(No Model.) 4 Sheets—Sheet 1.

# G. J. CAPEWELL.

## MACHINE FOR FORMING TUBES.

No. 589,694. Patented Sept. 7, 1897.

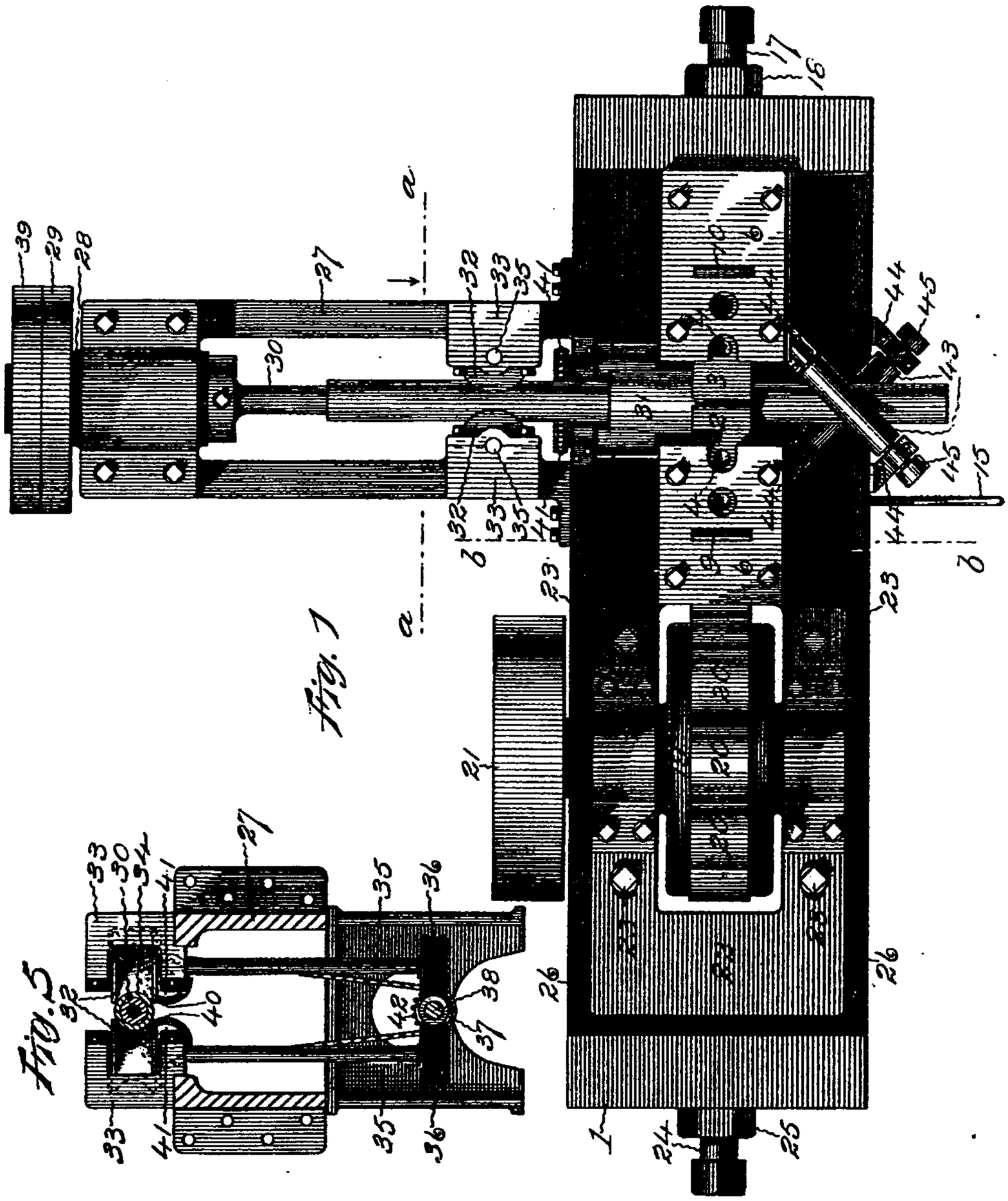

Fig. 1



Fig. 5

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