(No Model.) 6 Sheets—Sheet 1.

# J. ROBERTSON.

## APPARATUS FOR MAKING TUBES, &c.

No. 429,098. Patented May 27, 1890.

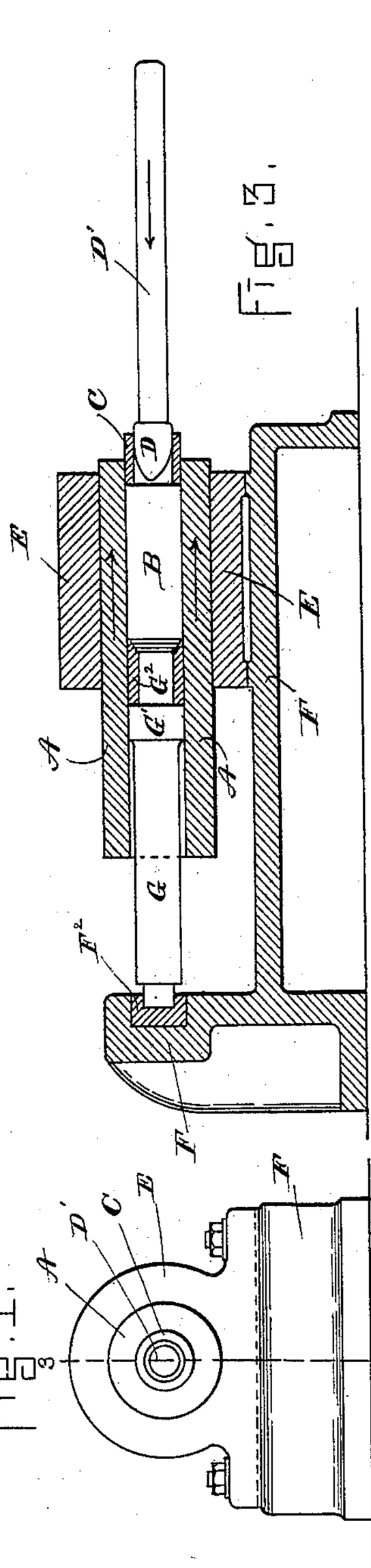


FIG. 5.

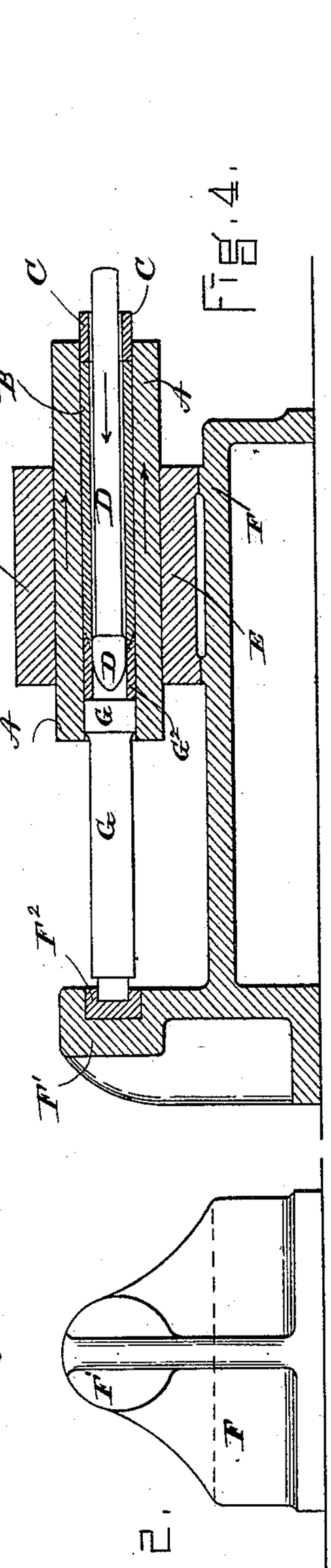


FIG. 4.

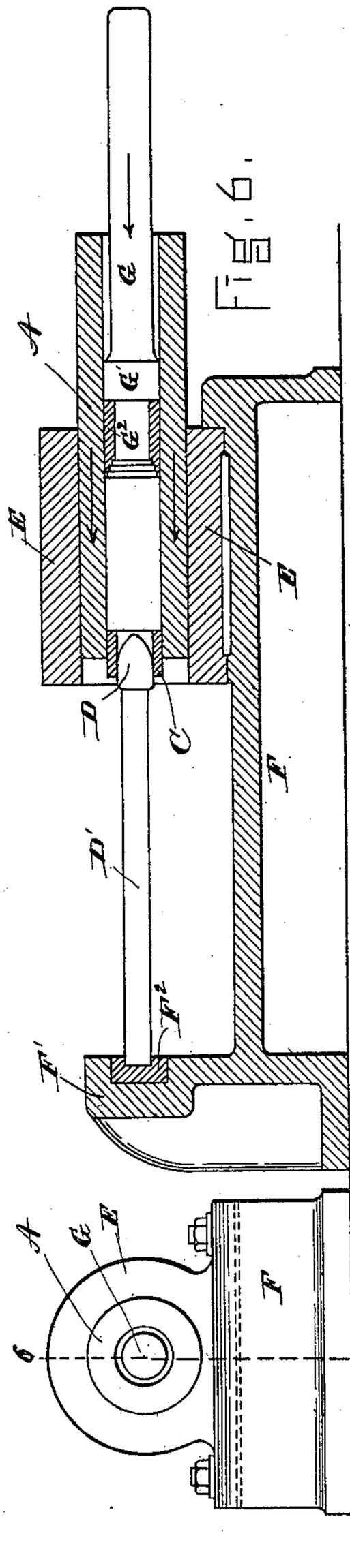


FIG. 6.




FIG. 1.




FIG. 2.




FIG. 3.

WITNESSES.

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# J. ROBERTSON.

## APPARATUS FOR MAKING TUBES, &c.

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FIG. 10.

