(No Model.) 12 Sheets—Sheet 1.

O. P. BRIGGS.

AUTOMATIC SHEET METAL TUBE MAKING MACHINE.

No. 563,255. Patented July 7, 1896.

Fig. 1.

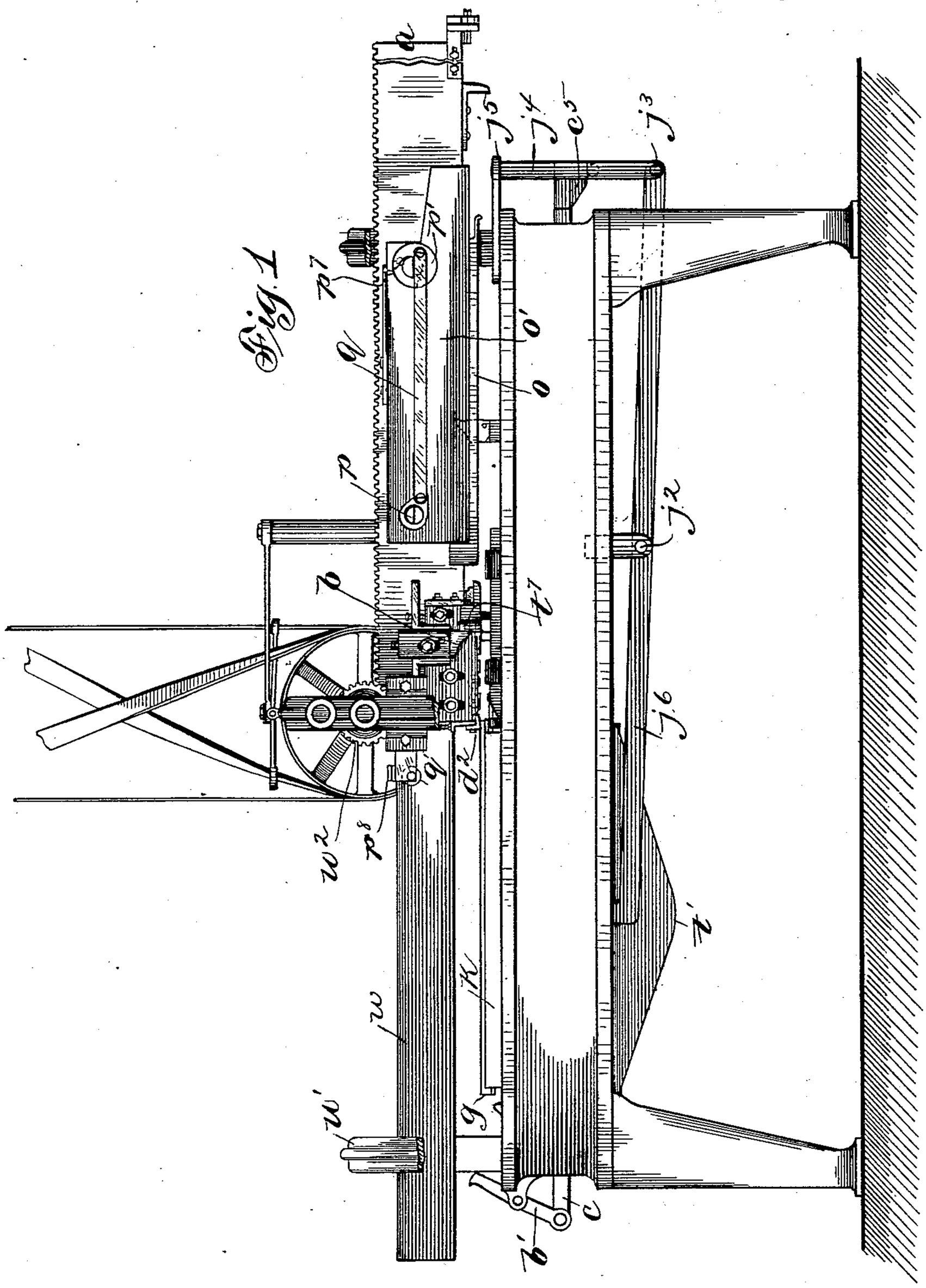

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Fig. 2.