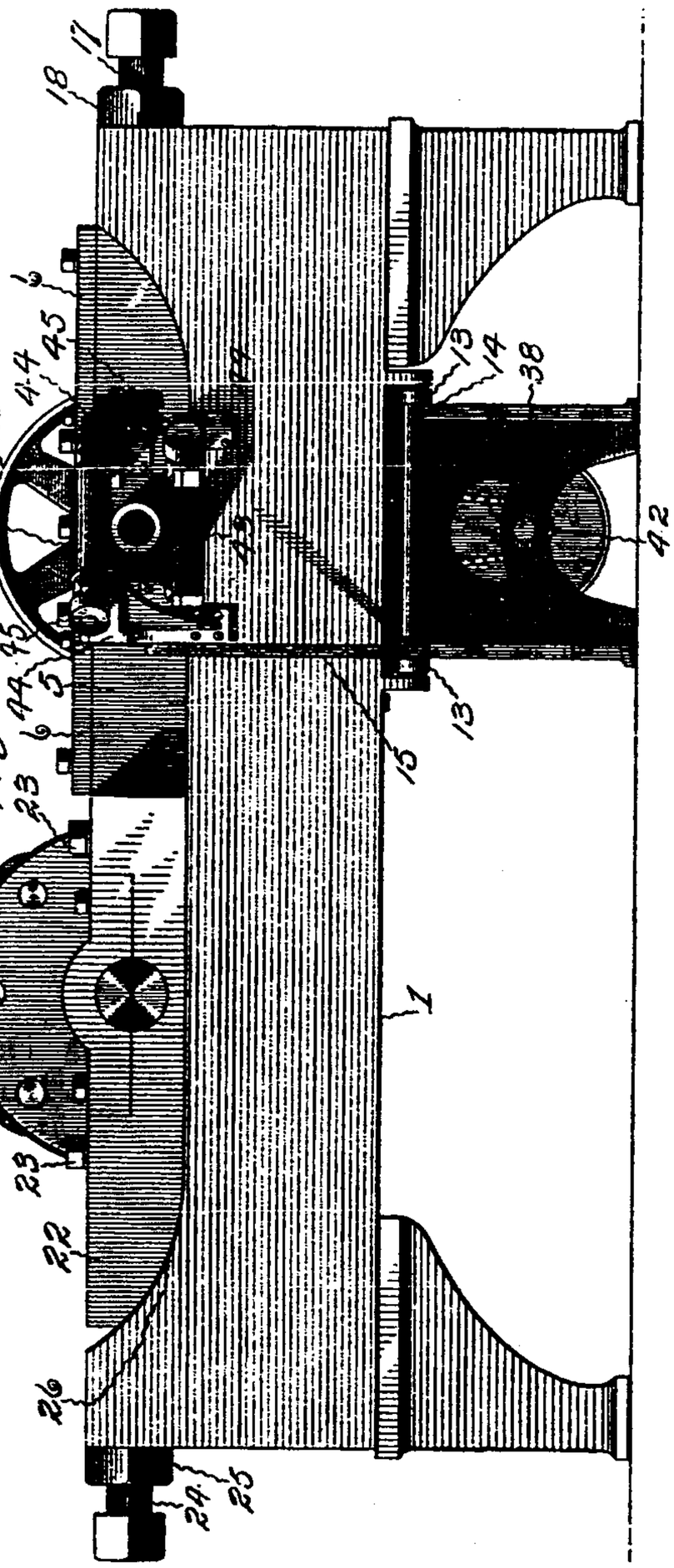


Fig. 2.

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(No Model.)

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# G. J. CAPEWELL.

