet when the latter is being compressed, and then to move in the opposite direction with the exuding metal when the tube is being formed, so that both the compression of the billet and the formation of the tube are attended with the minimum of frictional resistance.

The invention consists, secondly, in an improved method of and means for protecting a tube-forming mandrel from injury at the end of its stroke, and for readily disengaging said mandrel from the completed tube, all of which I will now proceed to describe and claim.

In the accompanying drawings, forming part of this specification: Figure 1 represents a side elevation of an apparatus embodying my invention, the parts being shown in the position they occupy before the tube-forming operation. Fig. 2 represents a longitudinal section of the same, the parts being in the position shown in Fig. 1. Fig. 3 represents a similar section, showing the parts near the beginning of the tube-forming operation. Fig. 4 represents a similar section, showing the parts at or near the close of the operation. Figs. 5, 6 and 7 represent sectional views, showing improvements hereinafter referred to. Fig. 8 represents a sectional view on line 8—8 of Fig. 2.

The same letters of reference indicate the same parts in all the figures.

In the drawings: A represents a metal holding cylinder or die, having a longitudinal forming cavity extending through it from end to end, said die being fitted to slide in the directions indicated by the arrows *b* and *c* in a fixed frame or holder A^3, having a guide or way in which the die A is movable.

C represents a fixed stem-rod or head, adapted to enter the rear end of the die, and to support the billet B against the pressure exerted upon it by the mandrel.

D represents the mandrel, which is formed on or affixed to a stem-rod D′, the latter being attached to any suitable holder adapted to be impelled in the direction indicated by the arrow *a*. The holder and the mandrel may be impelled by hydraulic means or otherwise, and, as means for forcing the mandrel into a die as here indicated are common and well-known, I do not describe and show any means for operating the mandrel.

The billet B, which may be of any suitable metal, such as iron, steel, copper, &c., is placed in the die, the billet being heated so that it is in a soft and viscid condition. The rear end of the billet is supported indirectly by the stem-rod C, through a mandrel-receiving or landing piece B^3 B^6 hereinafter described. The mandrel is then introduced into the die in the direction indicated by the arrow *a*, the

point of the mandrel first striking the outer end of the billet and compressing the billet longitudinally. During the compression of the billet, the die A moves in the same direction with the mandrel, as indicated by the arrow *b* (Fig. 3), until the billet B and the landing-piece B^3 B^6 are both longitudinally compressed and laterally expanded to the extent required to completely fill the die. Thereafter, until the mandrel nearly reaches the end of its stroke, the die has no end motion, but the metal of the billet is caused to exude in the form of a tube through the annular space between the mandrel and the cavity of the die. When the mandrel nearly reaches the end of its stroke, the die begins to move in the opposite direction, as indicated by the arrow *c* in Fig. 4, and this motion continues until the forward stroke of the mandrel ceases. During the time that ensues between the cessation of the movement of the die with the mandrel as indicated in Fig. 3, and the beginning of the movement of the die in the opposite direction as indicated in Fig. 4, the pressure on the mandrel is relieved by the metal squirting past the mandrel, the amount of the reduction of the pressure thus caused being about one-third of the total pressure or force applied to the mandrel. For example, if the total force applied to the mandrel in the direction of the arrow *a* is six hundred (600) tons, there is a force exerted on the die in the direction indicated by the arrow *c* by the exuding metal of about two hundred (200) tons, the pressure on the mandrel being relieved about this amount.

In makiug tubes of steel of about a quarter of an inch in thickness, in the manner above described, the metal is prevented from being packed too hard in the die before the mandrel D by the relieving action caused by the squirting of the metal along the walls of the die and over the mandrel bulb in a reverse direction to the motion of the mandrel, said action tending to draw the quiescent mass of the billet B and the die A away from the stem-rod C. This relieving action is equal to about ten (10) tons to every square inch of the area of the end of the stem-rod opposite the largest diameter of the mandrel D, and, although not sufficient to propel the die A forward in the direction of the arrow *c* until nearly the end of the stroke of the mandrel, is sufficient to prevent the excessive packing of such metals as copper, which flows with sufficient freedom for this purpose when in a hot soft state. Steel does not flow so readily, so that, in making tubes of steel, the squirting movement of the metal has not of itself sufficient relieving action. I therefore find it necessary, when making steel tubes, to apply additional force to move the die in the direction indicated by the arrow *c*, and to this end a hydraulic ram R may be employed, as shown in Fig. 1, said ram being brought in contact with the die and moved in the direction indicated by the arrow *c* after the completion of the endwise movement of the die in the direction indicated by the arrow *b*, the ram being either removed from contact with the die or left loose so as to retreat before it when the die is moving in the direction of the arrow *b*.

C^4 represents a pipe, which admits a fluid such as water under pressure into the stem-rod C, which has a passage C^3 to conduct the fluid into the die, for the purpose of cooling the die, tube and mandrel, and ejecting the tube and mandrel from the die, as shown in my Letters Patent of the United States dated August 16, 1892, No. 481,060.