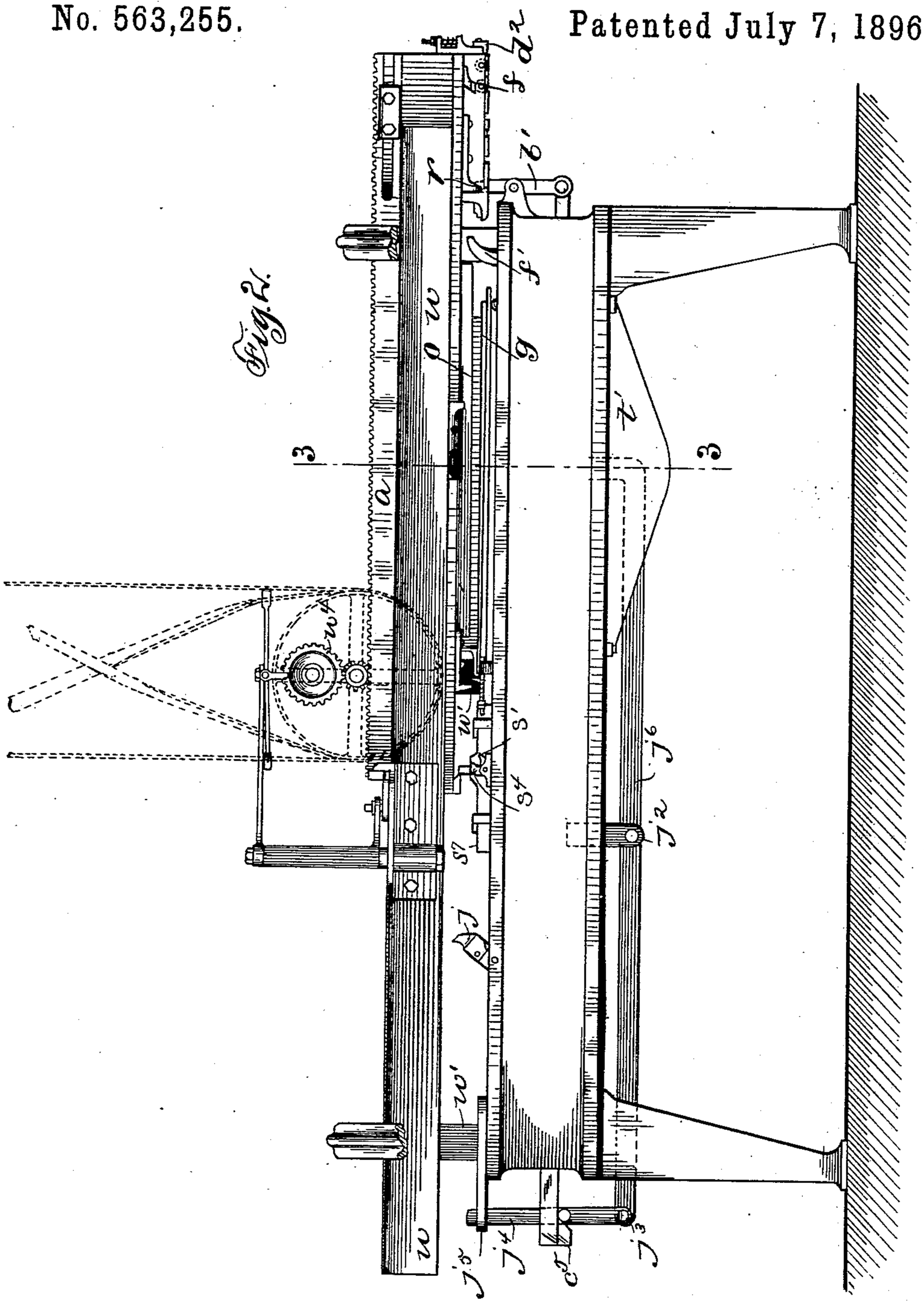

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Fig. 3

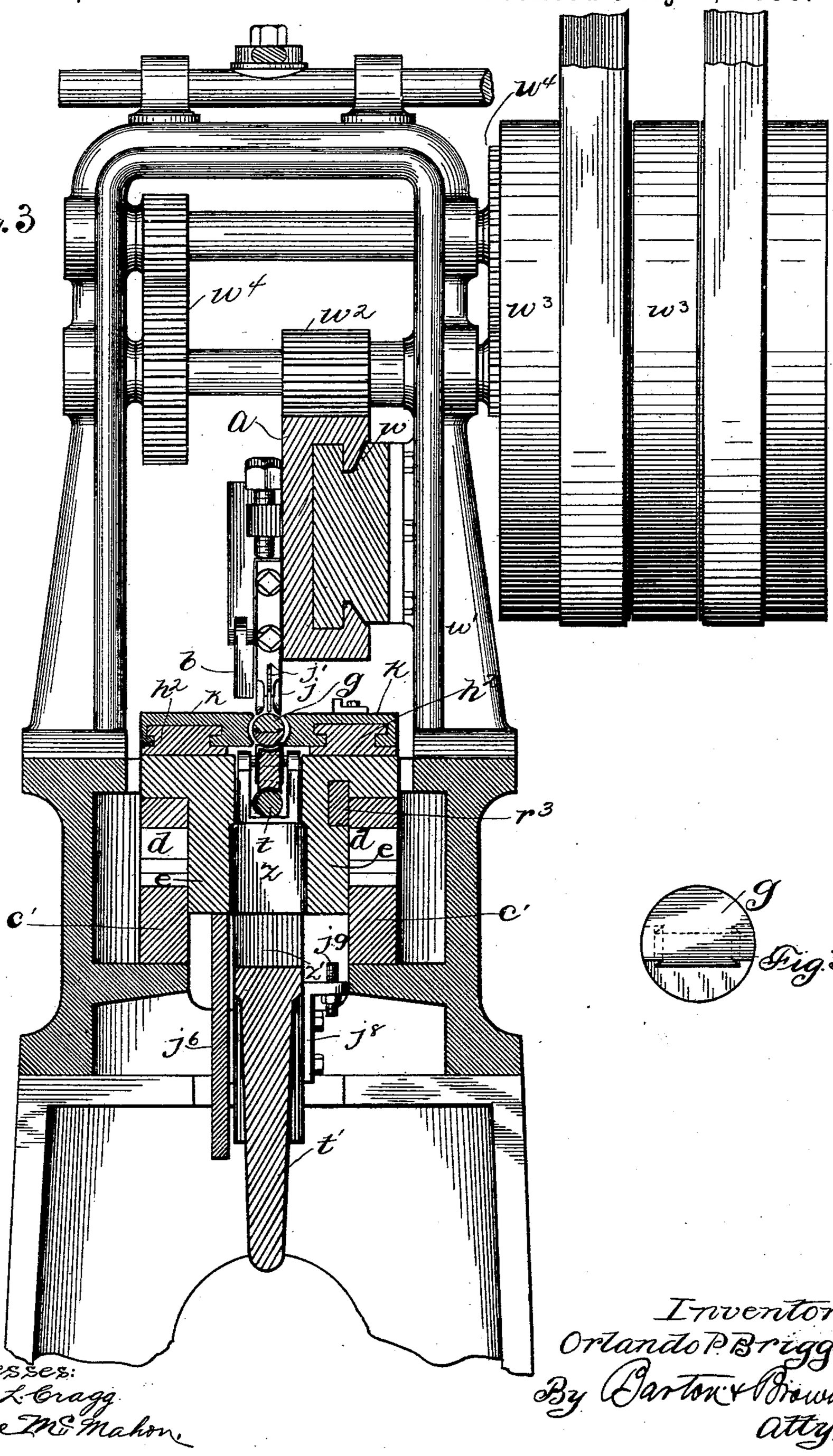

Fig. 3a

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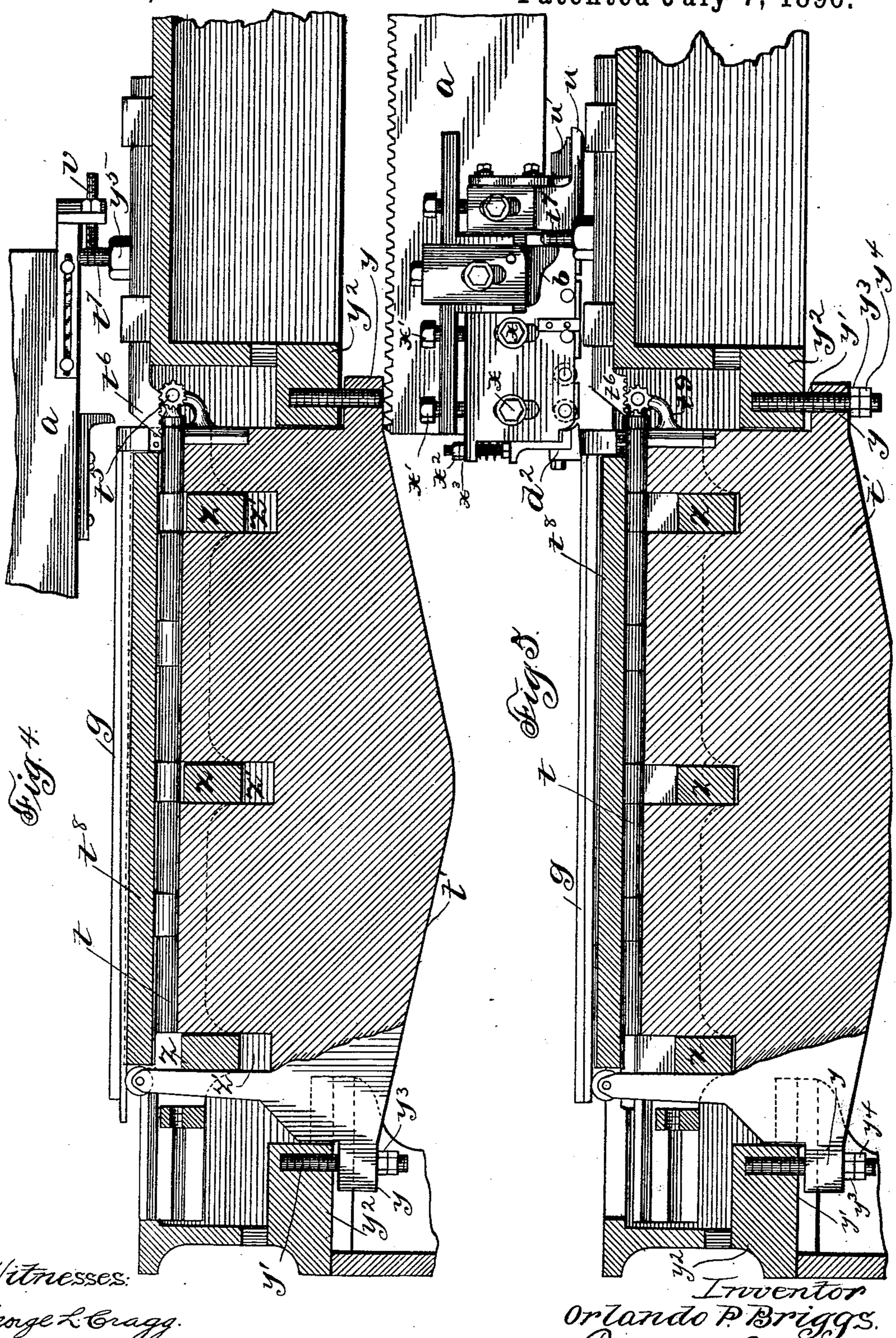

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AUTOMATIC SHEET METAL TUBE MAKING MACHINE.

No. 563,255. Patented July 7, 1896.

Fig. 6

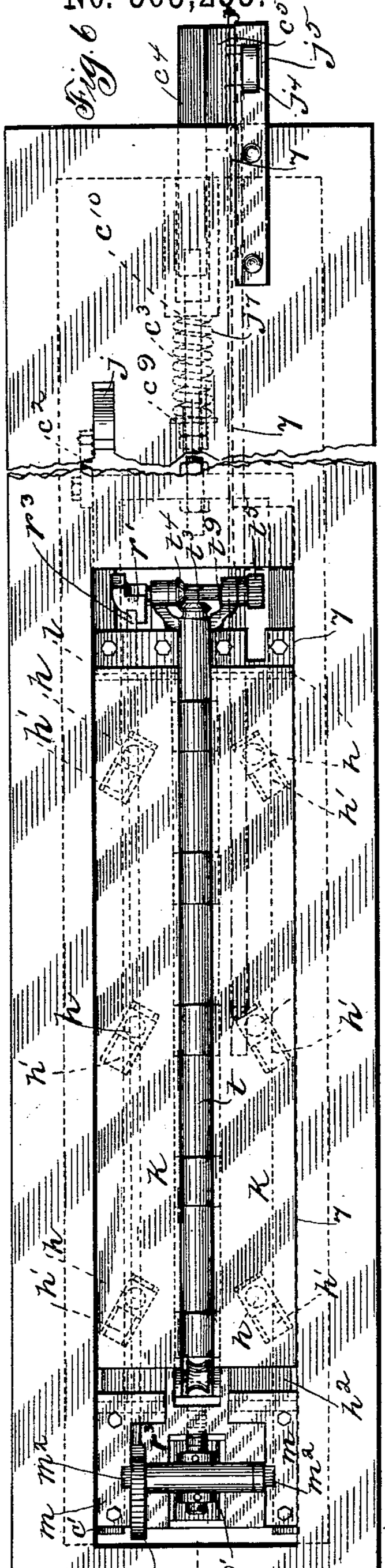
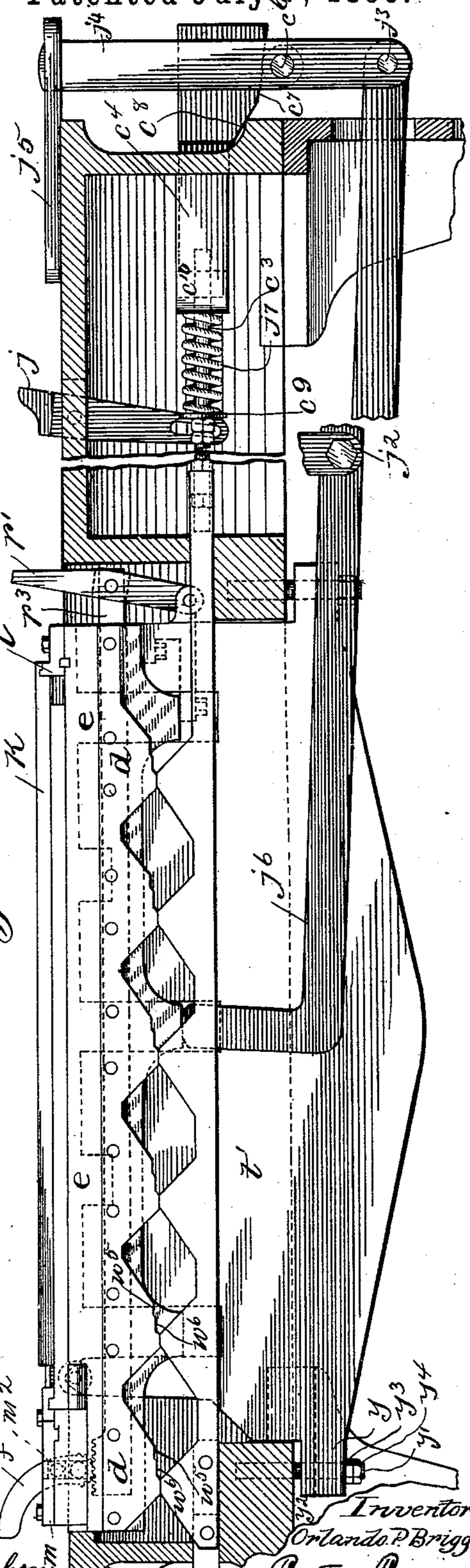


Fig. 7



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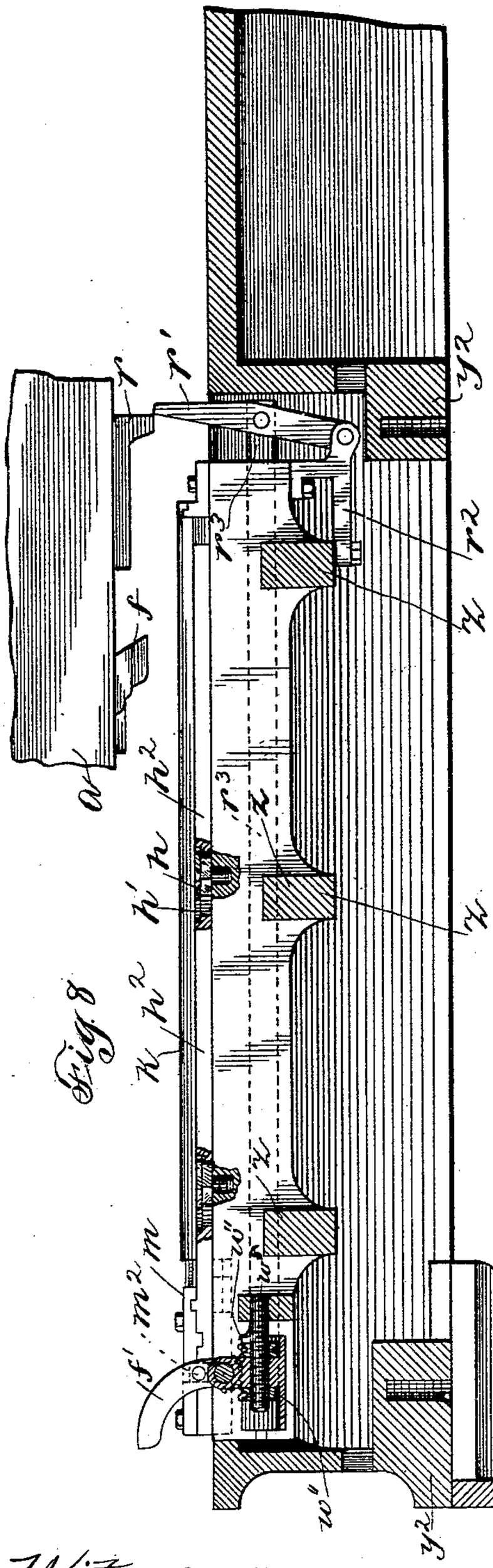

Fig. 8

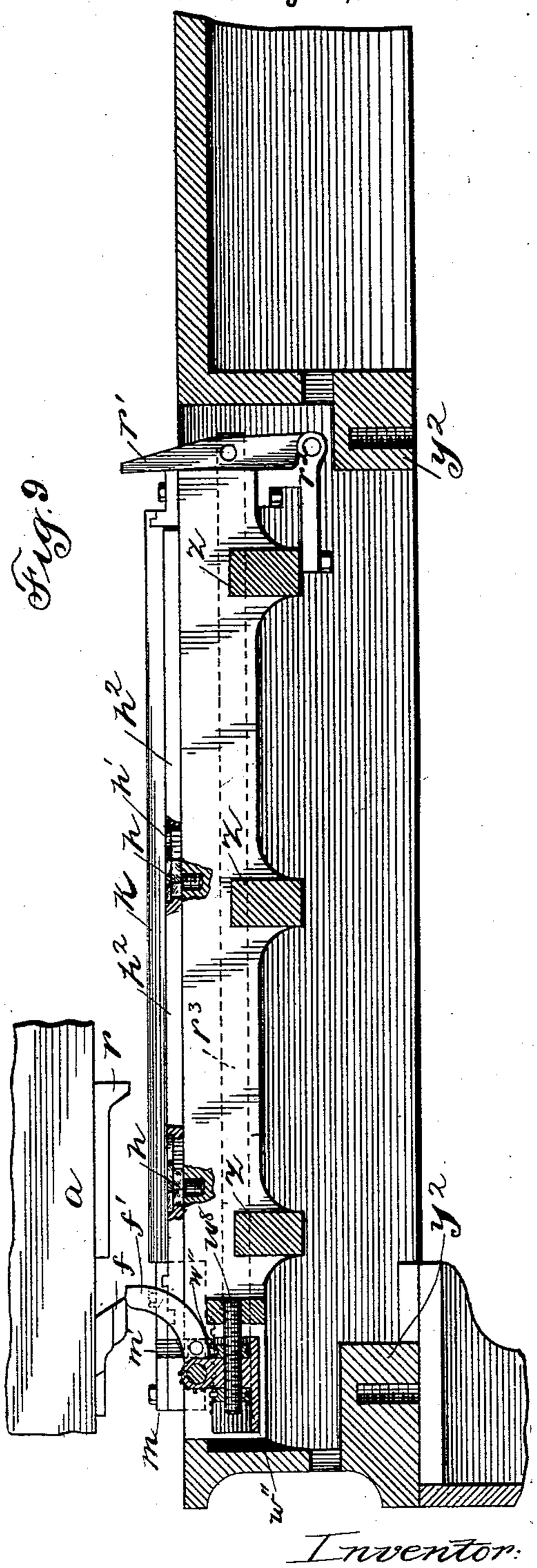

Fig. 9

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AUTOMATIC SHEET METAL TUBE MAKING MACHINE.