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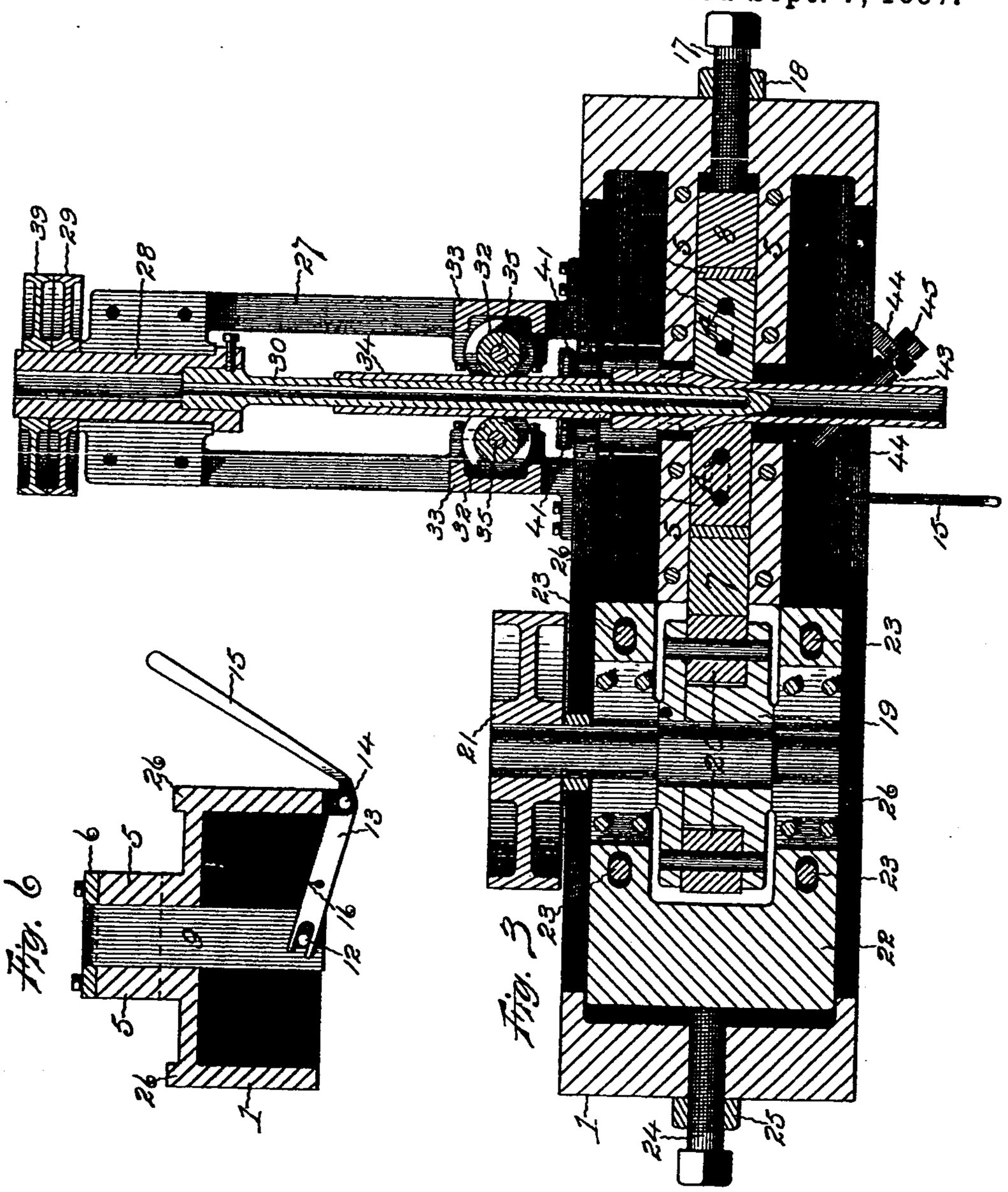


Fig. 3




Fig. 6

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(No Model.) 4 Sheets—Sheet 4.

# G. J. CAPEWELL.

## MACHINE FOR FORMING TUBES.

No. 589,694. Patented Sept. 7, 1897.