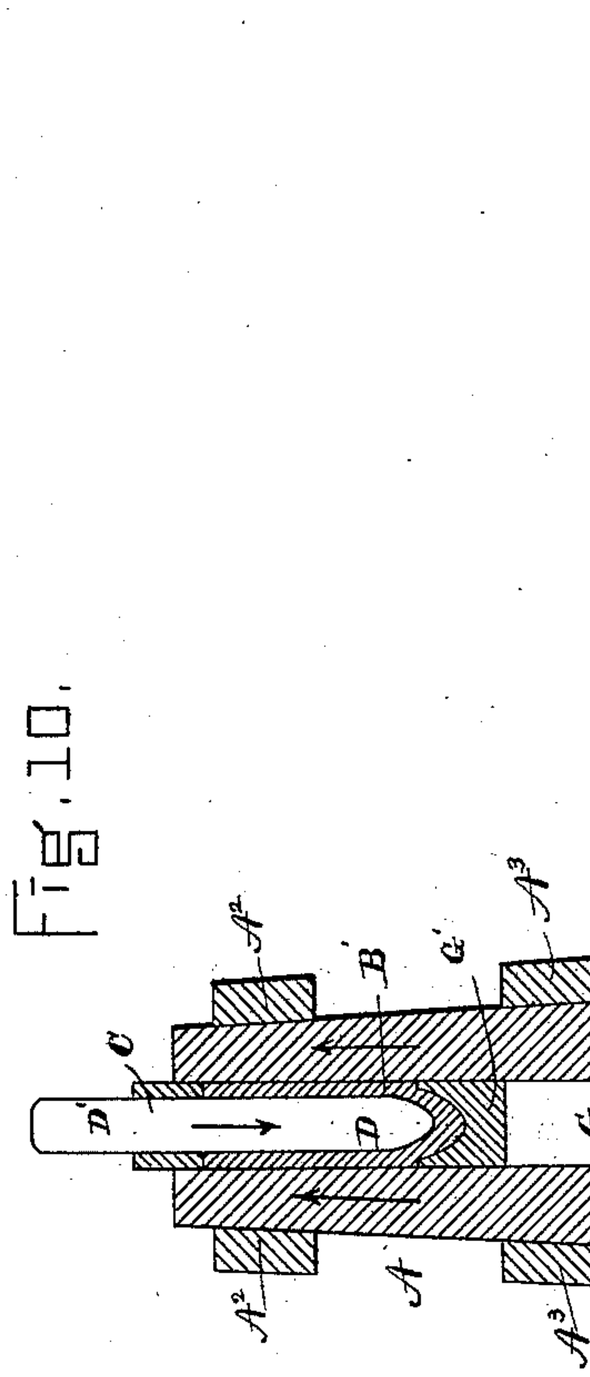



FIG. 7.

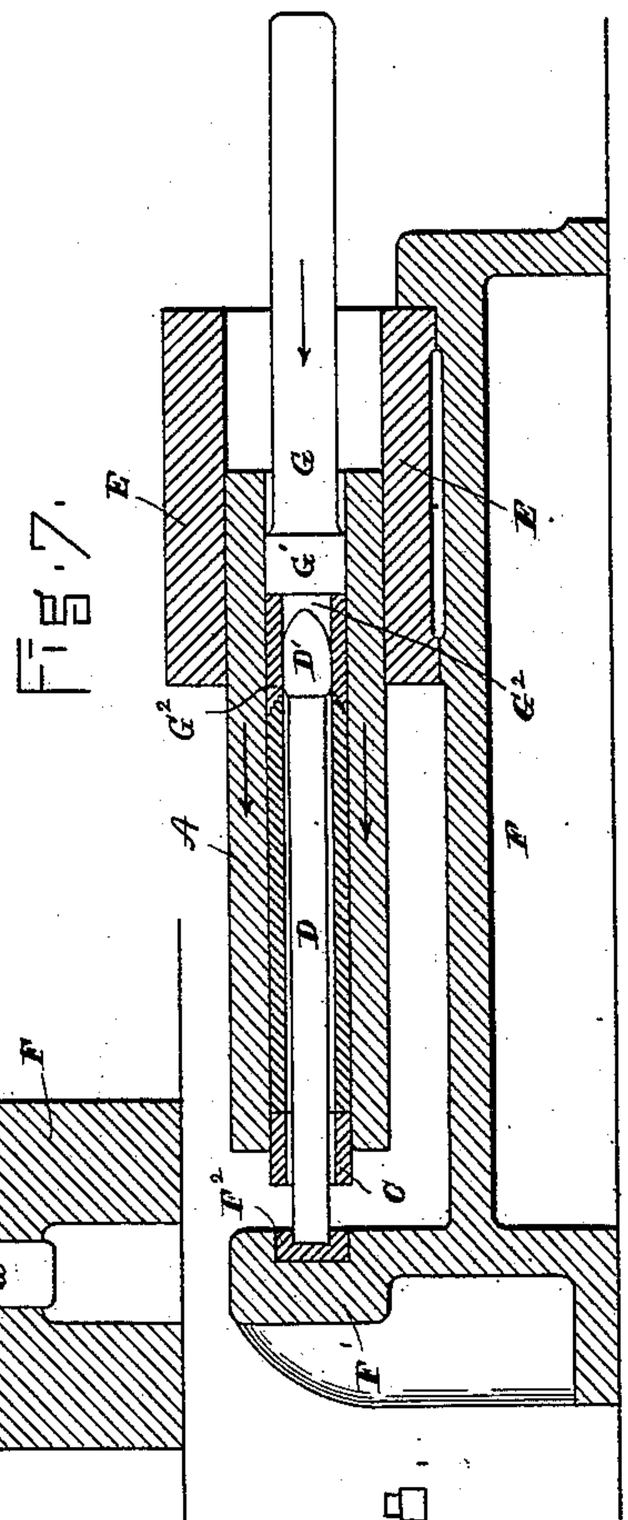



FIG. 9.

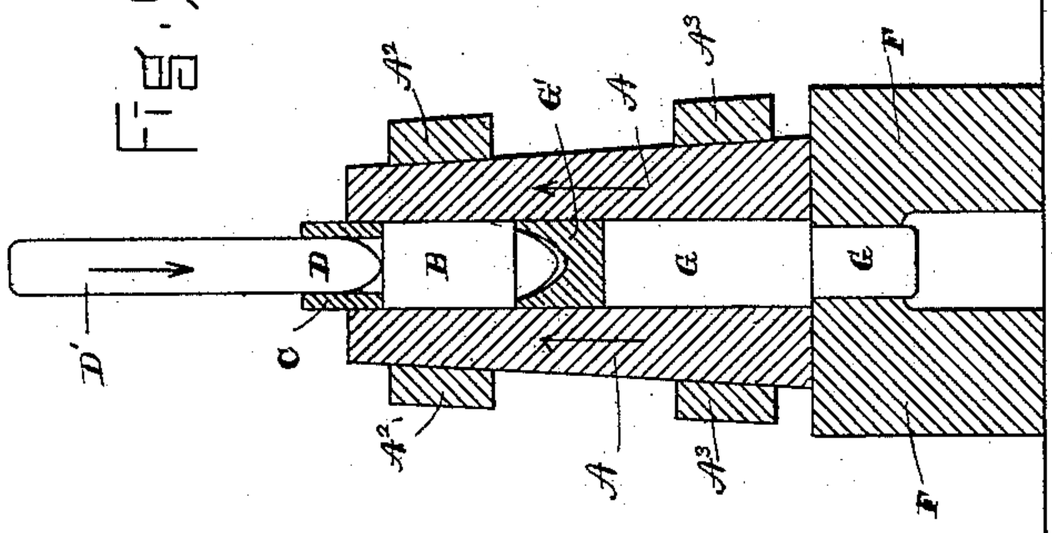
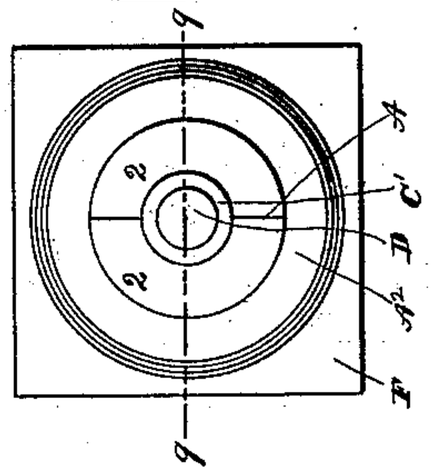



FIG. 8.