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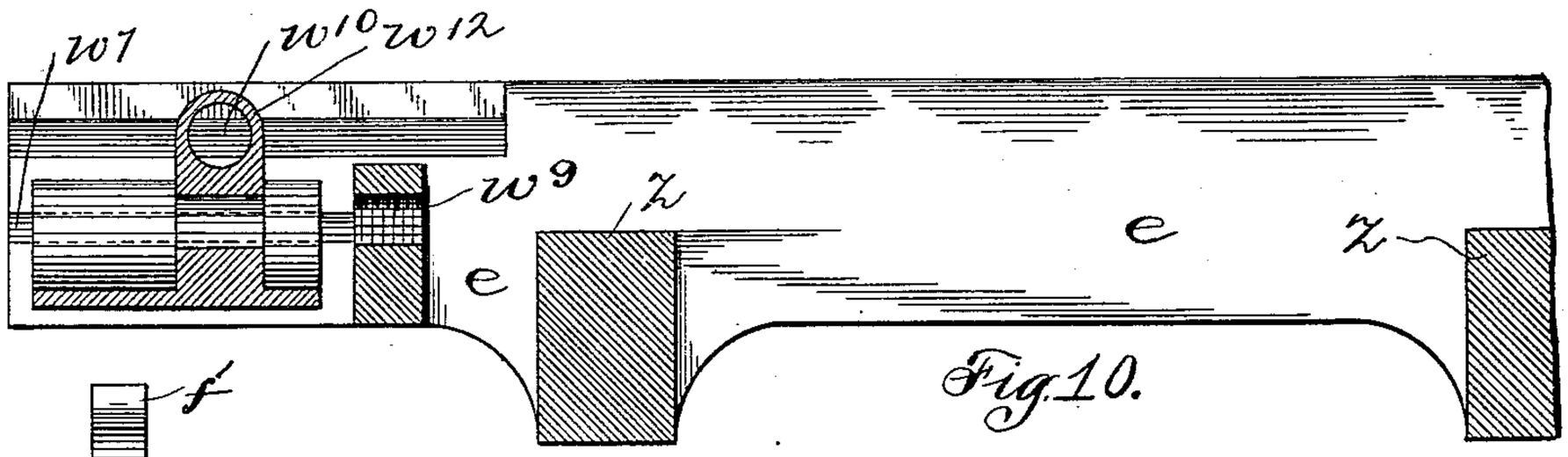

Fig. 10.

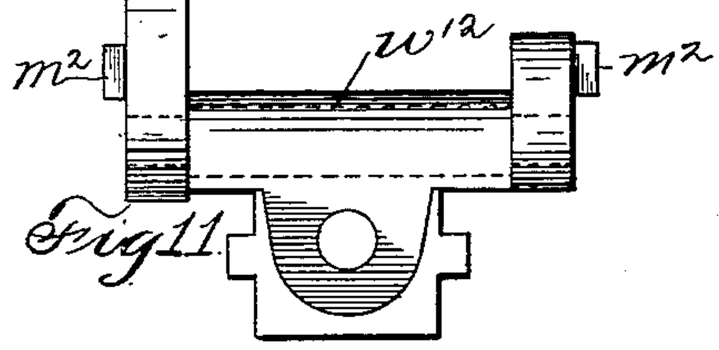

Fig. 11.

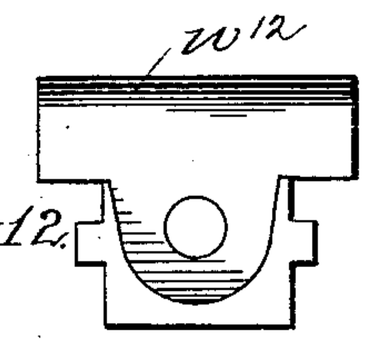

Fig. 12.

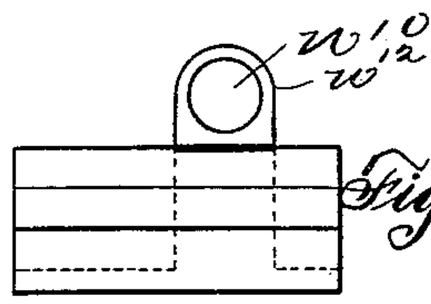

Fig. 13.

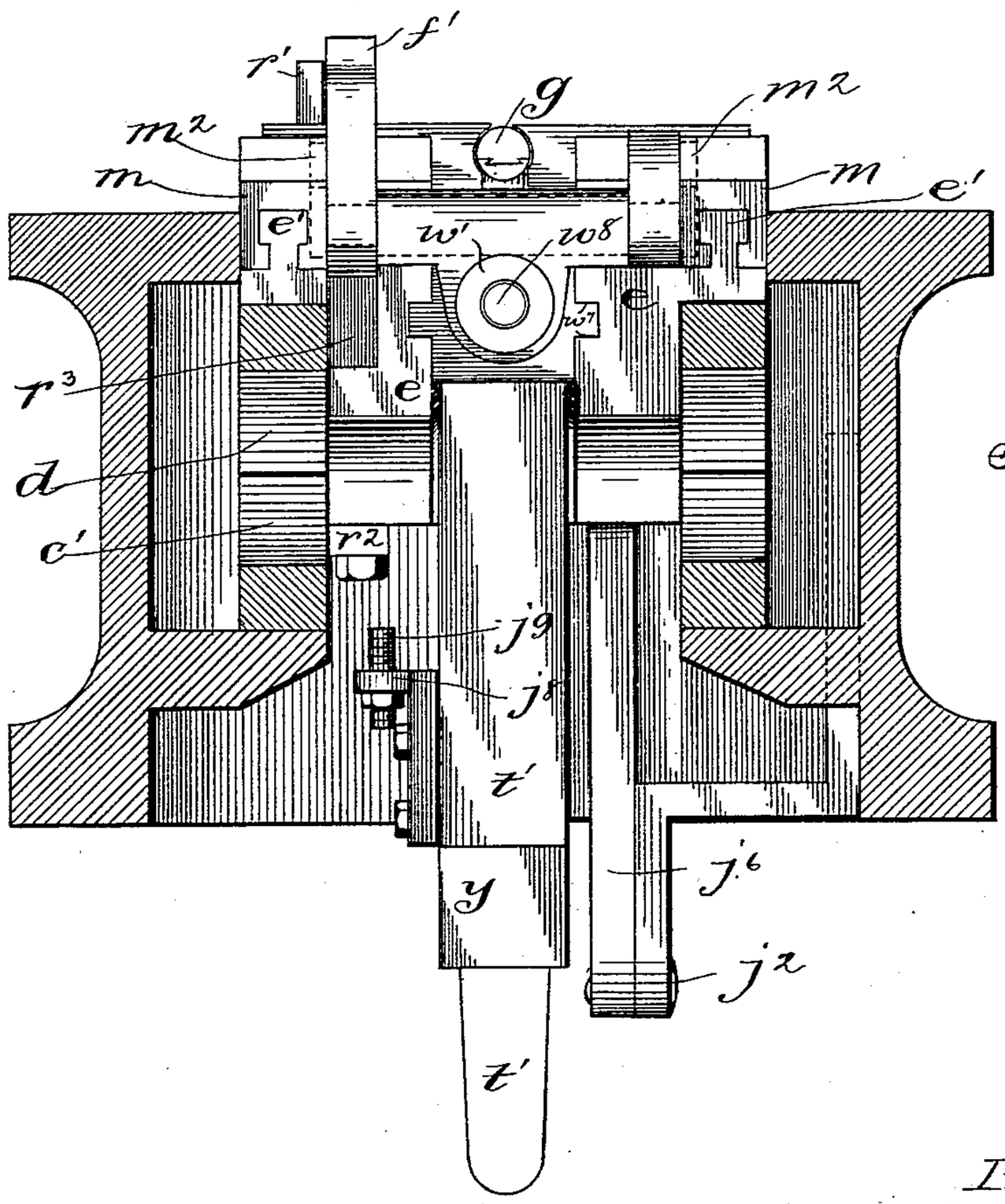

Fig. 14.

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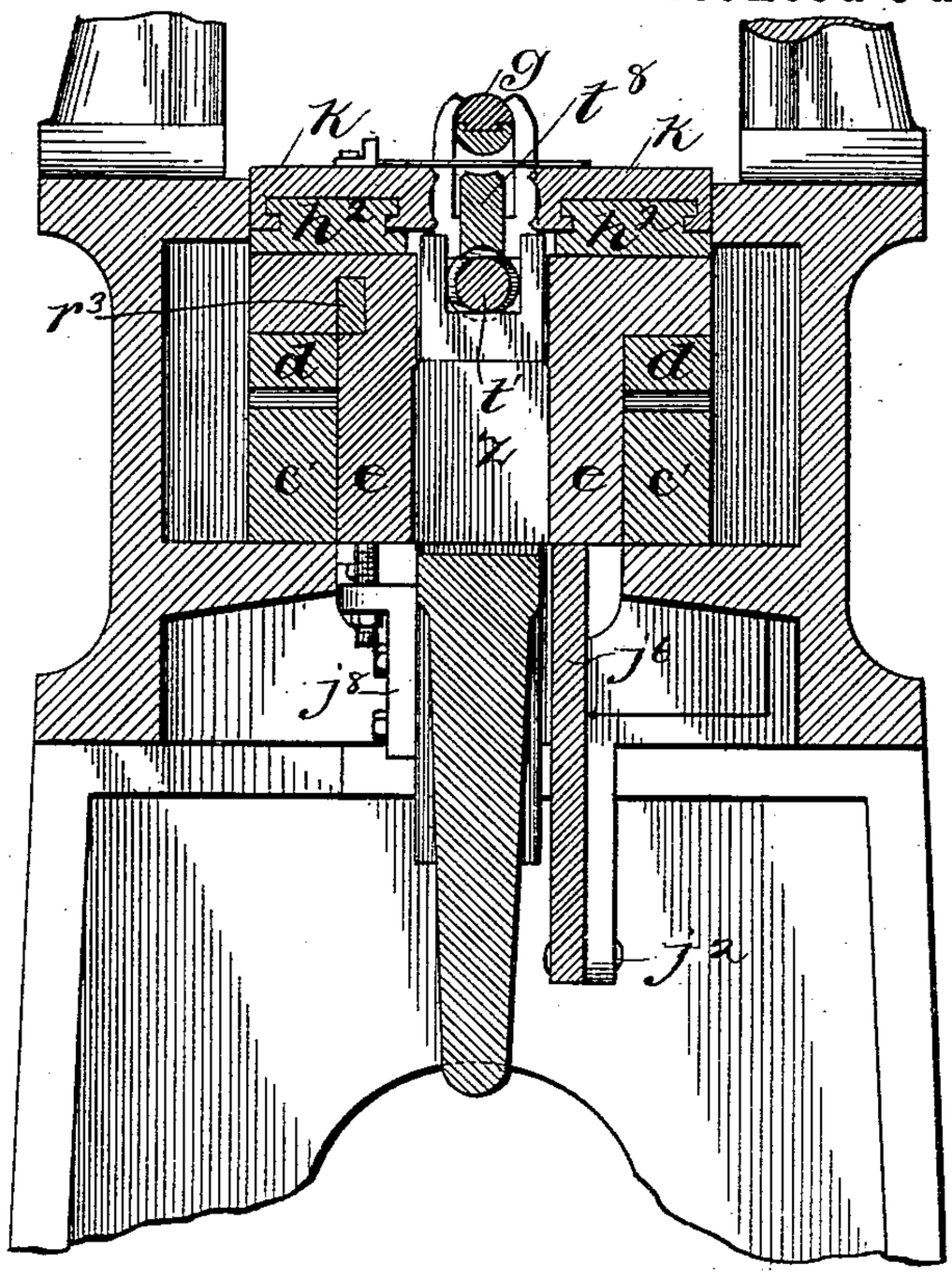

Fig. 15.