Between the inner end of the stem-rod C and the landing-piece is or may be interposed a perforated disk E, the object of which is to distribute the water that passes through the passage C^3 over the entire area of the cross-section of the die. The landing-piece, composed preferably of sections B^3 B^6 as hereinafter described, constitutes an important feature of my improvement. I have found, during the course of my experience in making tubes after the manner and with the apparatus herein described, that, if the inner end of the billet bears directly upon the stem-rod head or other support provided for it in the die, the die cannot pass entirely through the billet but remains embedded in a solid cap integral with the tube, unless a rupturable service-plate or abutment is placed within the die and backed by a cavity large enough to receive the mandrel after the service-plate or abutment has been ruptured, as shown in my said Letters Patent of the United States No. 481,060. When the mandrel remains embedded in a solid cap integral with the tube, as above described, it is necessary to cut away said cap in order to release the mandrel and the tube, and there is liability of injury to the mandrel by the protracted contact with heated metal thus involved. The landing-piece sections B^3 B^6 are designed as a substitute for the said rupturable service-plate or abutment, and by their use I materially simplify the apparatus and enable the mandrel and tube to be readily separated at the end of the operation, and obviate liability of injuring the mandrel. Said landing-piece sections, as shown in Figs. 2, 3 and 4, are semicircular, and are or may be of the same metal that the billet is composed of, and are placed loosely in the die before the billet is inserted, said sections being also heated to about the same degree as the billet. It will be seen that the landing-piece sections constitute a soft and compressible receptacle or landing-place into which the mandrel passes when it emerges from the billet, the result being that all of the metal of the billet is converted into a tube, as indicated in Fig. 4, the outward flowing of portions of the landing-piece sections caused by the entrance of the mandrel into them being sufficient to practically force the inner end of the tube off from the head of the mandrel. After the tube has been formed, the landing-piece is ejected with the tube and mandrel

from the die. The sectional construction of the landing-piece, the same being composed of a plurality of sections placed loosely together, enables the water to find its way immediately to the head of the mandrel through the crevices between the landing-piece sections. If the landing-piece sections are made of copper, they do not weld or unite by the pressure that is exerted upon them, so that the water readily passes between them, as above stated; but, when said sections are made of steel, it will be desirable to interpose slips of asbestus between them to prevent welding, said asbestus being indicated at *b* in Fig. 8.

In Figs. 5 and 6, I show the landing-piece sections as made tapering or substantially conical in form, and inserted in a cup-piece *x*, formed internally to receive the tapering landing-piece sections, and provided with holes or passages x' x^2, to receive water from the passage C^3, and thus permit the ready access of the water to the landing-piece sections. The cup-piece *x* may be used repeatedly, and by its employment I economize metal, less metal being required for the landing-piece sections than when said cup-piece is not employed.

In Fig. 7, I show an end view of a landing-piece composed of three sections B^3, B^6 and B^8. I do not limit myself, however, to the number of sections employed, nor to the employment of a plurality of sections, as a single landing-piece formed to receive the head of the mandrel would subserve a useful purpose, although it would not be as desirable as a plurality of sections, because it would not permit the immediate contact of the water with the head of the mandrel, but would remain in contact with the head of the mandrel, and prevent the access of water thereto, while the tube, the mandrel and the landing-piece are being ejected from the die.

I do not limit myself to the employment of the landing-piece with a movable mandrel and a fixed opposing billet-support, as said landing-piece may be interposed between a fixed mandrel and a head or ram which is movable within the die, as shown in Figs. 7 and 8 of another application filed by me concurrently with this application and having Serial No. 440,157.

I claim—

1. In an apparatus for forming tubes from billets of heated metal, the combination of a metal holding cylinder or die, a fixed holder in which said die is adapted to slide lengthwise in both directions, a fixed stem-rod or head arranged to support the rear end of a billet in said die, a movable piercing mandrel adapted to enter the die, and external means for imparting an endwise movement to the die in a direction opposite the movement of the mandrel during a part of the piercing stroke of the mandrel, as set forth.

2. The improved method hereinbefore described of protecting a tube-forming mandrel from injury and of separating it from the formed tube, the same consisting in interposing a landing-piece of hot, soft metal between the billet and the head or support which cooperates with the mandrel in compressing the billet, said piece receiving the mandrel at the close of the tube-forming operation, as set forth.

3. The combination with a metal holding cylinder or die, a piercing mandrel and a billet-support within the die, of a mandrel landing-piece interposed between said support and the billet and adapted to receive the mandrel at the end of the tube-forming operation, as set forth.

4. The combination with a metal holding cylinder or die, a piercing mandrel, a billet-support within the die and means for introducing a fluid under pressure into the die, of a landing-piece composed of two or more sections interposed between the said support and the billet, the joints or seams between said sections being open to permit the passage of the said fluid through the landing-piece to the mandrel, as set forth.

5. The combination with a tube-forming cylinder, a mandrel and a billet support, of a landing-piece formed to be inserted in the tube-forming die, and composed of two or more loose sections, as set forth.

6. The combination with a tube-forming cylinder, a mandrel and a billet support, of a cup-piece formed externally to fit the cavity of the tube-forming die and provided with a cavity to receive a conical landing piece and with one or more water conduits, as set forth.

7. The combination with a tube forming cylinder, a mandrel and a billet support of a landing-piece of substantially conical form, composed of two or more loose sections, combined with a cup-piece formed externally to fit the cavity of the tube-forming die, and provided with a cavity to receive the landing-piece and with one or more water conduits, as set forth.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 14th day of April, A. D. 1892.

JAMES ROBERTSON.

Witnesses:
ARTHUR C. HALL,
ARTHUR H. POPE,
9 *Mount St., Manchester, England.*