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(No Model.) 6 Sheets—Sheet 3.

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## APPARATUS FOR MAKING TUBES, &c.

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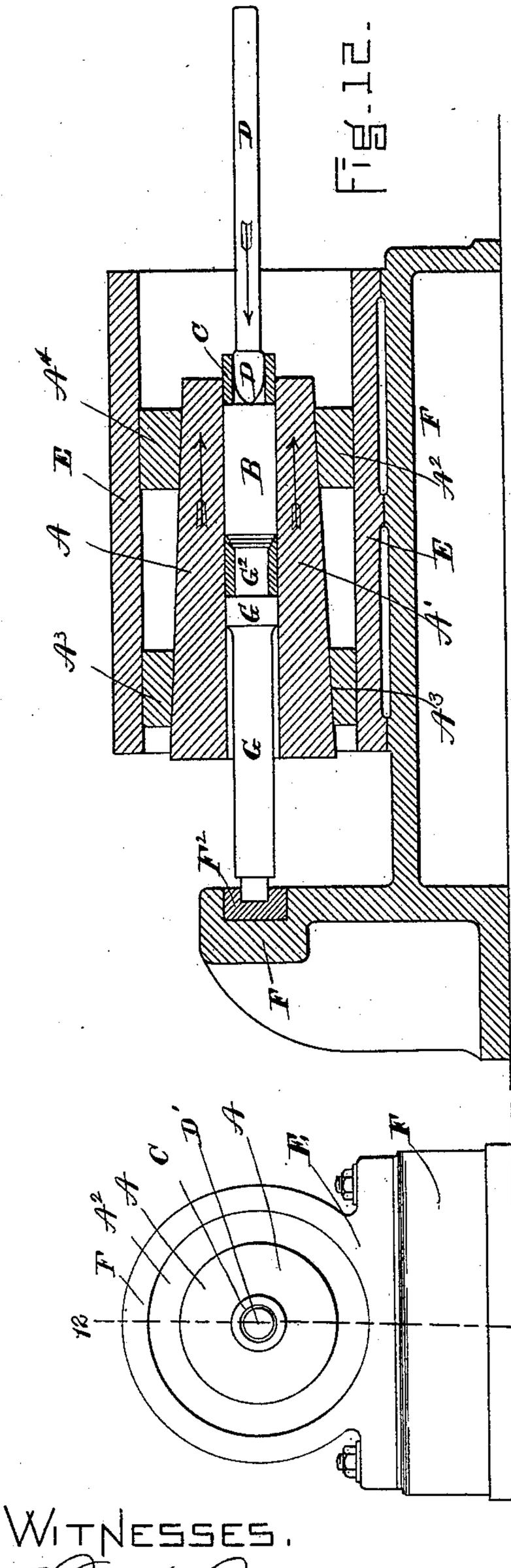


FIG. 12.

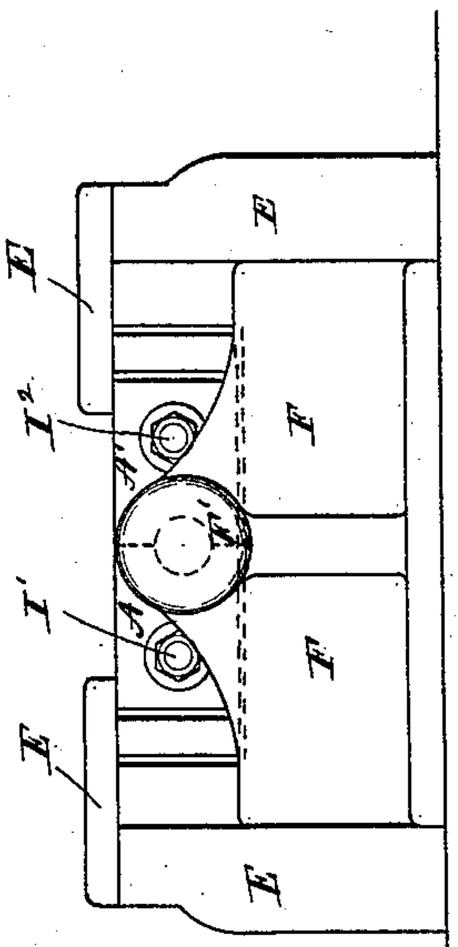


FIG. 14.

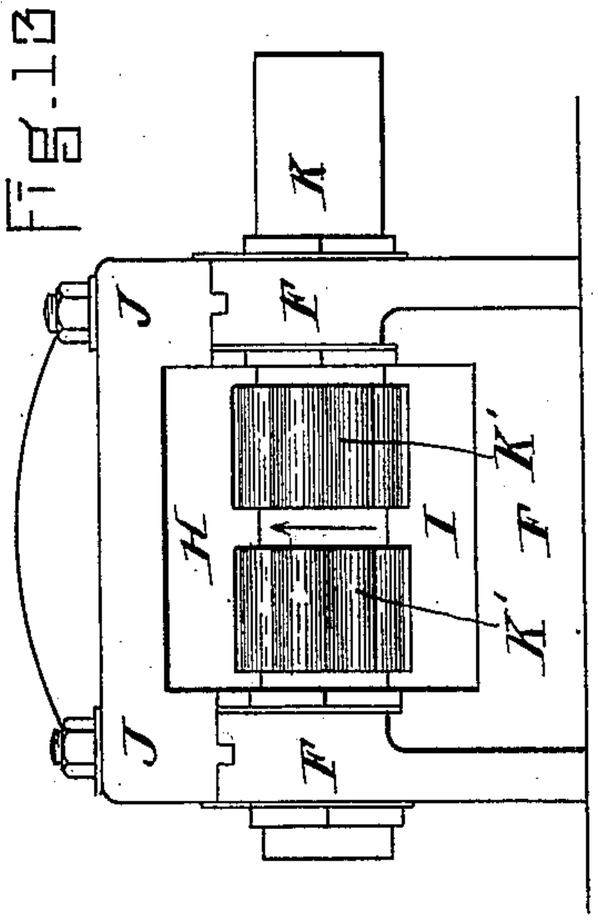


FIG. 13.