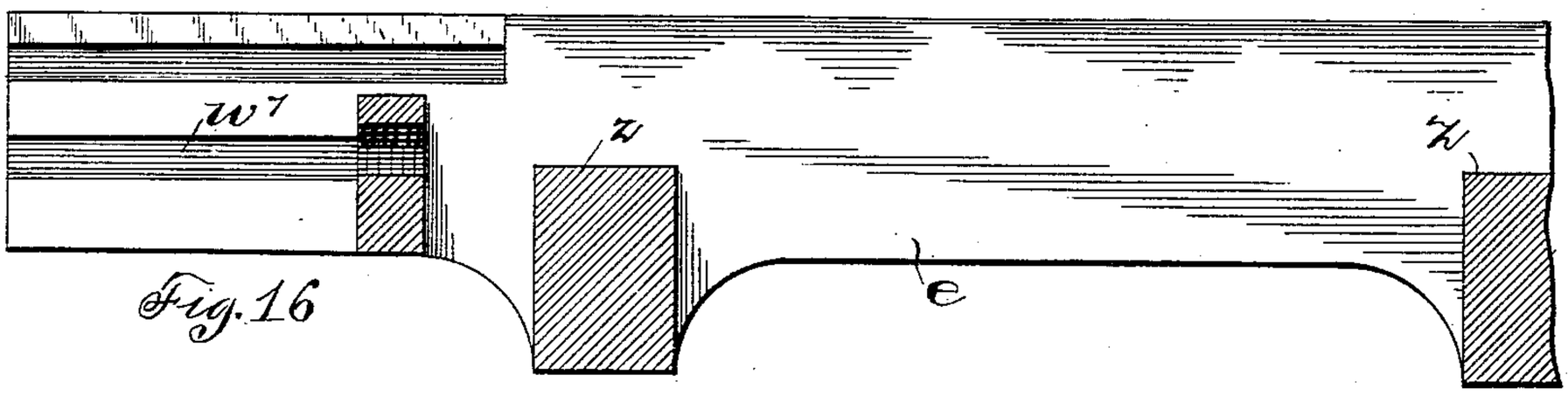

Fig. 16

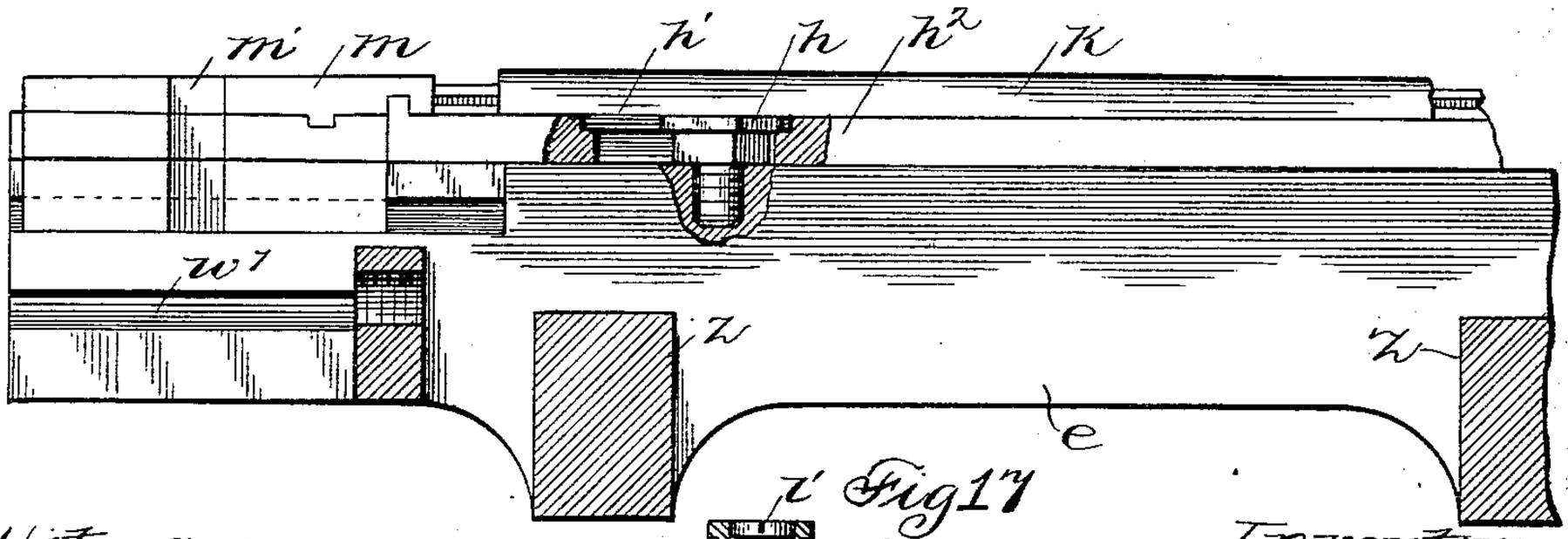

Fig 17

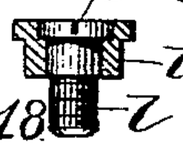

Fig. 18.

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AUTOMATIC SHEET METAL TUBE MAKING MACHINE.

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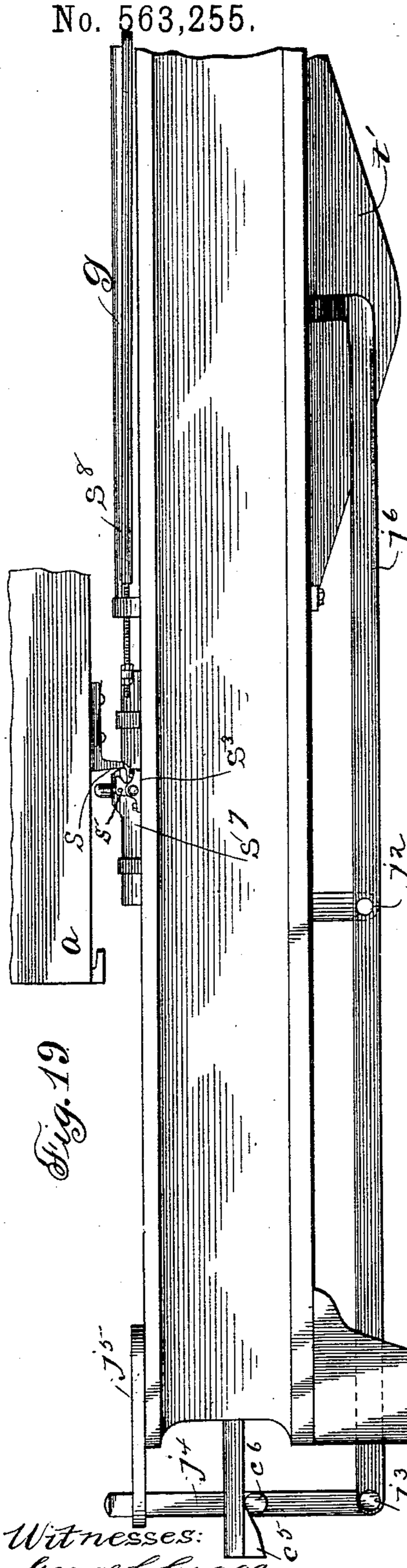
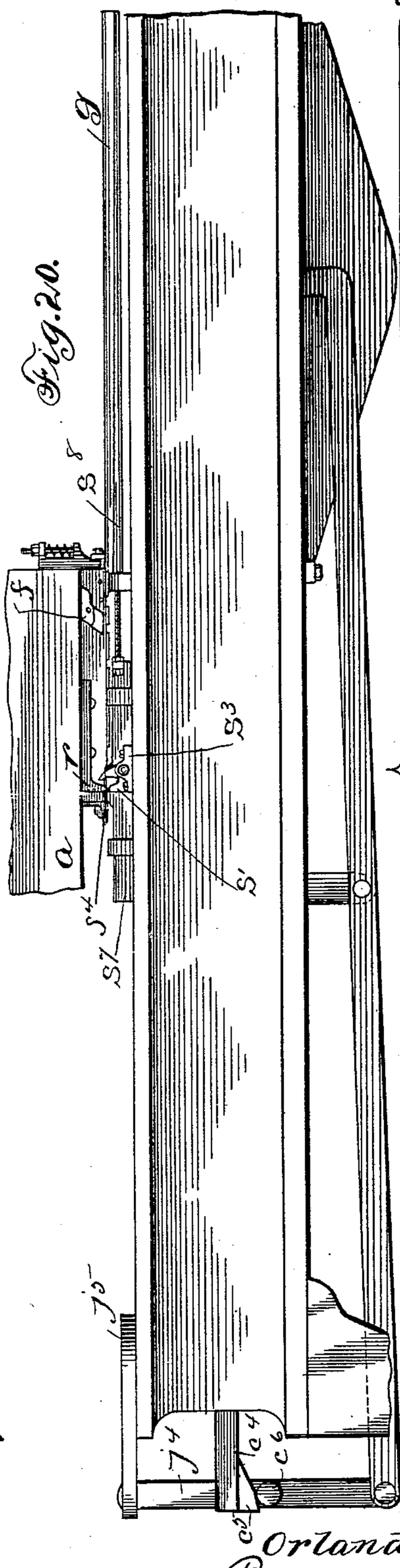


Fig. 19.



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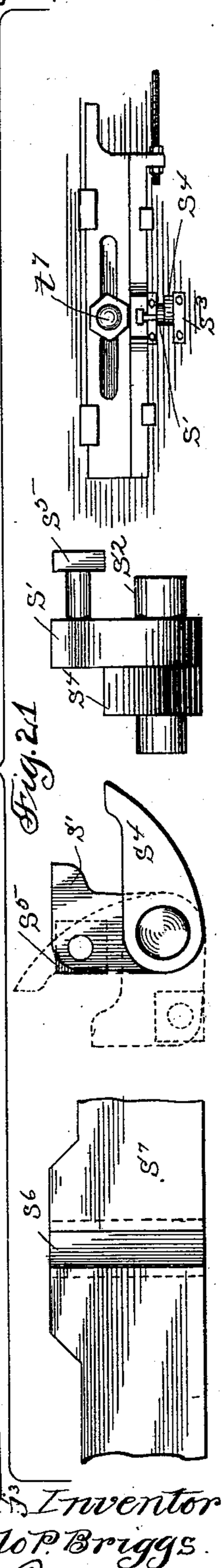

Fig. 21

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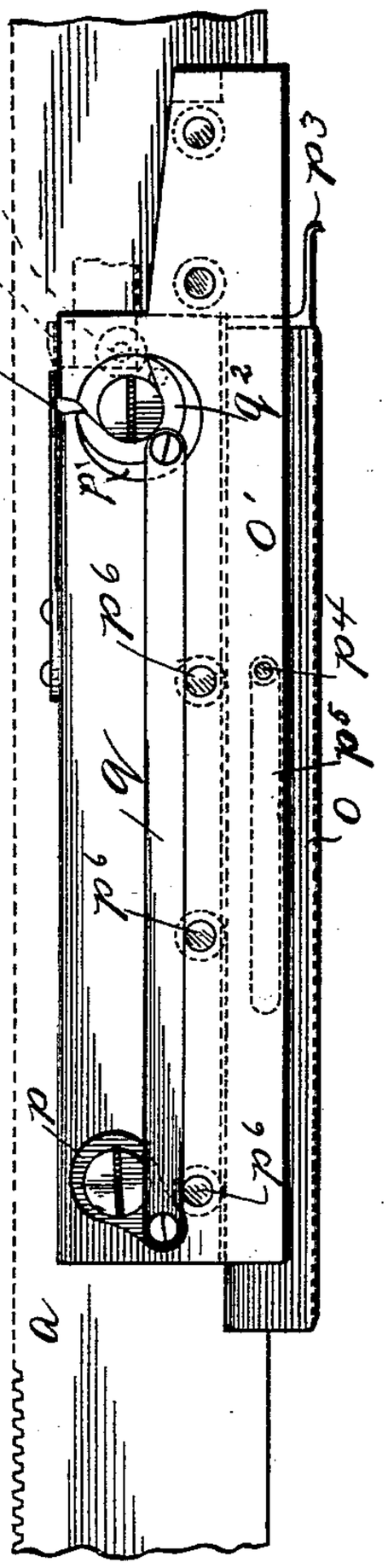


Fig. 22.

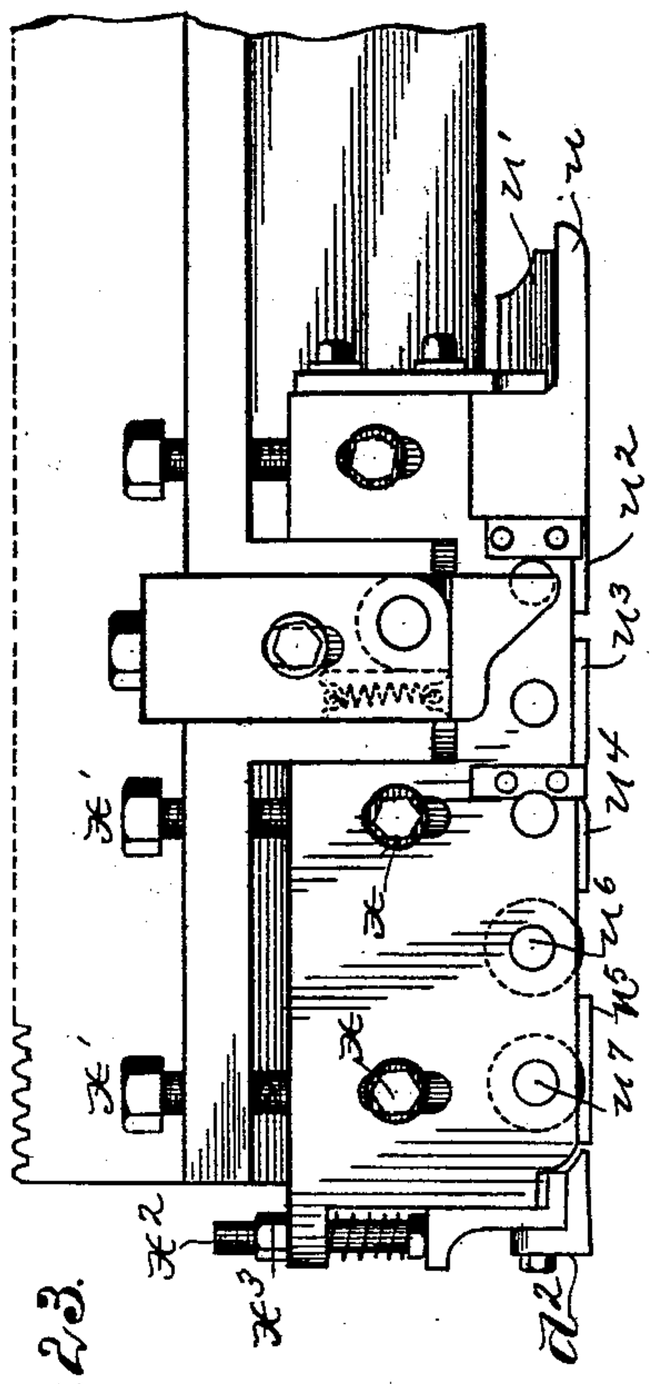


Fig. 23.