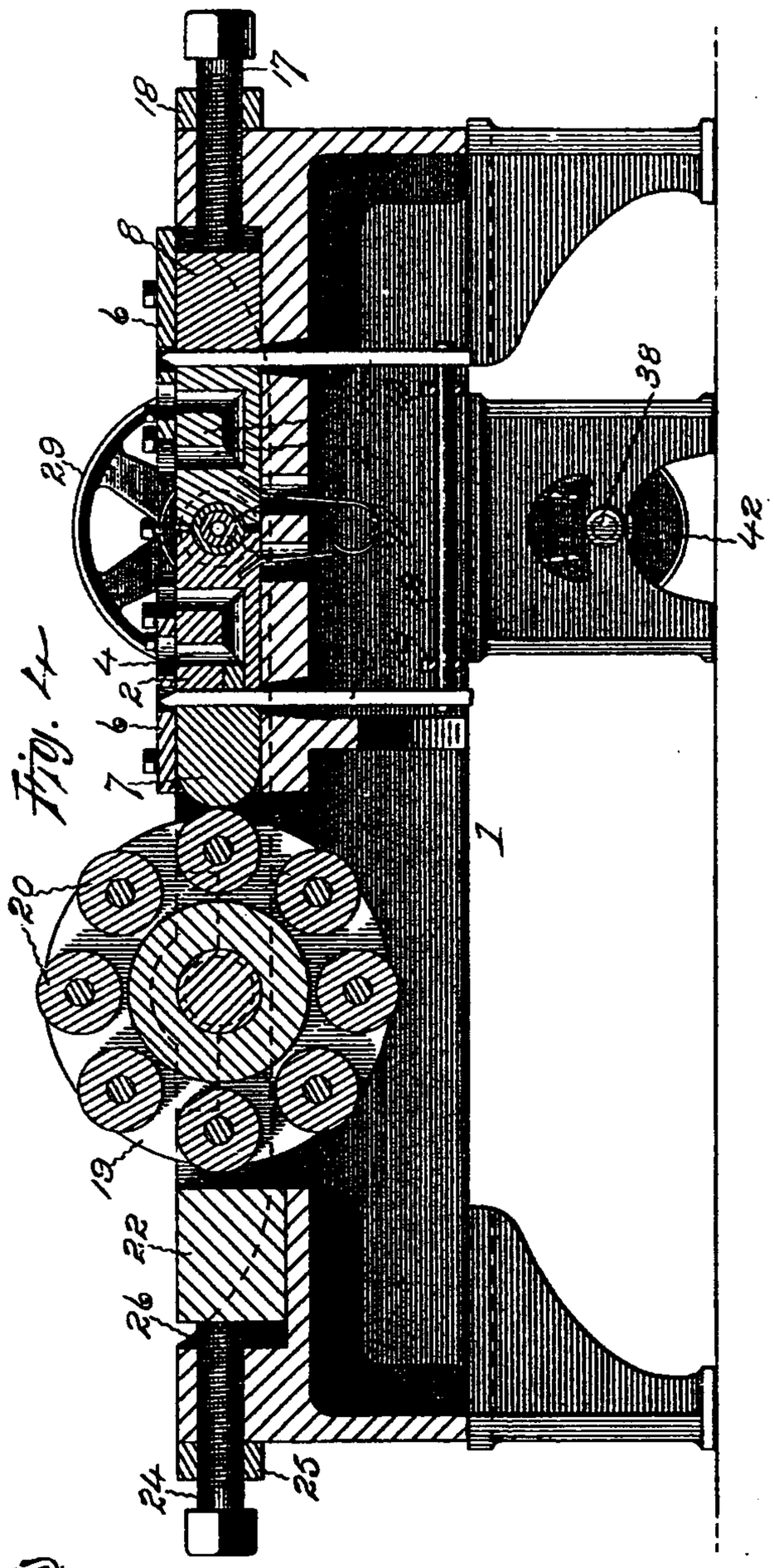


Fig. 4.

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# UNITED STATES PATENT OFFICE.

GEORGE J. CAPEWELL, OF HARTFORD, CONNECTICUT.

## MACHINE FOR FORMING TUBES.

SPECIFICATION forming part of Letters Patent No. 589,694, dated September 7, 1897.

Application filed July 1, 1896. Serial No. 597,677. (No model.)

*To all whom it may concern:*

Be it known that I, GEORGE J. CAPEWELL, a citizen of the United States, residing at Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Machines for Forming Tubes, of which the following is a specification.

The invention relates to the class of machines built to form light and strong seamless metallic tubes.

It more particularly relates to those machines provided for forming steel tubes; but of course the machines embodying the invention are applicable to the forming of tubes from other metals, including bronze.

The object of the invention is to produce a machine which will in an inexpensive manner form tubes quickly, accurately, and uniformly of the finest and highest grades of steel, thereby producing tubes that are light and strong and that can be accurately tempered, which tubes are specially applicable and desirable for use in the construction of the frames of bicycles and similar vehicles of the best grades.

To this end the invention resides in a machine having swaging-dies, mechanism for giving the swaging-dies an opening and closing movement of exceedingly short interval, and mechanisms for feeding the tube-blank, perforated billet, or skelp between the dies, where it receives a large number of rapid vibratory blows upon all sides, which action of the dies on the blank squeezes, compacts, and reduces the metal in such manner as to form a tube with its texture in an exceedingly desirable and useful condition.