FIG. 11.

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## APPARATUS FOR MAKING TUBES, &c.

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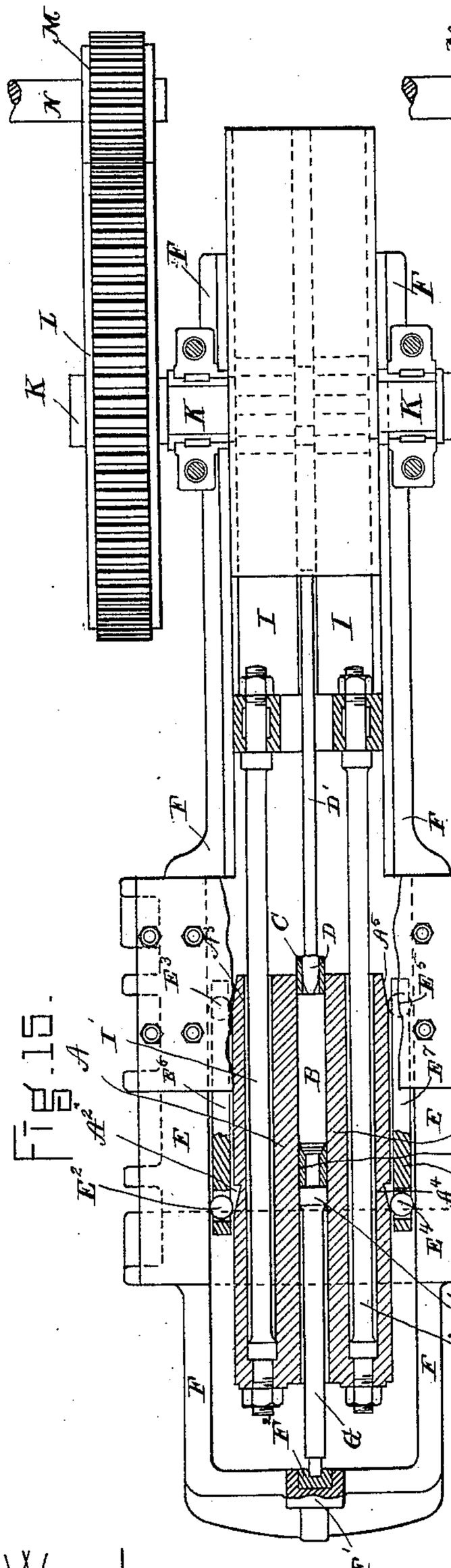

FIG. 15.

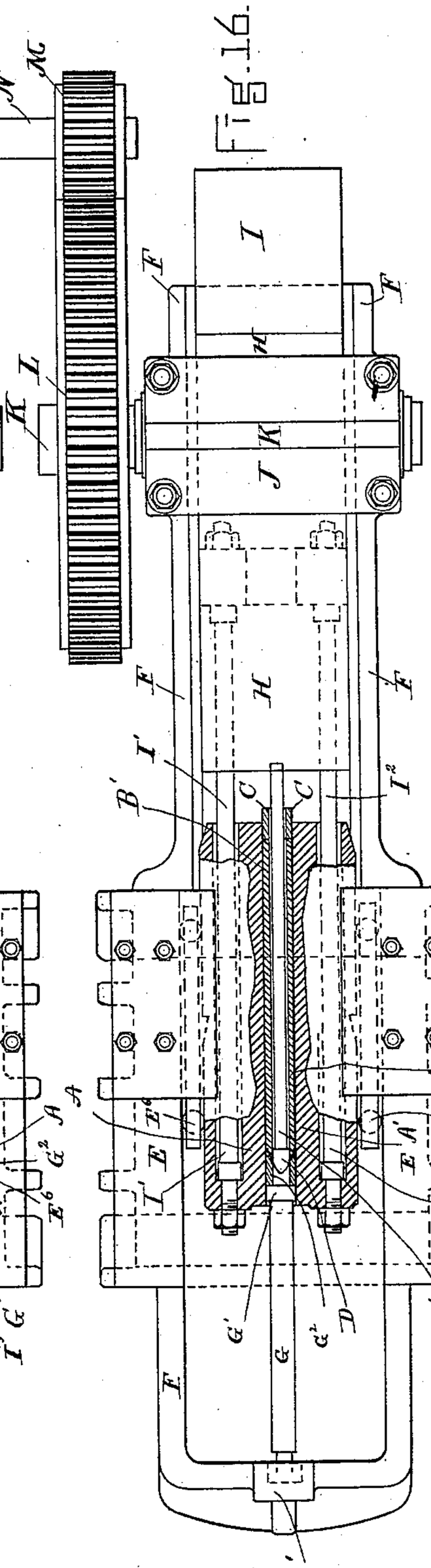

FIG. 16.

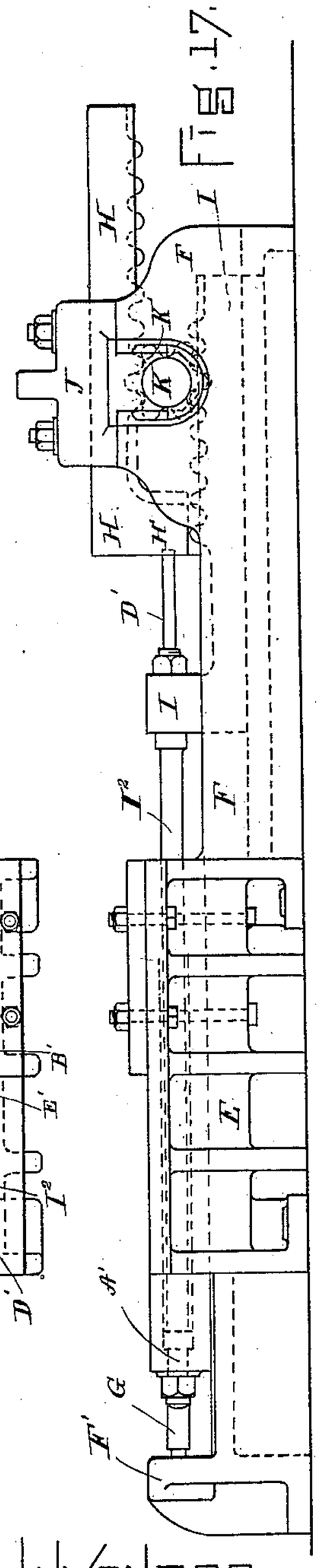

FIG. 17.

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(No Model.) 6 Sheets—Sheet 5.

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## APPARATUS FOR MAKING TUBES, &c.

No. 429,098. Patented May 27, 1890.