Fig 22a

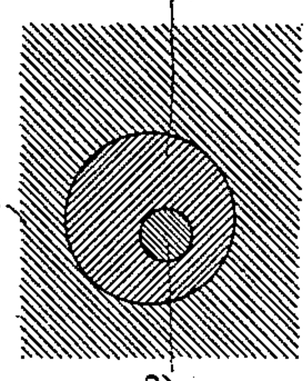
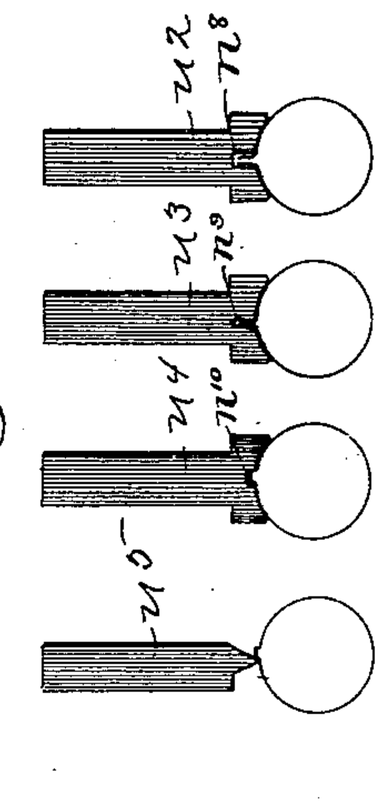


Fig. 23a



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AUTOMATIC SHEET METAL TUBE MAKING MACHINE.

No. 563,255. Patented July 7, 1896.

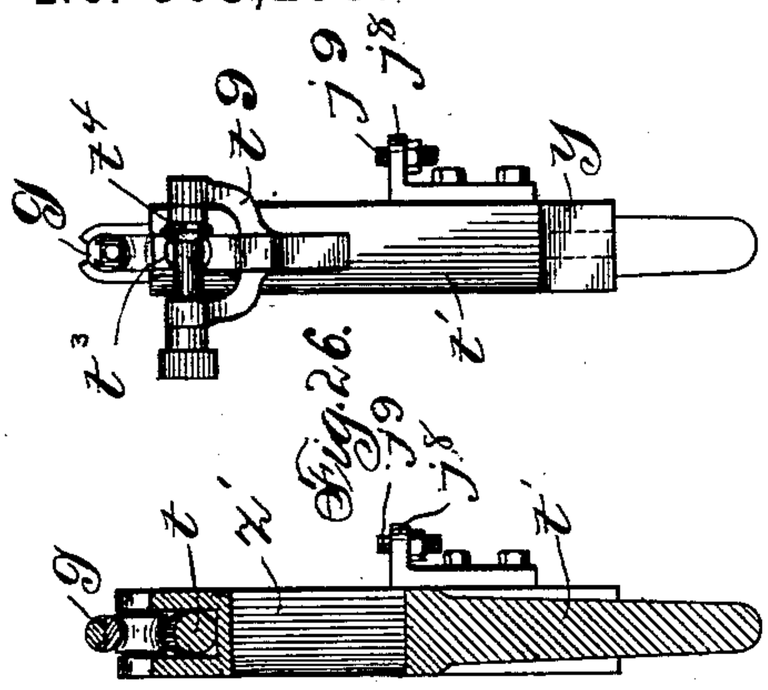

Fig. 25.

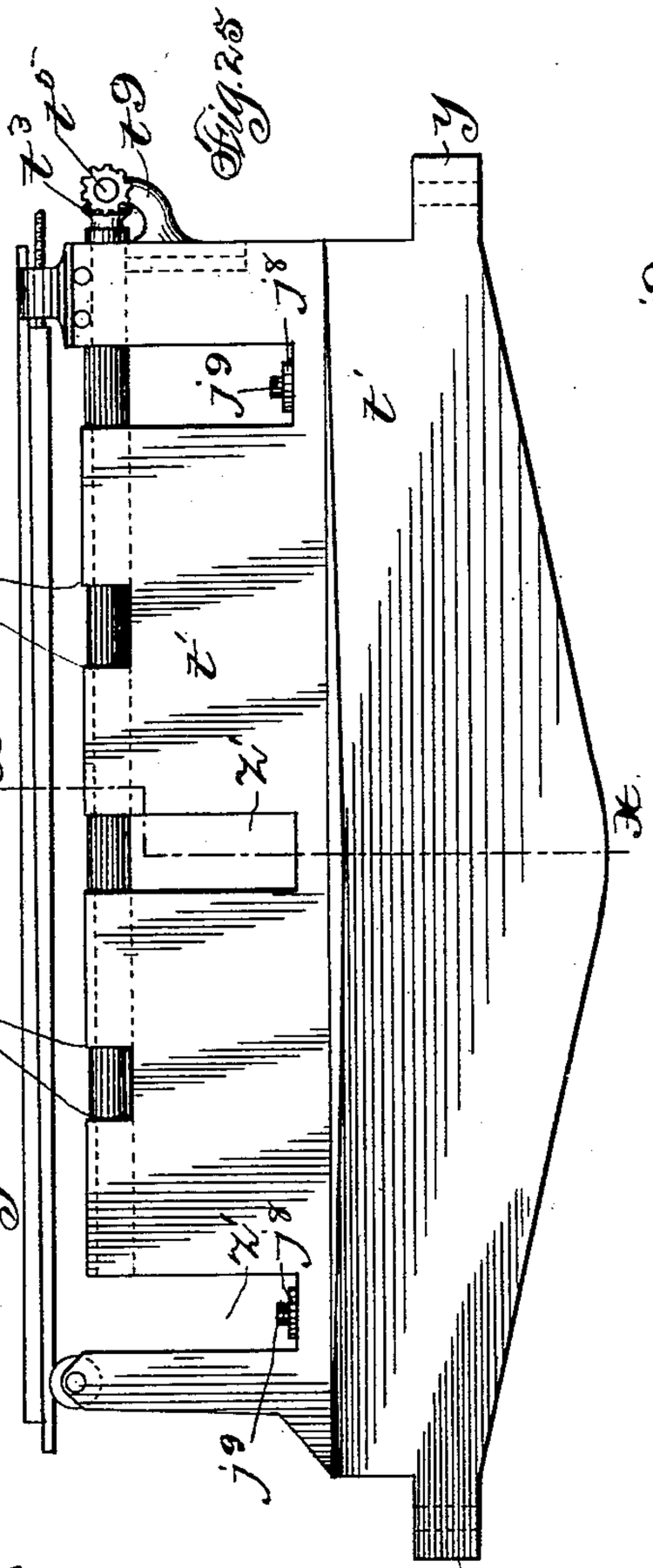

Fig. 24.

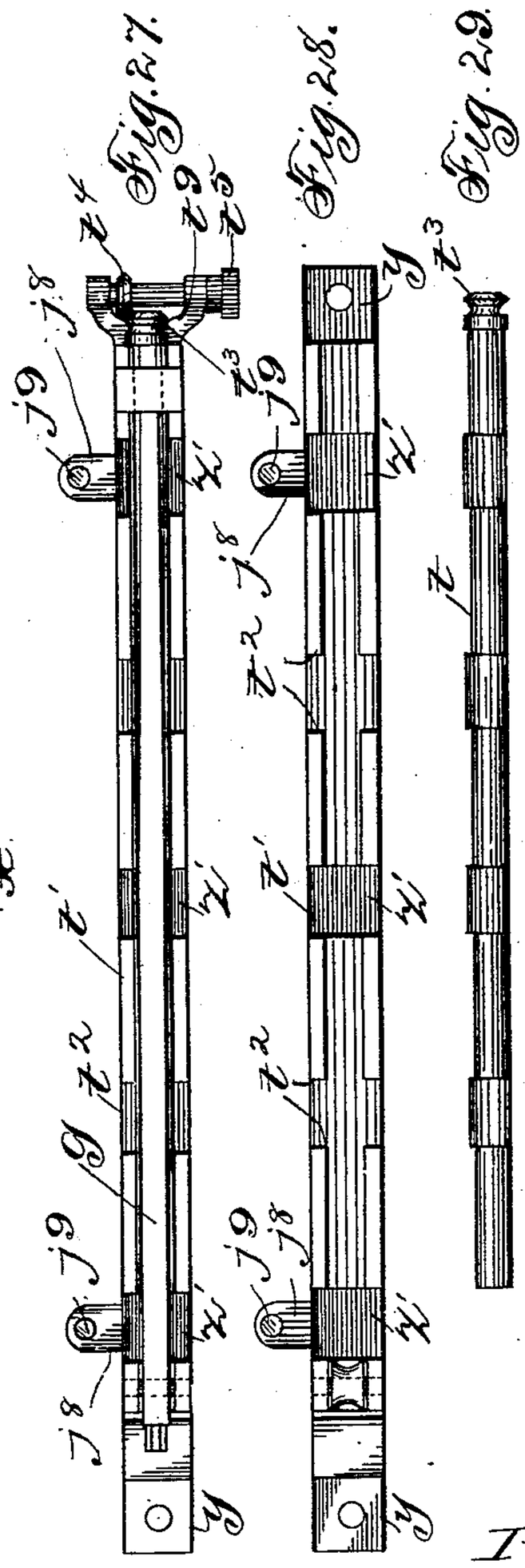

Fig. 27.

Fig. 28.

Fig. 29.

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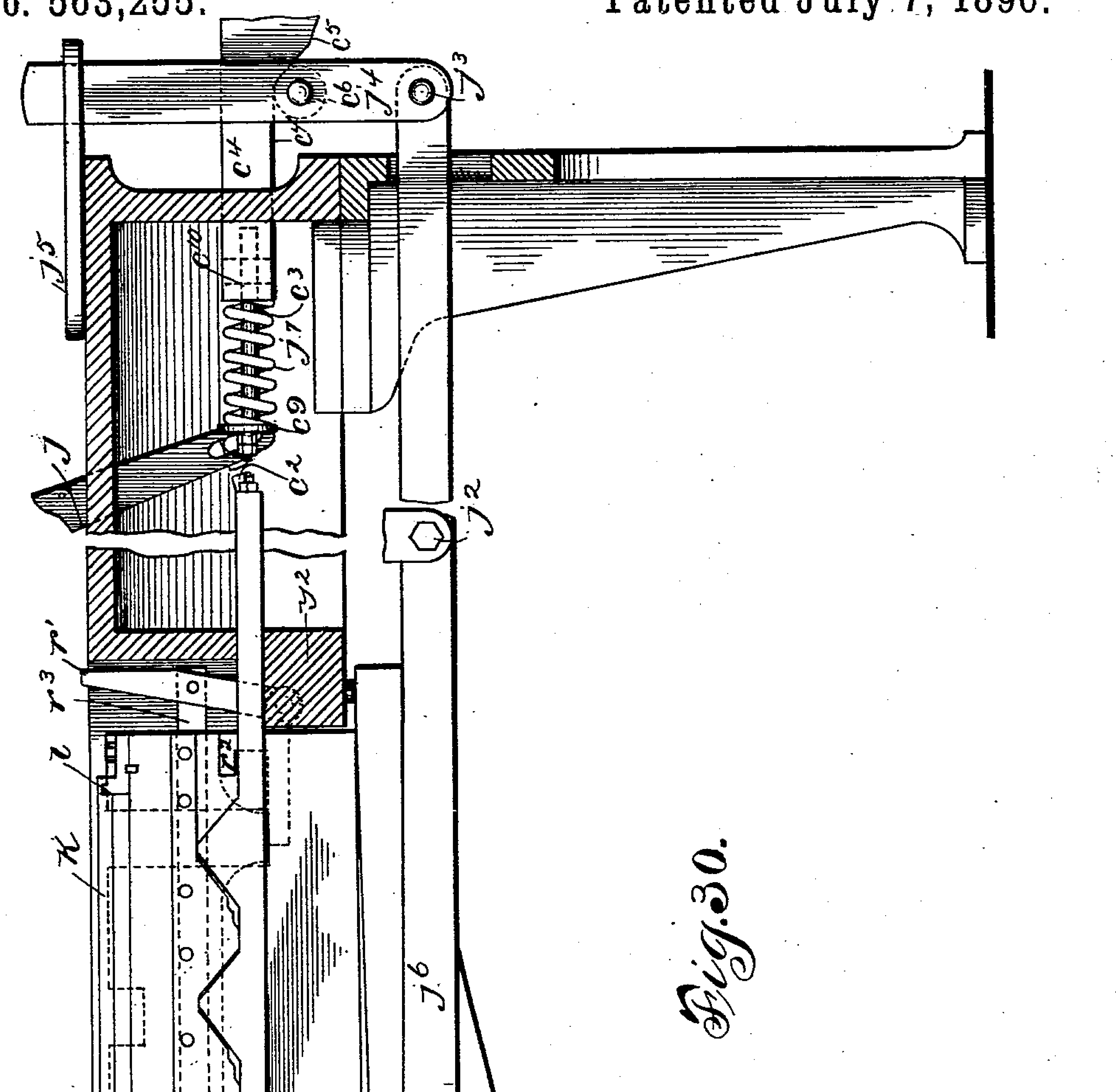

Fig. 30.