Referring to the accompanying drawings, wherein a machine embodying the invention is illustrated, Figure 1 is a plan of such machine. Fig. 2 is a side elevation. Fig. 3 is a horizontal section on a plane passing through the mandrel, dies, and percussive wheel. Fig. 4 is a vertical section on a plane passing through the dies and the percussive wheel. Fig. 5 is a vertical section on plane denoted by the broken line *a a* of Fig. 1, and Fig. 6 is a vertical section on plane denoted by the broken line *b b* of Fig. 1.

The main frame 1 of the machine is preferably iron cast to a strong and substantial shape and mounted on legs of any suitable design. Upon the surface of the bed of this frame are dies 2 and 3. These dies have exceedingly hard working faces that are cut to the necessary outline to properly swage the surfaces of the blanks and shape the tubes to be formed. In order to keep the working faces of the dies from softening, particularly when operating upon heated blanks, openings 4 may be made in the dies, and these openings can be connected with water-pipes whereby cold water may circulate through the openings, and this will of course keep the temperature of the dies low, so their faces will retain the correct shape and remain in the necessary condition to accomplish accurate work for a long period. The dies are loosely fitted into a slideway that is between walls 5, which rise from the bed, and plates 6 are secured, preferably by bolts, to the tops of these walls for holding the dies down. Back of these dies are located hardened blocks or shoes 7 8. These shoes loosely fit the walls of the slideway and are held down to the bed by the same cover-plates that hold the dies. Between the dies and the shoes are the recoil-plates, gates, or wedges 9 10. These wedges are held in position in such manner that they may be removed from between the dies and shoes when desired, and a spring 11 is provided for thrusting the dies away from each other and back against the shoes when the wedges are removed. These wedges extend down through the bed, and beneath the frame they may be joined by a rod 12, that is connected with the rocker-arms 13, that project from an arbor 14, which is supported by bearings beneath the frame and is adapted to be oscillated by a lever 15. When the lever is in the position shown in Fig. 6, the pull of the spring 16 on one of the rocker-arms holds the wedges up between the dies and shoes; but when the lever is thrown toward the frame the rocker-arms draw the wedges from between the dies and the shoes, allowing the spring 11 to thrust the dies back against the shoes. With the dies in this open position a blank may be readily located between them to be operated upon. Then when the lever is drawn away from the frame

the wedges are again forced between the dies and shoes, crowding the dies toward each other ready to operate upon the blank.

Projecting through a part of the frame against the shoe 8 is a thrust-screw 17, which may be turned in or out to adjust the block 8 and the die 3. The opening through the bed for the passage of the wedge 10, as shown in Fig. 4, is made sufficiently large to allow the necessary adjustment of these, and the upper edge of the wedge is beveled off in order that it may readily work itself between the die and the shoe. A nut 18 may be set on this adjusting thrust-screw to clamp it in position when the desired adjustment is attained. The opening through the bed for the wedge 9 is enlarged, so that the die 2 and block 7 may be adjusted and may be permitted to vibrate, and the upper edge of this wedge is beveled, so that it will easily work its way between the die and shoe.

Adjacent to the block 7 is located a wheel or drum 19. This wheel bears a number of rolls 20, and these rolls are arranged about the periphery in such manner that when the wheel is rotated the revolving rolls make percussive contact with the end of the shoe 7. The journal that bears this wheel is held by bearings of any suitable form, and upon this journal is a driving-pulley 21, which may be connected by a belt with any suitable source of power. The bearings for this journal are shown as formed in a block or carriage 22, which is adapted to be moved along the bed of the frame. This carriage is held to the bed by bolts 23, which pass through slots in the carriage into the bed. When these holding-bolts are loosened, the carriage may be adjusted along the bed by turning the thrust-screw 24 in or out. When the proper adjustment is attained, the thrust-screw may be held by its clamp-nut 25 and the carriage further secured by tightening the holding-bolts.

The carriage preferably moves along the bed between flanges 26, which flanges, besides providing a guiding-way for the carriage, may also be shaped to strengthen the frame, and particularly those parts at the ends which support the thrust-screws 17 and 24.