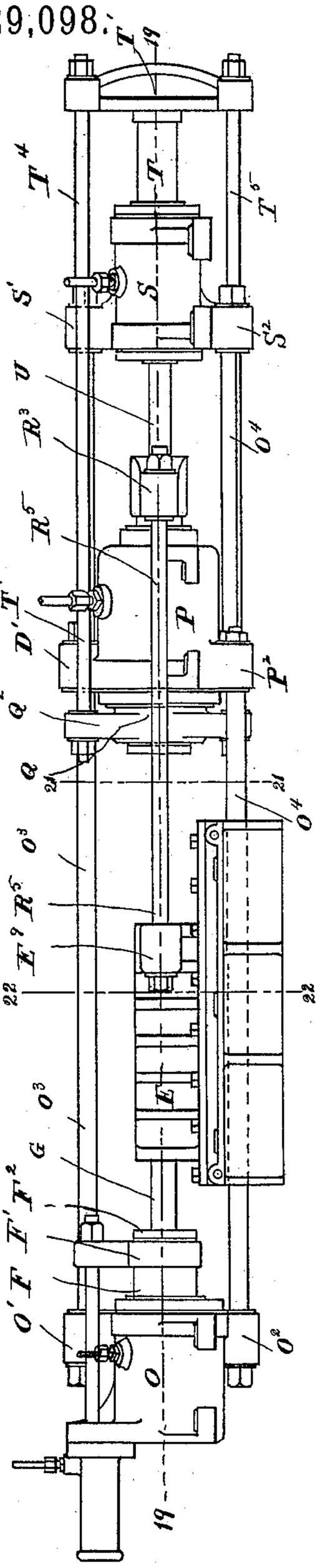


FIG. 16.

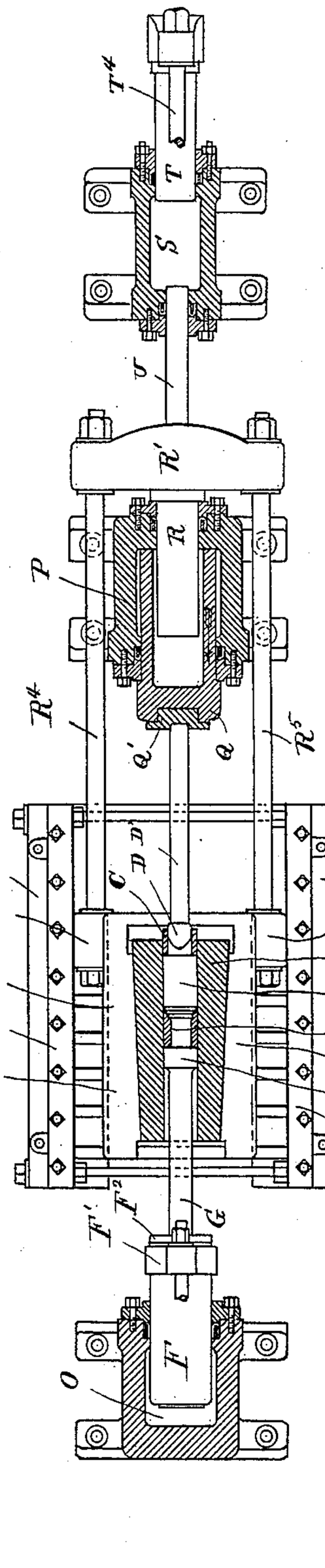


FIG. 17.

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(No Model.) 6 Sheets—Sheet 6.

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## APPARATUS FOR MAKING TUBES, &c.

No. 429,098. Patented May 27, 1890.

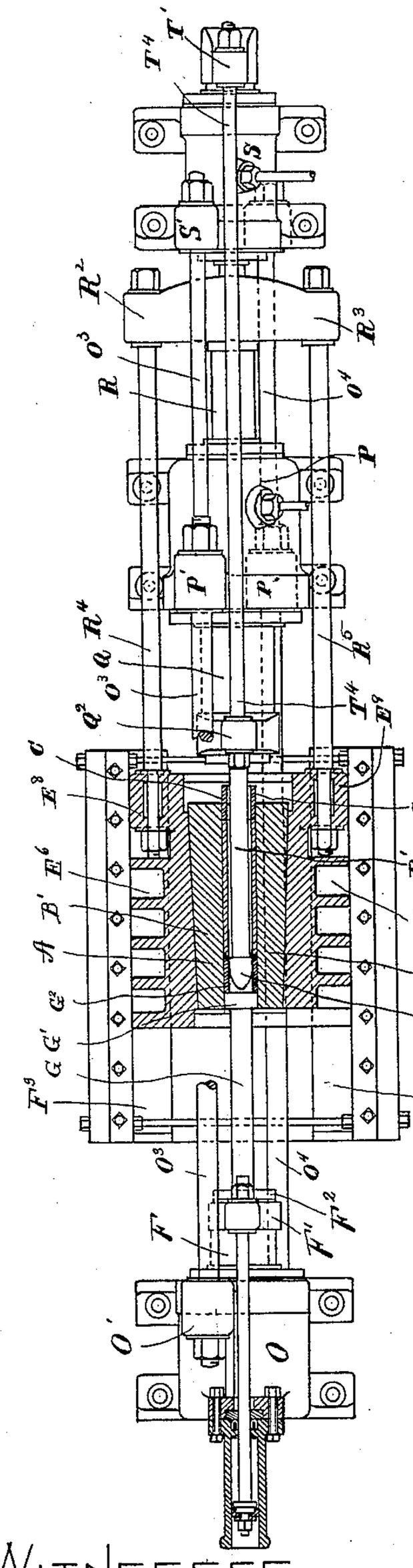

FIG. 20.