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

ORLANDO P. BRIGGS, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE WESTERN ELECTRIC COMPANY, OF SAME PLACE.

AUTOMATIC SHEET-METAL-TUBE-MAKING MACHINE.

SPECIFICATION forming part of Letters Patent No. 563,255, dated July 7, 1896.

Application filed May 12, 1893. Serial No. 474,023. (No model.)

To all whom it may concern:

Be it known that I, ORLANDO P. BRIGGS, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Automatic Sheet-Metal-Tube-Making Machines, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to automatic sheet-metal-tube-making machines; and it has for its object the construction of a machine which will take sheet metal of proper size and automatically form it into tubes by a series of steps in which the metal is formed to the desired shape, and then the same is folded and pressed close and smooth and the tube finally passed off, leaving the machine ready for the next piece of sheet metal.

Before going into a detailed description of a machine of my invention I will indicate in a general way the essential features thereof, and broadly its method of operation.

The sheet metal which is to be formed into a tube by the automatic action of my machine is placed beneath a mandrel, and this mandrel constitutes one of the important features of my invention. The metal is bent about the mandrel, the mandrel first having been increased in cross-section, and while the metal is thus bent about the mandrel and held firmly in that position the tuckers, seamers, and smoothers operate to fold, press, and smooth the seam of the tube, after which the mandrel is reduced in cross-section to permit the ready removal of the finished tube. The mandrel is of an approximately circular cross-section and is composed of two pieces which are dovetailed longitudinally. Each of the two longitudinal pieces of the mandrel tapers from a large end to a small end, the large end of one piece being placed opposite the small end of the other piece. These pieces are free to move on one another longitudinally and are controlled by a traveling beam, upon which are mounted dogs which operate upon corresponding levers, which control the size of the mandrel, in a manner to be hereinafter described more in detail. I preferably gear this traveling beam, upon which are mounted the dogs for controlling the size of the mandrel and other processes of the machine, to run at a slow rate of speed, but I give it all the power which is necessary to accomplish the work. A pusher mounted upon the head of the beam removes the finished tube from the mandrel just after the mandrel has been decreased in cross-section. Back of this pusher are smoothers, seamers, and tucker, which accomplish each a step in the formation of the complete seam. A pair of folders are mounted upon the main portion of the machine, and these, in conjunction with the bar mounted centrally beneath the mandrel, act as a clutch and serve to hold the sheet metal firmly upon the mandrel while the various tools are performing their functions in the operation of completing the seam. The three blocks which so hold the sheet metal I shall call "chuck-jaws," or "jaws" when spoken of severally. These jaws are mounted upon blocks, which in turn are mounted upon other blocks, to which are securely bolted serrated bars, which are worked by a lever, two of whose members are serrated to correspond with said serrated bars. When the sheet metal has been placed under the mandrel by the operator, it rests upon these lateral jaws, which are then raised by means of the aforesaid serrated lever working in connection with the serrated bars, as will be set forth more in detail hereinafter. When the jaws have been thus raised, they are moved toward each other at right angles to the mandrel and shape the sheet metal about the mandrel. This transverse movement is caused by an arrangement of slots and sliding blocks. The slots are cut into blocks, upon which are mounted the chuck-jaws at a suitable angle with the mandrel and engage with square blocks rigidly mounted upon supporting-blocks, and the whole is so arranged that the longitudinal motion of the supporting-blocks is transformed into a transverse motion of the jaws, as will be clearly shown hereinafter. The chuck-jaws are allowed only a direct transverse motion, as they are mounted upon fixed transverse guides. The two blocks, the slots of which slide upon the aforesaid fixed blocks, are caused to slide back and forth upon each backward motion of the traveling beam. As the blocks slide back the two chuck-jaws

are caused to open laterally, while the centrally-mounted lower jaw is caused to fall by the partial revolution of a cam-bar mounted beneath it, thus permitting the removal of the finished tube and the placing in position of a new piece of metal when the two side jaws are again closed and the lower jaw raised, and the process of forming a tube is then repeated.

My invention will be more readily understood by reference to the accompanying drawings, in which the construction of the various parts of the machine is displayed in detail.

Figure 1 is a side elevation of my machine as seen from the side on which the operator is situated. Fig. 2 is a reverse elevation. Fig. 3 is a section on line 3 3 of Fig. 2 with the chuck-jaws raised. Fig. 3[a] is an end view of the mandrel. Fig. 4 is a detail longitudinal sectional view of the front portion of the machine, showing the cam-bar in its upright position and the centrally-mounted jaw raised close to the mandrel thereby. Fig. 5 shows a detail of the same portion of the machine with the cams of the cam-bar turned away from the centrally-mounted chuck-jaw, thus lowering the jaw away from the mandrel. Fig. 6 is a plan view of the bed of the machine, a portion being broken away and the lower jaw being removed to reveal the cam-bar. In this view is shown in dotted lines the slots and bolts which control the position of the two lateral chuck-jaws with relation to the mandrel. Fig. 7 is a longitudinal section on line 7 7 of Fig. 6, showing the serrated lever which controls the vertical position of the jaws in complete elevation. Fig. 8 is a longitudinal section of the front portion of the machine, with the square sliding blocks in such a position within the diagonal slots as to cause the jaws to be open away from the mandrel. Fig. 9 is a similar section, with the square sliding blocks in such a position within the slots, however, as to cause the jaws to be closed about the mandrel. Fig. 10 shows a portion of one of the blocks upon which are mounted the square blocks which control the position of the chuck-jaws. Fig. 11 is a detail view of the rocking lever which controls the excursions of the slotted blocks. Fig. 12 is a front view of the adjustable bearing in which is mounted the rocking lever. Fig. 13 is a side elevation of such bearing. Fig. 14 is a front view of the mechanism contained within the body of the machine, the front portion of the casing being removed. Fig. 15 is a transverse section of the machine with the traveling beam removed, the chuck-jaws separated from the mandrel, and the sheet metal in place. Fig. 16 is a view of the block mentioned in the description of Fig. 10, with the rocking lever removed. Fig. 17 is a view of the same block, with a portion broken away, revealing a square sliding block mounted thereon, said block being in such a position within the slotted block upon which is mounted a chuck-jaw as to cause said jaw to be removed from the mandrel. Fig. 18 is a detail view of one of the sliding blocks. Fig. 19 shows a dog upon the traveling beam just in the act of completing the enlargement of the cross-section of the mandrel, making said mandrel ready for the reception of the sheet metal. Fig. 20 shows a dog upon the traveling beam just in the act of completing the decretion of the cross-section of the mandrel. Fig. 21 illustrates more in detail the mechanism shown in Figs. 19 and 20. Fig. 22 is an elevation of a plate mounted upon the traveling beam. This plate rests upon the mandrel while the sheet metal is being clasped by the chuck and is removed when the formation of the seam is begun. Fig. 22[a] is a cross-sectional detail view showing the cam for raising and lowering the above-mentioned plate. Fig. 23 is a detail view of the head-piece of the traveling beam, showing the pusher, seamers, smoothers, and tucker mounted thereon. Fig. 23[a] shows details of the seamers. Fig. 24 is an elevation of the plate, which is provided with a longitudinal slot to accommodate the cam-bar. Fig. 25 is a section thereof on line $x\,x$ of Fig. 24. Fig. 26 is an end elevation thereof. Fig. 27 is a plan view thereof. Fig. 28 is another plan view thereof with the mandrel and cam-bar removed. Fig. 29 is a detail view of the cam-bar. Fig. 30 is a view showing the serrated lever in the position it occupies prior to raising the chuck-jaws.

Like parts are indicated by similar letters of reference throughout the different views.

In Fig. 1 I have shown the traveling beam a in its extreme backward position. During the backward trip a certain adjustment of the parts has been accomplished, which I will now describe in detail.

Referring now more particularly to Figs. 1, 3, 6, 7, and 14, the first adjustment of the parts to take place is the raising of the chuck-jaws, which is accomplished by a flexible trip-dog b, coming in contact with a rocking lever b', which brings the serrated members $c'\ c'$ of link c into engagement with the serrated bars $d\ d$, which are securely riveted to the blocks $e\ e$, as shown in Fig. 7. After the chuck-jaws have thus been raised dog f impinges against the rocking lever f', which causes the jaws to advance and clasp the sheet metal about the mandrel g.

As will be observed by reference to Figs. 6, 7, 8, and 9, the blocks $e\ e$ have fixedly mounted thereon square sliding blocks $h\ h\ h$, which engage with corresponding diagonal slots $h'\ h'\ h'$ in blocks $h^2\ h^2$. The form of sliding block which I preferably use is shown in Fig. 18. It consists of a bolt i, provided with a suitable screw-head i'. This bolt is provided with a shoulder which rests against the surface of the block e. A cap i^2 is provided with a circular shoulder adapted to fit the head of the bolt and which may be held thereby securely in place. This cap is square and is provided with an extension which rests

against a corresponding shoulder in the slot h', cut in block h^2, and serves to hold said block close upon the face of block e.

Blocks h^2 h^2 are provided with mortises which accommodate corresponding tenons upon jaws k k. These jaws move upon transverse guides t t. (Shown in Figs. 6, 7, 8, and 9.) These transverse guides permit of the movement of the jaws in a direction at right angles only to the mandrel.

The plates h^2 are securely bolted to plates m m, as shown most clearly in Figs. 6, 8, 9, 14, and 17. These plates m m, as shown in Fig. 14, are in engagement with, but free to move longitudinally upon, the blocks e e, the tenons e' e', in connection with their corresponding mortises, acting as guides for said plates m m.

Referring now to Figs. 6, 7, 9, 14, and 17, upon the inner faces of the plates m m are vertical grooves m' m', which receive the blocks m^2 m^2 of the rocking lever f'. As before mentioned, the dog f impinges against the rocking lever f', this being the second result accomplished by the backward trip of the traveling beam. This impingement of dog f on the rocking lever f' causes the blocks m^2 m^2 to push the plates m m back, the plates carrying with them the blocks h^2 h^2, which, as said, are securely bolted to said plates m m. Now, the diagonal blocks h h h being immovably mounted on the blocks e e, motion is imparted to the blocks h^2 h^2 in a diagonal direction, but, inasmuch as the jaws k k are free to move only on transverse guides, the travel of such jaws is limited to a direction at right angles to the mandrel, which motion is accomplished by the jaws k k partaking of the diagonal motion of blocks h^2 h^2 only that portion which gives them the transverse motion, and sliding upon blocks h^2 h^2 longitudinally. It is thus that the lateral jaws are brought about the mandrel. After the jaws have been raised and brought close to the mandrel, the tucker, seamers, and smoothers are brought into play. These seamers, &c., are shown in detail in Fig. 23. The tucker is also shown in Fig. 3. The tucker n is the first to be brought into operation upon the sheet metal. This tucker is made up of two parts which prepare the sheet metal for the seamers and smoothers which follow. Between the two members of this tucker or folder is placed a strip n', which prevents the sheet metal at that stage from being overlapped. There are four seamers n^2, n^3, n^4, and n^5 (shown in detail in Fig. 23) and two smoothing-rollers n^6 n^7. As already mentioned, each of these seamers completes a step in the formation of the seam, after which follow the smoothing-rollers which finish the seam.

It will be observed by the illustration Fig. 23^a, which shows the tube in successive stages of the process of forming the seam, that after the partially-formed tube passes from the tucker n the seamer n^2, which has the slot n^8 at one side of the center, brings the edges closer together and gives them a bend to one side. This process is carried still further by seamer n^3, which is provided with slot n^9, and finally seamer n^4, with its slot n^{10} in the center and much shallower and broader than the slots in the preceding seamers, completes the process of folding the seam of the tube, which then is pressed close and smoothed by rollers n^6 and n^7 and tool n^5.

As illustrated in Figs. 1, 22, and 22^a, the plate o is carried upon the plate o', which latter is so supported from the traveling beam that it may be raised and lowered. To effect this movement, circular cams p p' are provided which fit within circular openings or recesses provided in the plate o'. The screws o^2 o^2, that secure the plate o' to the traveling beam and serve as the journals for the rotation of the cams, pass eccentrically through the cams, which are so situated that movement thereof from the position shown in Fig. 22 to that shown in Fig. 1 causes the portions of the cams of greatest eccentricity to rise above the axis of rotation, thus raising the plate o'. The cams are connected by a link, so that they move together. Motion is imparted to the cams by means of the centrally-pivoted crescent-shaped cam q^2, against the horns of which the roller q' is adapted to impinge to rotate the cam. In Fig. 22 roller q' is shown in its travel to the right and has impinged against the right-hand horn of cam q^2 to lower the plate o, while in Fig. 1 the roller q' has impinged against the left-hand horn of cam q^2, thus raising the plate o. As this plate o is brought to bear upon the mandrel upon the forward journey of the traveling beam, a further description of its functions will be reserved for the description of the results taking place on such forward trip.