With the proper adjustment, when the wheel is rotated the rolls give the shoe 7 a large number of blows, which blows are transmitted through the wedge 9 to the die 2 and imparted to the metal of the blank between it and its complementary die 3. The spring 11, as stated, throws the die 2 back or tends to press it in such manner against the wedge 9 that the shoe is continually crowded back into the path of the rolls as they revolve. The motion imparted to the die 2 by the blows of the rolls is very slight, but the blows are so frequent and strong that the die 2 is given a powerful vibration of very short interval—that is, its movement is very short, but it is moved powerfully a great many times a minute. With this construction a large number of blows are struck upon the blank in such a rapid manner as to practically produce a squeezing effect between the two dies.

A supplementary frame 27 is connected with the main frame about opposite the dies. This frame near one end is provided with bearings in which is supported a hollow shaft or spindle 28, and this hollow spindle is provided with a pulley 29, by means of which it may be rotated. Connected so as to rotate with this hollow spindle is a mandrel 30, which mandrel is preferably a hollow tube. Water may be conducted into this mandrel through the hollow spindle by any common pipe and allowed to flow out into any suitable escape, so that the mandrel may be kept cool. The mandrel projects forward between the dies, and the blank being formed into a tube is compressed upon it by the action of the dies.

The blank 31, which is to be formed into a tube, is passed between the dies onto the mandrel, the opening in the blank being preferably slightly larger than the diameter of the mandrel in order that the blank may be easily slipped onto the mandrel.

Rolls 32, supported by bearings in brackets 33, mounted on the frame 27, are provided for feeding the blank between the dies. The bearing-brackets are adjustably connected with the frame and the rolls are grooved so that they will properly grip the part to be fed. These feed-rolls may be set so as to work against the outer surfaces of the blank, if desired, in order to feed it forward between the dies; but it is preferred to place a sleeve 34 back of the blank on the mandrel and to cause the feed-rolls to grip and push forward the sleeve, which, by butting against the blank, will force the blank between the dies as it is reduced. The shafts 35 of the feed-rolls may be provided with worm-wheels 36, which may mesh with a worm 37 on the shaft 38, as shown in Fig. 5, and the shaft 38 may be provided with a pulley, which can be belted to the pulley 39 on the spindle 28.

When the dies have operated upon the blank sufficiently to compress it against the mandrel, the blank will be rotated with the mandrel, so that the dies operate upon all sides. In order to rotate the blank at the commencement of the swaging operation, before it has been sufficiently reduced to grasp the mandrel and rotate with it, and also to aid the mandrel in rotating the blank, a pair of rollers 40 may be mounted in suitable bearings on the frame with their peripheries engaging the surface of the blank near the dies. The shafts of these rollers may be provided with sprocket-wheels 41, and a chain may be run to a sprocket-wheel 42, mounted upon the shaft 38, that is below.

When the lever is thrown so that the wedges are drawn from between the shoes and the dies, the dies are thrown apart, so that a blank, perforated billet, or skelp may be quickly thrust between them upon the mandrel. When the lever is thrown back, the wedges are forced between the shoes and the

dies so that the faces of the dies bear against the surface of the blank. Then when power is applied the percussive wheel is rotated rapidly and the rollers caused to give the shoe 7 a large number of blows per minute, which blows are transmitted to the die 2, so that die has a very rapid and forcible vibration against the surface of the blank. At the same time the mandrel and the rollers 40 are being rotated, so that the blank is rotated between the dies. Simultaneously the feed-rolls are caused to feed the blank forward, but as they do not feed positively the blank is only forced forward when the dies have reduced the metal sufficiently to allow it to pass between them. By the operation of these mechanisms the blank is rapidly rotated and at the same time is given an exceedingly large number of minute blows, which reduces it, and as fast as it is reduced the blank is fed forward. A hot or a cold blank may be operated on, as desired, for the dies and the mandrel may always be kept cool by a flow of water through them.

To facilitate the feeding of the blank between the dies and also aid its rotation, particularly when the end of the blank has reached the dies, a pair of rollers 43 may be arranged diagonally in bearings 44, connected with the frame opposite the dies. The shafts of these rollers may be provided with pulleys 45, which can be belted to any source of power. When the tube reaches these rollers, it is gripped by them, and their action tends to pull the blank forward and to rotate it at the same time.