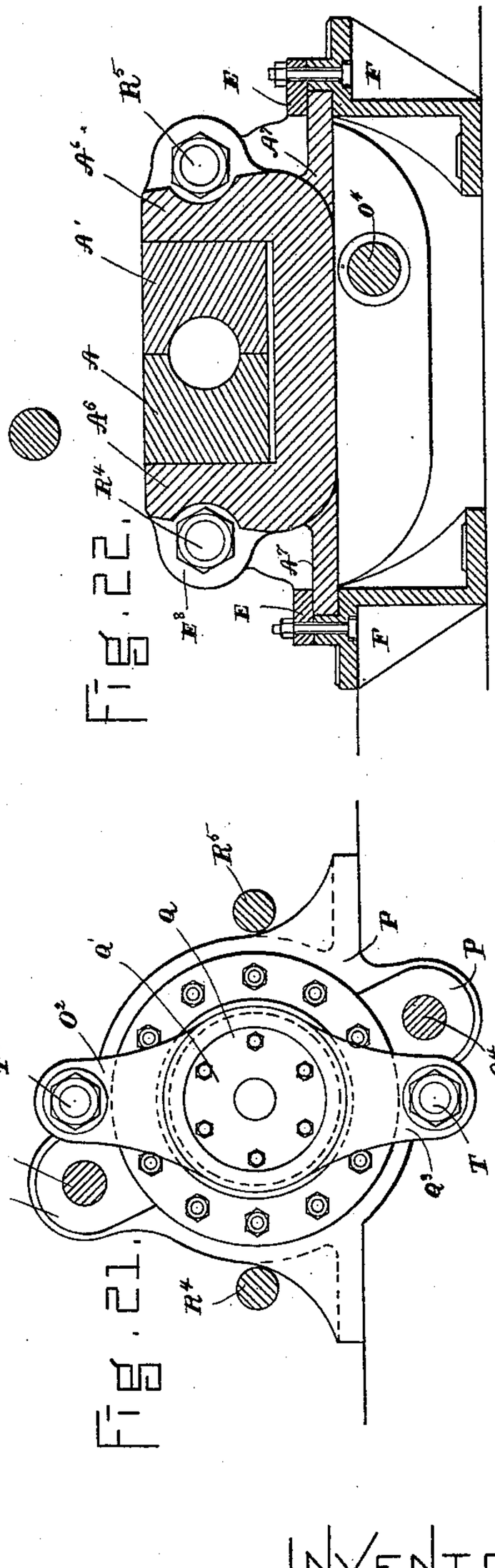

FIG. 22.



FIG. 21.

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# UNITED STATES PATENT OFFICE.

JAMES ROBERTSON, OF BIRMINGHAM, COUNTY OF WARWICK, ENGLAND.

## APPARATUS FOR MAKING TUBES, &c.

SPECIFICATION forming part of Letters Patent No. 429,098, dated May 27, 1890.

Application filed February 24, 1890. Serial No. 341,412. (No model.)

*To all whom it may concern:*

Be it known that I, JAMES ROBERTSON, of Birmingham, in the county of Warwick, England, have invented certain new and useful Improvements in Apparatus for Making Seamless Tubes, Tube-Blanks, and like Seamless Tubular Articles, of which the following is a specification.

This invention relates to the manufacture of seamless metal tube-blanks and tubes and like seamless tubular metal articles, such as boiler-flues, pipe-coupling rings or sockets, broad rims of pulleys or rolls, and other hollow articles of either parallel or tapering form, such as blanks for shot and shell.

The invention has particular reference to the articles above indicated by the employment of a long die having a tube-forming bore or seat of cylindrical form, a piercing-mandrel adapted to penetrate a heated billet of metal placed in said die at the end opposite the end which the mandrel enters.

In Letters Patent of the United States granted to me November 26, 1889, I have shown as the billet-supporting means a head supported by a stem-rod which is adapted to move synchronously with the mandrel, said head moving, however, at a slower rate than the mandrel, so that its retreating movement corresponds to the rate at which the metal of the billet displaced by the mandrel recedes before the mandrel, the purpose of said head being to furnish a sufficient support for the rear end of the billet to prevent the metal of the billet or the walls of the tube in process of formation from being cracked or broken by the pressure of the mandrel against it.

In the apparatus shown in said patent the die is shown and described as fixed, and the mandrel, as well as the billet-supporting head, movable, so that the tube as fast as it is formed by the action of the mandrel moves or slips over the forming-surface of the die, the metal of the billet squirting out, as it were, between the mandrel and the portion of the die immediately surrounding the mandrel, and moving toward the forward end of the fixed die.

I have found that in many cases it is advantageous to make the die movable longitudinally, so that it will move when the metal of the billet within it is being converted into a tube, the surface of the die moving with the metal that is squirted out or passed in tube form over the mandrel, instead of remaining stationary while the metal moves over it, as in my former patent.

My invention, therefore, consists, first, in the combination, with a piercing-mandrel and a head adapted to support a billet against the pressure imparted to the billet by the mandrel, of a die having a tube-forming bore or seat which receives said billet, mandrel, and head, and is movable longitudinally, so that it will move with the metal which exudes over the mandrel in the form of a tube as the mandrel is forced into the billet, the tube having, therefore, no frictional movement upon the walls of the die, the only part of the metal used in the formation of the tube that is frictionally moving upon the walls of the die being the unformed or solid portion of the billet, said portion gradually decreasing in length as the tube is formed.

My invention also consists in the combination, with the mandrel, the billet-supporting head, and the movable die, of means for positively impelling said die, so that the frictional contact of the exuding metal will not necessarily be relied upon to cause the movement of the die, although in many cases said frictional contact will be sufficient, as hereinafter pointed out.

My invention also consists in certain combinations of parts and mechanism incidental to the purposes of my invention, all of which I will now proceed to describe and claim.

Of the accompanying drawings, forming a part of this specification, Figures 1 and 2 represent elevations of opposite ends of a die and its container embodying my invention. Figs. 3 and 4 represent longitudinal sections on line 3 3, Fig. 1, said figures showing also the mandrel and the billet-supporting head, Fig. 3 showing the billet and the parts that co-operate in forming the tube in the position they occupy before the commencement of the operation, while Fig. 4 shows the parts in the position they occupy at the end of the tube-forming operation, the mandrel being movable and the billet-supporting head fixed in said Figs. 1, 2, 3, and 4. Fig. 5 represents an end elevation of a somewhat different construction embodying my invention. Figs. 6 and 7 represent sections on line 6 6, Fig. 5,

Fig. 6 showing the parts in the position they occupy before and Fig. 7 in the position they occupy after the tube-forming operation, said Figs. 5, 6, and 7 showing the mandrel fixed and the billet-supporting head movable. Fig. 8 represents an end elevation of another embodiment of my invention, in which the die, mandrel, and billet-supporting head are arranged vertically. Figs. 9 and 10 represent a section on line 9 9, Fig. 8, Fig. 9 showing the parts in the position they occupy before and Fig. 10 after the tube-forming operation. Fig. 11 represents an end elevation of another form of apparatus embodying my invention, and Fig. 12 represents a section on line 12 12 of Fig. 11. Figs. 13 and 14 represent opposite end elevations, and Fig. 15 a top plan view, partly in section, of an organized machine embodying my invention, and showing means for positively moving the die. Fig. 16 represents a top plan view, partly in section, of the machine shown in Fig. 15, the die and mandrel being in the position they occupy after the tube-forming operation. Fig. 17 represents a side elevation of the machine shown in Figs. 13, 14, 15, and 16. Fig. 18 represents a side elevation of an organized machine embodying my invention, in which hydraulic mechanism is employed to actuate the die, mandrel, and billet-supporting head. Fig. 19 represents a section on line 19 19 of Fig. 18, showing the machine before the tube-forming operation, the billet being shown in place in the die. Fig. 20 represents a top view of the machine shown in Figs. 18 and 19, parts of the machine being shown in section, the die and mandrel being shown in the position they occupy after the tube-forming operation. Fig. 21 represents a section on line 21 21, Fig. 18, looking toward the right. Fig. 22 represents a section on line 22 22, Fig. 18, looking toward the right.