By the time that the tube is finished a dog r impinges against lever r' and causes the rocking lever f' to be raised through the medium of the bar r^3, connecting the two, as seen by reference to Fig. 8. As shown therein, I have provided a suitable bearing r^2 for the lever r'. This lever is provided with a recess which accommodates the end of the bar r^3. Upon the other end of this bar is provided a short rack which engages with a segmental gear, which is integral with the rocking lever f' and concentric with the journal of said rocking lever, as will be readily seen by reference to Figs. 8 and 11. The elevation of this rocking lever f' causes the blocks m^2 m^2 to be raised within the vertical slots m' m', thus carrying forward with them the plates m m and the blocks h h, securely bolted therewith. This advancement of the blocks h h separates the jaws mounted upon them from the mandrel by a process the reverse of that by which they are closed upon the mandrel and leaves them ready to be lowered. Dog r is next brought into play upon dog s', and then the direction of travel of the beam a is reversed.

Referring now to Figs. 19, 20, and 21, the

dog s' is keyed to shaft s^2, which shaft is mounted in bearings s^3 s^3, securely bolted to the bed of the machine. This dog s' is also integral with dog s^4, the use whereof will be explained later. On the dog s' is mounted the sliding block s^5, which engages a vertical slot s^6 in the sliding plate s^7. To this sliding plate is adjustably bolted the lower half s^8 of the mandrel g. As shown, the bolt is connected with the larger end of the lower half.

In Fig. 20 I have shown the dog r just in the act of leaving dog s', which has been moved thereby from the position shown in Figs. 19 and 21 to the position shown in Fig. 20 and in dotted lines in Fig. 21. In acquiring this position the block s^5 is moved backward, as shown in dotted lines in Fig. 21, which block s^5 carries with it the plate s^7, together with the lower half of the mandrel connected therewith. The small ends of the mandrel are thus caused to approach each other, thus reducing the cross-section of the mandrel and allowing the tube, which by this time has been finished, to fit loosely thereon and to be easily removed.

The last thing accomplished by the backward trip of the traveling bar is the lowering of the central chuck-jaw, which is accomplished in a manner which I will explain in connection with Figs. 5, 6, 15, 24, and 29. The rocking cam-bar t has preferably four cams. This cam-bar plays within a recess cut in the upper portion of the plate t', slots t^2 t^2 t^2 being also cut within said plate to permit the free play of the cams. These cams I make cylindrical in shape, the axes of which are eccentric to the bar proper. Upon the end of this cam-bar is fixed a small gear-wheel t^3, which engages with another gear-wheel t^4. The gear-wheel t^4 is actuated, through the medium of gear t^5, by the rack t^6. This rack t^6 is allowed a limited excursion, enough to cause a quarter-revolution of the cam-bar. To an elongation of this rack-bar is adjustably fastened the post t^7, which is impinged against by the trip-dog b. This impingement, which occurs once on each backward trip of the traveling beam, results in lowering the cams and therewith the lower chuck-jaw t^8. The gears t^4 and t^5 are securely mounted in a forked bearing t^9, whose stock fits within a groove cut within the plate t', and is firmly bottomed therein. The cam-bar rests upon and secures the immovability of said stock. When the jaw t^8 has thus been lowered, the belts are shifted and the traveling beam started on its forward journey.

In Fig. 2 I have shown the traveling beam advanced to its extreme forward position. I shall now recount the results of this forward trip.

The removal of the finished tube is begun upon the forward start of the traveling beam, the mandrel, as before mentioned, having been previously decreased in cross-section, an adjustable pusher d^2 being mounted upon the head of the traveling beam for this purpose. Trip-dog j is next acted upon by dog j', which results in the lowering of the chuck-jaws k k in the way I will now describe.

Referring now to Figs. 6 and 7, the trip-dog j is pivotally mounted upon the machine and is adjustably connected with lever c by link c^2. The forward movement caused by the impingement of the dog j against dog j' causes the teeth of the serrated members c' c' to recede and mesh with the corresponding teeth on blocks d d, thus allowing said blocks and the jaws k k, fastened thereto, to fall. In order to prevent a too sudden fall of the jaws, which would severely jar the machine, I provide an arm j^6, which supports the blocks e e directly and permits of their gradual descent. This arm is fulcrumed at j^2 and pivoted at j^3 to the upright bar j^4, which works within and is guided by a slot in the projecting arm j^5. To the lever c is attached a rod c^3. The other end of this rod is attached to a block c^4. This block c^4 projects beyond the casing of the machine and has mounted upon it a block c^5, which is made, preferably, of the shape shown. The block c^4 bears upon a roller c^6. When the jaws k k are raised, the block c^5 is in the position shown in Fig. 7. When the trip-dog j is shoved forward, the blocks c^4 and c^5 are shoved farther out, and the roller c^6 rolls upon the slanting surfaces c^7 c^8 of the block c^5, thus allowing the bar j^4 to rise gradually, and the jaws k k, which, as said, are supported by the arm j^6, to fall gradually. The positions of the blocks c^4 and c^5 after the jaws are lowered are shown in Figs. 2 and 30.

A spring j^7 is provided to serve as a cushion for the lever c. This spring encompasses the rod c^3 and bears against a washer c^9 and an angle-plate c^{10}. As will be seen, the arm j^6 is sufficient to support both of the blocks e e, inasmuch as these two blocks are connected by webs z z z. Slots z' z' z' are cut into the plate t', which accommodate and allow for the vertical movement of the webs. I provide upon the plate t' angle-plates j^8 j^8. Through these angle-plates are passed adjustable threaded rods j^9 j^9, as shown in Figs. 3, 14, 15, 24, 25, and 26. The blocks e e rest upon these rods j^9 j^9 when in their lowest position.

After the jaws k k have fallen and the sheet metal has been inserted under the mandrel by the operator, the next readjustment of parts in order is the enlargement of the mandrel. This enlargement is accomplished, in fact, during the time it takes to lower the chuck-jaws. Referring now to Figs. 19 and 21, the dog s^4 is struck by dog s, carried upon the beam a at the end opposite to that carrying dog r, thus changing the position of said dog from that shown in Fig. 20 and in dotted lines in Fig. 21 to that shown in Fig. 19 and in full lines in Fig. 21. This movement of the dog s^4 carries forward with it the block s^5, mounted upon the companion dog s' and sliding in vertical slots s^6, thus advancing the sliding plate s^7, which advancement causes an enlargement

of the mandrel, for the larger end of the upper half of the mandrel is caused to approach the larger end of the lower half.

After the enlargement of the mandrel has been effected the plate *o* is brought to bear upon the mandrel in the manner I will now describe.

Referring now to Figs. 2 and 22, the plate *o* is shown as having been so acted upon by the roller q' as to lower it upon the mandrel. After the plate *o* has been lowered the traveling beam still has a portion of its forward trip to finish. To prevent a useless wearing of the plate *o* upon the mandrel, I mount it upon the plate o' in such a manner that it may be held stationary by the hook p^3, which engages with the end of the mandrel. The plate *o* is mounted upon plate o' by means of a roller p^4, which fits a slot or channel p^5, cut within the plate *o*. This slot is of sufficient length to allow the traveling beam to complete its trip. The plate *o* passes back and forth within a channel in plate o'. (Shown in dotted lines in Fig. 22.) Roller-bearings p^6 p^6 p^6 are provided for the plate *o* within the plate o'. A detent p^7 is provided which locks the eccentric cam-plates *p* and p' in position. When the plate *o* is to be lifted, this detent is raised by the shelf p^8, the detent being mounted upon the end of a spring which rides upon the shelf p^8 to raise the detent, thus allowing ready action by the roller q' upon the crescent-shaped cam-plate q^2.

The last result accomplished by the traveling beam upon its forward trip is the elevation of the lower centrally-mounted chuck-jaw t^8, which is accomplished as follows: Referring now to Figs. 4 and 6, the adjustable dog *v* upon the rear end of the traveling beam impinges against the post t^7 and advances same together with the rack-bar t^6, connected therewith. This rack-bar causes a quarter-turn of the cam-bar, thus raising at the same time the cams thereon, and, consequently, the jaw t^8, motion being communicated, as said before, from the rack-bar t^6 through gear-wheels t^5, t^4, and t^3. It is to resist the upward pressure of this lower jaw that I have provided the plate *o*, before mentioned.

I have now described what results are caused by the traveling beam. How upon the backward trip of such beam the chuck-jaws are raised and brought together about the mandrel, after which the tools are brought to bear upon the sheet metal; how the plate *o* is removed from the mandrel; how the lateral chuck-jaws are moved away from the mandrel preparatory to being lowered; how the mandrel is made smaller for the purpose of removing the finished tube; and, lastly, how the lower chuck-jaw has been lowered away from the mandrel.

I have shown how upon the return trip of the traveling beam the tube is removed; how the jaws are gradually lowered, after which the sheet metal may be inserted under the mandrel; how the mandrel is enlarged; how the plate *o* is brought to bear upon said mandrel and held stationary thereon; and, lastly, how the centrally-mounted lower jaw is elevated.

I will now describe some of the details of construction.

Referring more particularly to Figs. 1, 2, and 3, it will be seen that the traveling beam *a* slides upon the stationary beam *w*, which is secured to the uprights w' w' w'. The upper surface of this traveling beam is toothed, so as to mesh with a suitable driving-gear w^2. In most instances the speed communicated to the driving-pulleys w^3 w^3 is too great, especially when the speed is supplied from a shaft which drives machines that have lighter work to perform than my machine. I decrease the speed by suitable intermediate gearing w^4, which gearing causes a corresponding increase of power to be applied to the traveling beam.

Tubes of different diameter may be made upon my machine. When a sufficient stock of one size is turned out, the mandrel may be removed and a mandrel of a smaller or larger diameter put in its stead, while the jaws *k k* can be removed and others corresponding to the changed mandrel may be put in place of them. The lower jaw t^8 has also to be removed and one of the proper size put in its place.

Referring to Fig. 7, it will be seen that I provide two offsets in the teeth of blocks *d d*. By vertically adjusting the trip-dog *b*, the excursion of the lever *c* may be so controlled as to allow the teeth thereof to bear upon either of these offsets. The offsets w^5 are to be used when the largest of the three sizes of tubes, which in practice I have found it necessary to provide for, is to be made. The next offsets w^6 are to be used when the medium size tube is to be made, while that engagement (shown in Fig. 7) of the lever *c* with the teeth of blocks *d d* is used when the tube of the smallest diameter is to be made.

When the size of the mandrel and chuck-jaws is changed, the initial position of the chuck-jaws must be regulated. The bearing w^{12} of the rocking lever f' is adapted to slide in slots w^7 w^7, provided in the blocks *e e*, as shown clearly in Figs. 10, 14, 16, and 17.

As shown more clearly in Figs. 8 and 9, the bearing w^{12} is held in position by a bolt w^8, one end of which is secured in position, the other end passing loosely through said bearing and serving to hold the same in position through the agency of jam-nuts w^{11} w^{11}, screwed one against each face of the bearing. Two jam-nuts w^{11} w^{11} hold this bearing in its proper position. When the initial position of the jaws *k k* is to be changed, the bearing w^{12} is adjusted by means of bolt w^8 and jam-nuts w^{11} w^{11}. As is readily seen by reference to the drawings, the adjustment of this bearing adjusts also the jaws *k k* through the me-

dium of the plates *m m*, bolted therewith, and the rocking lever *f'*, which is in engagement with said plates *m m*.

When the chuck-jaws and mandrel are readjusted, it is obvious that the seamers, smoothers, tucker, and pusher must be vertically adjusted, while the seamers have to be changed for ones which accommodate themselves to the new mandrel. The vertical adjustment of the aforesaid seamers, &c., is regulated by bolts *x x x*, working within the slots *x' x' x'*, while the pusher is adjusted by bolt and nuts x^2. When the adjustment of the seamers, &c., has been made, such adjustment is made secure by set-nuts x^3 x^3 x^3.

Upon replacing the lower jaw a vertical adjustment of the plate *t'* is of necessary consequence. This plate *t'* is provided with two projections *y y*, through which pass freely bolts *y' y'*, which are screwed into the lugs y^2 y^2. Nuts y^3 y^3 are screwed upon this bolt and support the plate *t'* and adjust the position thereof. Jam-nuts y^4 y^4 are provided, which secure the adjustment of said plate *t'*

The time of lowering the cams of the cambar *t* is controlled by adjusting the longitudinal position of the post *t'*, while the elevation thereof is controlled by adjusting the bolt *y'*.

My invention is susceptible of many modifications in matters of detail, and I do not therefore desire to limit myself to the precise constructions shown.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a sheet-metal-tube-making machine, the combination with an expansible mandrel, about which the sheet metal is formed, of a number of radially-movable jaws adapted to form the sheet metal about said mandrel and hold the same thereon, substantially as described.