A blank, which may be a perforated billet or a skelp, can be quickly inserted onto the mandrel of this machine in position to be acted upon by the dies, which by their rapid successive short but powerful vibratory blows compact and squeeze the metal, so as to elongate it into a strong tube. The effect of each blow is slight, and the forward feed is almost infinitesimal after each blow, and this causes the metal to flow in such manner that the fibers are not stretched or the texture strained. Of course the large number of blows that can be administered by the dies under the percussive blows of the rollers on the wheel insures a comparatively fast travel of the blank between the dies. This action of the dies compacts the metal to a certain extent and pushes the rest back. The effect of the operation of the dies in this manner permits the use of high-carbon steel of the best grade, for the hard metal is not torn apart as is hard metal when drawn into tubes by the usual drawing roll or whirtle and mandrel processes. The former of these processes gives only a superficial hardening to the surface of the tube, leaving the inside stretched and comparatively weak, while the latter stretches and tears the metal, leaving an undesirable surface that is not particularly strong. Furthermore, with the whirtle-drawing process the gage cannot be kept accurate when hard metal is used, for such metal grits and wears the whirtle and oftentimes so grooves it that the tubes which emerge have long scratches on their surfaces.

There is no tearing apart of the texture of the metal by the action of the dies of this machine, nor are the dies subjected to such wear that they require a frequent adjustment to keep the gage accurate. These dies will not so wear as to scratch and mar the tubing. The tubing which issues will be tough, for hard metal can be used without any particular amount of wear to the face of the dies, and the mode of operation compacts the metal clear through, leaving a smooth and polished surface.

Tubes of fine steel, as can be formed by this machine, can be made very hard and accurately tempered to meet the specific requirements of the positions in which they are to be used. The tubes made by this machine, consequently, are light and strong and are exceedingly desirable for use in the construction of bicycle-frames and frames of a similar nature.

Blanks of other metals besides steel can be formed into tubes by this machine—such, for instance, as hard bronzes and other compositions which on account of their hardness cannot be successfully drawn by the rolling or whirtle processes with any degree of accuracy.

I claim as my invention—

1. In a tube-forming machine, in combination, a frame, non-rotating dies movably supported by a stationary frame, a rotary device adapted by percussive contact to violently drive forward one of the dies, means for opening the dies to permit the hollow blank to be fed between them, a mandrel held against longitudinal movement by the frame and extending between the dies for supporting the hollow blank, mechanisms for feeding the hollow blank along the mandrel between and through the opening and closing dies, and means for rotating the hollow blank as it is fed between the dies, substantially as specified.

2. In a tube-forming machine, in combination, a frame, chambered dies supported by the frame said chambers in the dies being adapted to be connected with a source of water-supply, mechanisms for rapidly and violently opening and closing the dies, a chambered mandrel extending between the dies said chamber in the mandrel being adapted to be connected with a source of water-supply, and mechanisms for feeding the hollow blank between and through the opening and closing chambered dies, substantially as specified.

3. In a tube-forming machine, in combination, a frame, dies supported by the frame, a percussive wheel for rapidly and violently closing and mechanism for rapidly opening the dies, a rotary mandrel extending between the dies for supporting and rotating the hollow blank, and feed-rolls for advancing the rotating hollow blank between and through

the opening and closing dies, substantially as specified.

4. In a tube-forming machine, in combination, a frame, non-rotating dies movably supported by a stationary frame, mechanisms for rapidly opening and closing the dies, a mandrel extending from the feed end of the frame to and between the dies and supporting the blank between the dies, rolls for advancing the hollow blank between and through the opening and closing dies, and means for rotating the hollow blank as it is fed between the dies, substantially as specified.

5. In a tube-forming machine, in combination, a frame, non-rotating dies movably supported by a stationary frame, a rotary device adapted by percussive contact to violently drive forward one of the dies, means for opening the dies to permit the hollow blank to be fed between them, mechanisms for feeding the hollow blank between and through the opening and closing dies, a mandrel extending from the feed end of the frame to and between the dies and supporting the blank between the dies, and means for rotating the hollow blank as it is fed between the dies, substantially as specified.