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

Referring to Figs. 1, 2, 3, and 4, A represents the die, which is provided with a cylindrical tube-forming bore or seat, and is sufficiently elongated to permit a billet B, placed in said bore or seat, to be elongated into a tube without protruding from the die during the forming operation. G′ represents a billet-supporting head, which is formed on a stem-rod G. Said rod is supported by a step $F^2$, which is fitted in a socket in a supporting-standard F′, formed on the bed or supporting frame F.

D represents the mandrel, which is formed on a stem D′, to which longitudinal motion is imparted in the direction indicated by the arrow in Figs. 3 and 4 by any suitable means—such, for example, as are shown and described hereinafter.

The die A is movable endwise, and is here shown as fitted to slide in a cylindrical holder or container E, which is suitably attached to the bed or frame F.

The billet B is placed in the die near the forward end thereof, as shown in Fig. 3, the die being moved back to the position shown in Fig. 3, which may be considered its starting position. Pressure being applied to the mandrel in the direction indicated by the arrow, the mandrel is caused to penetrate the billet, and the metal of the billet commences to exude or squirt out in the form of a tube through the annular space between the mandrel and bore or seat of the die. The exuding metal being in frictional contact with the die causes the latter to move forward with it in the direction indicated by the arrows marked on the die in Figs. 3 and 4, the die traveling at the same rate as the exuding metal. This movement of the die prevents the mandrel from being packed or stuck up in the metal, and makes it practicable to convert a solid billet of metal into a tube or to draw out a tubular blank in the manner described. The mandrel is also prevented from excessively packing or compressing the metal during the operation. The solid or unpierced portion of the billet, remaining stationary because supported by the fixed head G′, is in rubbing contact with the advancing die; but this fact is immaterial, because the solid portion of the billet is not as liable to injury by said rubbing contact as the exuding portion, which has been converted into a tubular form. Said solid portion grows shorter and shorter as the operation advances, until all the metal of the billet is converted into tubular form by the passage of the mandrel through it, as shown in Fig. 4. The mandrel-guide C is placed in the forward end of the die prior to the tube-forming operation to cause the mandrel to enter the billet centrally, said guide being shown and claimed in my former patent.

$G^2$ represents a tubular ferrule or extension, which is placed in the die between the head G′ and the rear end of the billet, said ferrule having its interior at the forward end formed as a series of steps or shoulders, which support the rear end of the billet and prevent the hot metal—such as hot soft steel or hot soft copper—from entering farther into the ferrule than the portion included by said steps, the metal of the billet being therefore caused to flow or exude past the mandrel in the form of a tube.

In Figs. 5, 6, and 7 I have shown the mandrel D′ as fixed and occupying the position in which the head G′ is placed in the preceding figures, the head G′ and its rod G being moved endwise to cause the mandrel to pierce the tube. In this case the direction of movement of the head G′ is indicated by the arrow marked on the rod G, and the direction of endwise movement of the die A by the arrows marked on said die in Figs. 6 and 7. The result produced by this arrangement is the same as by the arrangement first described, the only difference being that the mandrel is fixed and the billet-supporting head is movable.

In the construction shown in Figs. 8, 9, and

10 the die, the billet-supporting head, and the mandrel are arranged vertically, the head being fixed and the die and mandrel movable in opposite directions, as shown in Figs. 1, 2, 3, and 4. In this construction the movable die, instead of being guided by an external guide or holder, as E in the preceding figures, is guided by the stem-rod G, which supports the head G′, said rod being rigidly fixed to the supporting head or frame F in a vertical position. The die is in this case made in two sections 2 2, which are held by hoops or bands $A^2$ $A^3$. The construction shown in these figures is particularly adapted for forming military-shell blanks, the supporting-head G′ being provided with a conical recess to form the closed conical end of a military shell. The mandrel is forced downwardly in the forming operation, and the die is raised by the frictional contact of the exuding metal therewith, as shown in Fig. 10. After the article has been formed the die may be lifted off from the guiding stem-rod G and its parts separated by the removal of the hoops $A^2$ $A^3$ to permit the removal of the shell-blank. When the apparatus is constructed in the form last described, a hammer or other means for applying percussive force may be utilized for moving the mandrel.

Figs. 11 and 12 show a horizontally-arranged die made in two sections connected by hoops $A^2$ $A^3$, as in Figs. 8, 9, and 10. In this case the peripheries of the hoops are formed of the same size, and are fitted in the cylindrical horizontal guide or holder E, the construction shown in these figures differing from that shown in Figs. 1, 2, 3, and 4 only in the construction of the die, the latter being made in separable sections and guided by the contact of its hoops $A^2$ $A^3$ with the holder E, instead of being solid and in direct contact with said holder, as shown in Figs. 1, 2, 3, and 4.

Figs. 13, 14, 15, 16, and 17 show an organized machine in which the die A is positively impelled, instead of being impelled by frictional contact with the exuding metal of the billet. The die A is in this case of rectangular form in cross-sections, and the guide or holder E is correspondingly formed, as shown in Fig. 14. K represents a driving-shaft journaled in bearings near one end of the frame of the machine, and provided with pinions K′ K′, which mesh with racks H and I, which are fitted to move horizontally in guides formed in the supporting-frame, the racks H being above and the racks I below said shafts and pinions, so that when the shaft is rotated the rack H will be moved in one direction and the rack I in the opposite direction. The rack H has an offset or shoulder H′, which is engaged with the mandrel-rod D′, so that said rack gives to the mandrel its operative or billet-piercing movement. The rack I is connected by rods I′ $I^2$ with the die A, so that said rack gives the die a movement in the direction opposite to that of the mandrel, as will be readily understood. To facilitate the movements of the die, anti-friction rollers $E^2$ $E^3$ $E^4$ $E^5$, which are journaled in vertical plates or holders $E^6$, are interposed between the opposite sides or edges of the die and the corresponding sides of the guides E, as shown in Figs. 14, 15, and 16, said rollers bearing against both the guides and the sides of the die. The plates $E^6$ are movable freely endwise. The die is made in two halves or sections to facilitate the removal of the tube, and said sections are enabled to spring apart enough to loosen the tube at the end of the forming operation by means of recesses $A^2$ $A^3$ $A^4$ $A^5$ in the sides of the die, said recesses coinciding with the rollers $E^2$ $E^3$ $E^4$ $E^5$ when the die is returned to its starting position after the tube-forming operation, and permitting the sections of the die to spring slightly apart, so that the completed tube may be easily removed and another billet inserted. The shaft K, that impels the pinions K′ K′, has a large gear L affixed to it, which meshes with a pinion M on a driving-shaft N.