2. In a sheet-metal-tube-making machine, the combination with an expansible mandrel about which the sheet metal is formed, of jaws adapted to form the metal about the mandrel and hold the same firmly thereon, and a longitudinally-traveling beam carrying tools adapted to form the seam in the tube, substantially as described.

3. In a sheet-metal-tube-making machine, the combination with a mandrel about which said sheet metal is formed, of plates adapted to receive said sheet metal beneath said mandrel, means for raising said plates, thus bending the sheet metal about said mandrel, said plates being provided with jaws adapted to close upon said sheet metal and hold it firmly in position, and mechanism for forming, pressing, and smoothing the seam in said tube, substantially as described.

4. In a sheet-metal-tube-making machine, the combination with a mandrel about which said sheet metal is formed, of means for folding the metal about said mandrel and forming the seam in the tube, a plate *o* adapted to rest upon the mandrel to resist upward pressure upon said mandrel, said plate being adapted to be removed from said mandrel before the tube is formed, substantially as described.

5. In combination, a mandrel, jaws adapted to close about the bottom and two sides thereof, a traveling beam carrying tools and adapted to fold and press a seam in sheet metal folded about said mandrel, a plate carried by said traveling beam and adapted to rest upon the top of said mandrel while the metal is being folded thereon, and to be removed before the seam is formed, substantially as described.

6. The combination in a sheet-metal-tube-making machine, with a mandrel about which the metal is adapted to be folded, of means for folding said metal about said mandrel, a traveling beam adapted to carry tools for folding and pressing a seam in the sheet metal, a plate *o* carried by the traveling beam and adapted to rest upon the said mandrel when the metal is being folded, a pin p^4 adapted to slide in a slot p^5 and to hold said plate in a channel in a plate *o'* which is mounted upon said traveling beam and adapted to be lowered and raised; whereby said plate *o* is brought upon said mandrel and subsequently raised therefrom, substantially as described.

7. In an automatic sheet-metal-tube-making machine, the combination of a mandrel with three jaws adapted to shape the sheet metal about said mandrel, two of said jaws mounted laterally about, and the third centrally beneath, said mandrel, means for bringing said jaws about the mandrel when the sheet metal is in place, and means for removing said jaws away from said mandrel and also lowering the same in order that the finished tube may be removed and the machine refed, a traveling beam mounted centrally above said mandrel, said traveling beam carrying a plate which rests upon the mandrel during the time that the metal is being shaped about the same, whereby by means of said plate the upward pressure of the aforesaid lower jaw is resisted, said traveling beam carrying tools for making and smoothing the seam in the tube, said traveling beam also having mounted thereon a pusher to remove the finished tube, substantially as specified.

8. In an automatic sheet-metal-tube-making machine, a mandrel consisting of two tapering parts dovetailed together, said dovetailed parts adapted to be slid upon each other so as to increase or diminish the cross-section thereof, in combination with jaws mounted about said mandrel and adapted to be automatically moved close about or away from the mandrel, and a traveling beam mounted above said mandrel provided with tools for making and smoothing the seam of the tube, said traveling beam also provided with dogs which so act upon dogs which cause one of the tapering parts of said mandrel to move longitudinally, as to cause the cross-

section of the mandrel to be of a large cross-section, shortly previous to and during the formation of the tube and to be decreased in cross-section when the finished tube is to be removed, a plate mounted upon said traveling beam adapted to rest upon the mandrel when the sheet metal is being shaped about the same to withstand any upward pressure upon said mandrel, substantially as specified.

9. In an automatic sheet-metal-tube-making machine, the combination of a mandrel with jaws $k\,k$ and t^8 mounted about said mandrel, the jaws $k\,k$ mounted upon blocks $h^2\,h^2$, which in turn are mounted upon blocks $e\,e$, serrated plates $d\,d$ fastened to said blocks e by means of which and a link c provided with serrated members $c'\,c'$—said lever c having pivotally connected thereto an arm b' which is adapted to be engaged with by the flexible trip-dog b once upon each backward trip of the traveling beam, a dog u also pivotally connected to said link c, adapted to be engaged with by dog u' upon the same backward trip of the traveling beam—said blocks $e\,e$, together with the jaws $k\,k$ mounted thereon, are caused to fall away from the mandrel on each backward excursion of said serrated plates and caused to rise upon each forward excursion of said plates, means whereby the jaws may be made to recede from or advance about said mandrel, means whereby the centrally-mounted lower jaw t^8 may be raised or lowered, a traveling beam mounted above said mandrel provided with tools adapted to make and smooth the seam of the tube, and dogs mounted upon said traveling beam adapted to actuate the aforesaid serrated plates, said traveling beam also provided with a plate adapted to rest upon the mandrel just previous to and during the shaping of the sheet metal about the mandrel, substantially as described.

10. In an automatic sheet-metal-tube-making machine, the combination of a mandrel with jaws $k\,k$ and t^8 adapted to be brought about and removed and lowered from said mandrel, said jaws $k\,k$ mounted upon the blocks h^2 in such a manner as to have free longitudinal movement with relation to said blocks, said blocks h^2 mounted upon blocks e and allowed a limited diagonal motion thereon by means of the square sliding blocks h mounted upon said blocks e, and diagonal slots in the blocks h^2 which engage with said square sliding blocks h, said blocks $h^2\,h^2$ adapted to be actuated by a rocking lever f' through the medium of vertical sliding blocks $m^2\,m^2$ and blocks $m\,m$ provided with vertical slots which engage with said blocks $m^2\,m^2$, said blocks $m\,m$ in engagement with said blocks $h^2\,h^2$, the lower jaw t^8 adapted to be raised or lowered by the cam-bar t journaled within a recess in the central plate t', a traveling beam mounted centrally above said mandrel provided with tools to make and smooth the seam of the tube, a plate mounted upon said traveling beam to withstand any upward pressure upon the mandrel during the time that the metal is being shaped about the same, the dog f mounted upon the traveling beam adapted to close jaws $k\,k$ about the mandrel through the medium of the rocking lever f' and parts actuated thereby, dog r also mounted upon the traveling beam adapted to open the jaws $k\,k$ away from the mandrel through the medium of dog r', rack-bar r^3 and rocking lever f' and parts actuated thereby, adjustable dogs v and b adapted through the medium of post t^7, rack t^6, pinion t^5 and gears t^4, t^3, to raise and lower respectively the cams upon cam-bar t, and together therewith jaw t^8, substantially as specified.

11. In an automatic sheet-metal-tube-making machine, the combination of a mandrel with jaws adapted to advance and shape the sheet metal about said mandrel, two of said jaws $k\,k$ mounted laterally about said mandrel upon blocks $h^2\,h^2$, said blocks $h^2\,h^2$ mounted upon blocks $e\,e$, an arm u^6 so actuated by link c through the medium of rod c^3, blocks c^4 and c^5, roller c^6 and bar u^4 pivoted to arm u^6 at u^3 as to rise when said blocks e rise and to support said blocks while descending, a cushion u^7 encompassing said rod c^3, rests u^9 provided upon plate t' to support said blocks $e\,e$ and the mechanism thereon when in their lowered position, a traveling beam mounted above the mandrel, said traveling beam provided with tools to make and smooth the seam of the tube, and a pusher to remove the finished tube, a plate also carried upon said traveling beam adapted to rest upon the mandrel just previous to and during the time that the sheet metal is being shaped about the same, dogs mounted upon the traveling beam adapted to actuate lever u^6 through the medium of dog u, link c^2, rod c^3, blocks $c^4\,c^5$, rollers c^6 and bar u^4, substantially as and for the purpose specified.

12. In an automatic sheet-metal-tube-making machine, a mandrel composed of two parts dovetailed together, one of said parts held stationary, the other part s^8 linked to sliding plate s^7, a vertical slot s^6 in said plate s^7 in engagement with block s^5 mounted upon dog s', said dog s' keyed upon shaft s^2, as is also dog s^4—in combination with jaws adapted to fold the sheet metal about said mandrel, means for bringing said jaws about the mandrel and removing and lowering the same away from the mandrel, a traveling beam having mounted thereon a dog s adapted to impinge upon dog s^4 upon each forward trip of the traveling beam, which, through the medium of parts connecting the dog s^4 with part s^8 of the mandrel, results in enlarging the mandrel, a dog r mounted upon the traveling beam adapted to impinge upon dog s' upon each backward trip of the traveling beam, which, through the medium of parts connecting dog s' with part s^8 of the mandrel, results in decreasing the cross-section of the mandrel, a plate o mounted upon said traveling beam adapted to rest upon the man-

drel just previous to and during the time that the metal is being shaped about the same, substantially as and for the purpose specified.

13. In an automatic sheet-metal-tube-making machine, the combination of a mandrel with jaws adapted to shape sheet metal about same, means for bringing the jaws about and removing and lowering the same from the mandrel, a beam mounted and adapted to travel above said mandrel, said beam having cam-plates p p' mounted thereon, a plate o' supported upon said cam-plates, a link q connecting said cam-plates, a crescent-shaped cam q^2 adapted to be engaged with by a roller q' once upon each forward trip to lower, and once upon each backward trip to raise the plate o' and therewith a plate o mounted upon plate o', said plate o provided with a catch p^3 adapted to engage with one end of the mandrel when the plate is lowered, means whereby the plate o' is held stationary shortly previous to and during the time that the sheet metal is being shaped about the mandrel, detent p^7 adapted to engage one of said cam-plates, and shelf p^8 for raising said detent, said traveling beam provided with tools which make and smooth the seam of the tube, a pusher mounted upon said beam to remove the finished tube, substantially as and for the purpose specified.

14. In an automatic sheet-metal-tube-making machine, the combination of a mandrel with jaws adapted to shape sheet metal about the same, means for advancing the jaws about and removing and lowering them from the mandrel, a traveling beam mounted above said mandrel, a plate mounted upon said beam adapted to rest upon the mandrel shortly previous to and during the time that the sheet metal is being shaped about the same, folder n, metal strip n', seamers n^2 n^3 n^4 and smoothers n^5 n^6 n^7 mounted upon the front end of the traveling beam, adjustable pusher d^2 also mounted upon the front end thereof to remove the finished tube, substantially as and for the purpose specified.

15. In a sheet-metal-tube-making machine, the combination with an expansible mandrel about which the sheet metal is formed, of a radially-movable jaw adapted to press the middle portion of the sheet-metal blank against the mandrel, and a pair of plates provided with jaws and situated upon either side of said radially-movable jaw, said plates being capable of two motions, the one parallel to the motion of said radially-movable jaw, thereby bending the blank, and the other toward the mandrel, thereby pressing the blank against the mandrel and holding the same thereon, substantially as described.

16. In a sheet-metal-tube-making machine, the combination with a longitudinally-movable bar provided with serrations upon its upper surface, of a plate resting upon said bar and provided with serrations upon its lower surface meshing with the serrations on said bar, and a jaw carried upon said plate adapted to engage the blank and bend the same about the mandrel in its ascent, substantially as described.

17. In a sheet-metal-tube-making machine, the combination with a series of stationary studs, of a plate carrying a jaw and provided with oblique channels in which said studs are adapted to travel, and a mandrel toward which said jaw is moved by the oblique motion thus imparted to said plate, substantially as described.

18. In a sheet-metal-tube-making machine, the combination with a series of stationary studs, of a plate provided with oblique channels in which said studs are adapted to travel, and a transversely-moving jaw-plate dovetailed longitudinally to said first-mentioned plate, and transversely to stationary guides; whereby the oblique motion of said first-mentioned plate imparts a transverse motion only to said transversely-moving plate, substantially as described.

19. In a sheet-metal-tube-making machine, the combination with a vertically-movable jaw, of a rotatable shaft occupying a position parallel to the length of said jaw, and provided with cams adapted to engage said jaw at points along its length; whereby the rotation of said shaft effects the raising and lowering of said jaw, substantially as described.

20. In a sheet-metal-tube-making machine, the combination with an expansible mandrel comprising the longitudinally-movable tapering sections, of a traveling part adapted to engage and remove the completed tube from said mandrel, and means for locking said sections in position when the mandrel is contracted, thereby preventing expansion of the mandrel due to the friction caused by the removal of the completed tube, substantially as described.

21. In a sheet-metal-tube-making machine, the combination with the expansible mandrel g, one section thereof being movable, of the plate s^7 provided with a vertical slot, the cam s^5 adapted to engage said slot, said cam s^5 being adapted to be moved into position to lock the movable section of mandrel g, against movement from a thrust thereon, while the mandrel is contracted, substantially as described.

22. The method of forming sheet-metal tubes, which consists in bending the sheet-metal blank about an expansible mandrel, bending the edges of the blank to form a seam, and finally contracting the mandrel to permit the removal of the completed tube, substantially as described.

In witness whereof I hereunto subscribe my name this 20th day of January, A. D. 1893.

ORLANDO P. BRIGGS.

Witnesses:
GEORGE W. MCMAHON,
GEORGE L. CRAGG.