6. In a tube-forming machine, in combination, a frame, non-rotating dies movably supported by a stationary frame, percussive mechanisms for rapidly closing the dies, mechanisms for feeding the hollow blank between and through the opening and closing dies, mechanisms for rotating the hollow blank as it is fed between the dies, a mandrel held by the frame for supporting the blank, said mandrel extending between the dies, and mechanisms for rotating the mandrel, substantially as specified.

7. In a tube-forming machine, in combination, a frame, non-rotating dies movably supported by a stationary frame, mechanisms for rapidly opening and closing the dies, mechanisms for feeding the hollow blank between and through the opening and closing dies, mechanisms for rotating the hollow blank as it is fed between the dies, a mandrel for supporting the blank, said mandrel extending between the dies and having a chamber for the circulation of water at the die end, and means for rotating the mandrel, substantially as specified.

8. In a tube-forming machine, in combination, a frame, dies supported by the frame, mechanisms for rapidly opening and closing the dies, mechanisms for feeding the hollow blank between and through the opening and closing dies, and rolls for rotating the hollow blank before it reaches the dies, substantially as specified.

9. In a tube-forming machine, in combination, a frame, non-rotating dies movably supported by a stationary frame, mechanisms for rapidly opening and closing the dies, a mandrel extending between the dies for supporting the hollow blank, mechanisms for feeding a hollow blank between and through the opening and closing dies, means for rotating the hollow blank as it is fed between the dies, and cylindrical rolls supported by the frame in front of the dies and arranged at an angle with each other and with the blank for advancing and aiding the rotation of the blank, substantially as specified.

10. In a tube-forming machine, in combination, a frame, non-rotating dies movably supported by a stationary frame, mechanisms for rapidly opening and closing the dies, a mandrel extending between the dies for supporting the hollow blank, a sleeve supported by and movable independently of the mandrel for forcing the hollow blank between and through the opening and closing dies, feed-rolls for advancing the sleeve, and means for rotating the hollow blank as it is fed between the dies, substantially as specified.

11. In a tube-forming machine, in combination, a frame, non-rotating dies movably supported by a stationary frame, backing-shoes supported by a frame behind the dies, mechanisms for rapidly opening and closing the dies, a mandrel extending between the dies for supporting the hollow blank, mechanisms for feeding the hollow blank between and through the opening and closing dies, and means for rotating the hollow blank as it is fed between the dies, substantially as specified.

12. In a tube-forming machine, in combination, a frame, non-rotating dies supported by a stationary frame, backing-shoes supported by a frame behind the dies, removable wedges located between the dies and backing-shoes, mechanisms for rapidly opening and closing the dies, a mandrel extending between the dies for supporting the hollow blank, mechanisms for feeding the hollow blank between and through the opening and closing dies, and means for rotating the hollow blank as it is fed between the dies, substantially as specified.

13. In a tube-forming machine, in combination, a frame, dies supported by the frame, a percussive wheel adapted to drive one of the dies forward, a mandrel extending between the dies for supporting the hollow blank, and mechanisms for feeding the hollow blank between and through the opening and closing dies, substantially as specified.

14. In a tube-forming machine, in combination, a frame, dies supported by the frame, a percussive wheel mounted in bearings held by an adjustable block and adapted to percussively drive one of the dies forward, means for adjusting the block, a mandrel extending between the dies for supporting the hollow blank, and mechanisms for feeding the hollow blank between and through the opening and closing dies, substantially as specified.

15. In a tube-forming machine, in combination, a frame, non-rotating dies movably supported by a stationary frame, a spring for opening the dies, wedges held back of the dies, levers and arms connected with the wedges

whereby they may be removed from back of the dies to allow the spring to throw the dies open, a percussive wheel adapted to drive one of the dies forward, a mandrel extending between the dies for supporting the hollow blank, mechanisms for feeding the hollow blank between and through the opening and closing dies, and means for rotating the hollow blank as it is fed between the dies, substantially as specified.

16. In a tube-forming machine, in combination, a frame, hollow dies supported by the frame, a spring normally tending to thrust the dies from each other, wedges back of the dies, removable shoes back of the wedges, a revolving wheel with rolls adapted to make percussive contact with one of the shoes said wheel being mounted on a journal held by bearings on an adjustable carriage, a hollow rotary mandrel for supporting and revolving the blank between the dies, and feed-rolls for advancing the blank between and through the dies, substantially as specified.

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