In Figs. 18 to 22, inclusive, I show an organized machine in which propelling force is applied to the mandrel and die in different relative proportions, and with a balancing arrangement, whereby this relative degree or proportion of propelling force is given with any degree of cumulative force that may be required for both operations. As already indicated, the contact of the exuding annular mass of metal with the walls of the die is sufficient to move the die forward and relieve the action of the mandrel and prevent it from sticking in the metal; but for other and larger articles I find it an advantage to assist by a certain degree of force the endwise forward motion of the die, and to apply to the die a degree of force directly proportioned to that applied to the mandrel, the force applied to the die being preferably about one-third of that applied to the mandrel. To accomplish this result I prefer the means shown in the figures last referred to. In said figures I show two hydraulic rams Q and R, connected, respectively, with the mandrel and with the die A. The ram Q is fitted in a fixed cylinder P, and is provided with a step Q′, which supports the rear end of the mandrel rod or stem D′. The ram Q is moved in the direction indicated by the arrow marked thereon in Fig. 19 when fluid-pressure is admitted into the cylinder P. The ram R is of smaller area than the ram Q and projects into the latter, said ram Q being of annular form, as shown in Fig. 19. The ram R is arranged to be moved by the same fluid-pressure as impels the ram Q, but in a direction opposite to that of the latter, and has secured to its outer end a cross-head R′, which is connected by rods $R^4$ $R^5$ with ears $E^8$ $E^9$, formed on a slide-carrier $A^6$, which contains the die A. Said carrier $A^6$ and the die A contained therein are movable in the guides E E, the carrier having ears or flanges $A^7$ $A^7$ entering said guides, as shown in Fig. 22. It

will be seen that the different sizes of the two rams Q and R cause the fluid-pressure in the cylinder P to exert different degrees of force on the mandrel and die, the relative forces being the same whatever the cumulative force or pressure employed may be.

Fig. 19 shows the positions of the mandrel, die, and actuating-rams before the tube-forming operation. Fig. 20 shows the position of said parts after the forming operation.

To effect the return movement of the rams, mandrel, and die from the position shown in Fig. 20 to that shown in Fig. 19, prior to every fresh operation in making a tube, a small hydraulic cylinder S is employed, which is formed like the cylinder P, and has a similar ram U passing through one end and bearing against the cross-head R′, which is connected by the rods $R^4$ $R^5$ with the die-carrier, and a larger ram T passing through its opposite end, said ram T being provided with a cross-head T′, which is connected by rods $T^4$ $T^5$ with a cross-head $Q^2$, attached to the ram Q. When fluid-pressure is admitted to the cylinder S while the die and mandrel are in the position shown in Fig. 20, the ram U is moved in the direction required to move the die-carrier and die back to their starting position, and the larger ram T is moved in the opposite direction to carry the ram Q and mandrel D back to their starting position.

In Figs. 18, 19, and 20 I show a stem-rod G of the billet-supporting head G′ attached to a ram F, which is fitted to move in a fixed cylinder O. This cylinder and its ram serve to hold the rod G and head G′ steadily in its position during the tube-forming operation, and for the purpose of adjusting said rod and head to suit the length of the billet B. The cylinder O has ears O′ $O^2$, which are connected by rods $O^3$ $O^4$ with ears P′ $P^2$ on the cylinder P.

I claim—

1. As an improvement in apparatus for making and drawing out tube-blanks, tubes, tubular articles, and shells, the combination, substantially as hereinbefore set forth, with a billet-piercing mandrel and a billet-supporting head, of a longitudinally-movable die formed to receive said mandrel and head.

2. As an improvement in apparatus for making and drawing out tube-blanks, tubes, tubular articles, and shells, the combination, substantially as hereinbefore set forth, with a billet-piercing mandrel and a billet-supporting head, of a die formed to receive said mandrel and head, and a fixed guide or guides on which said die is longitudinally movable.

3. As an improvement in apparatus for making and drawing out tube-blanks, tubes, tubular articles, and shells, the combination, substantially as hereinbefore set forth, of a billet-supporting head, a billet-piercing mandrel movable toward and from said head, and a die formed to receive said mandrel and head and movable longitudinally in a direction opposite to the direction of motion of the mandrel.

4. As an improvement in apparatus for making and drawing out tube-blanks, tubes, tubular articles, and shells, the combination, substantially as hereinbefore set forth, of a billet-supporting head, a billet-piercing mandrel movable toward and from said head, a die formed to receive said mandrel and head, and means for impelling said die and mandrel simultaneously in opposite directions.

5. As an improvement in apparatus for making and drawing out tube-blanks, tubes, tubular articles, and shells, the combination, substantially as hereinbefore set forth, of a billet-supporting head, a billet-piercing mandrel movable toward and from said head, a die formed to receive said mandrel and head, and anti-friction rollers arranged to support and guide said die.

6. As an improvement in apparatus for making and drawing out tube-blanks, tubes, tubular articles, and shells, the combination, substantially as hereinbefore set forth, of a billet-supporting head, a billet-piercing mandrel movable toward and from said head, a die formed to receive said mandrel and head, and anti-friction rollers arranged to support and guide said die, said die being made in separable sections, which are provided with recesses arranged to coincide with said rollers at a given point in the movement of the die, whereby the sections of the die are permitted to separate.

7. As an improvement in apparatus for making and drawing out tube-blanks, tubes, tubular articles, and shells, the combination, substantially as hereinbefore set forth, of a billet-supporting head, a billet-piercing mandrel, a die, and fixed guides therefor in which the die is movable longitudinally, means whereby the mandrel may be impelled in one direction with a given degree of force, and means for simultaneously impelling the die in the opposite direction with a lesser degree of force.

8. As an improvement in apparatus for making and drawing tube-blanks, tubes, tubular articles, and hollow articles or shells, the combination, substantially as hereinbefore set forth, of a die having a forming bore or seat, a holder or carrier for said die placed in slides to allow both the die and its carrier to be moved endwise, a billet-supporting head entering the die-seat and fixed endwise, so that the die may move over the said head, a mandrel adapted to enter the die, an impelling piston or ram and connections between it and the mandrel, whereby the mandrel may be impelled in one direction with a given degree of force, and another piston or ram of smaller size, and connections between the last-mentioned ram and the die, whereby the die is moved synchronously with the mandrel, but in the opposite direction and with a smaller degree of force or pressure.

9. The combination, with the die and mandrel movable in opposite directions, of the billet-supporting head, its stem-rod, and the ram F and hydraulic cylinder O, whereby said head and rod are adjustably supported, as set forth.

10. The combination, with the head G′, the mandrel D, and the die A, of the cylinder P, rams Q R in said cylinder, connected, respectively, with the said mandrel and die and impelled simultaneously in opposite directions, the cylinder S, the rams U T in said cylinder, and connections between the ram U and the die and between the ram T and the mandrel-operating ram Q, whereby the die and mandrel may be restored to their starting positions, 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 January, 1890.

JAMES ROBERTSON.

Witnesses:
WILLIAM LINDSAY,
WM. ROBERTSON.