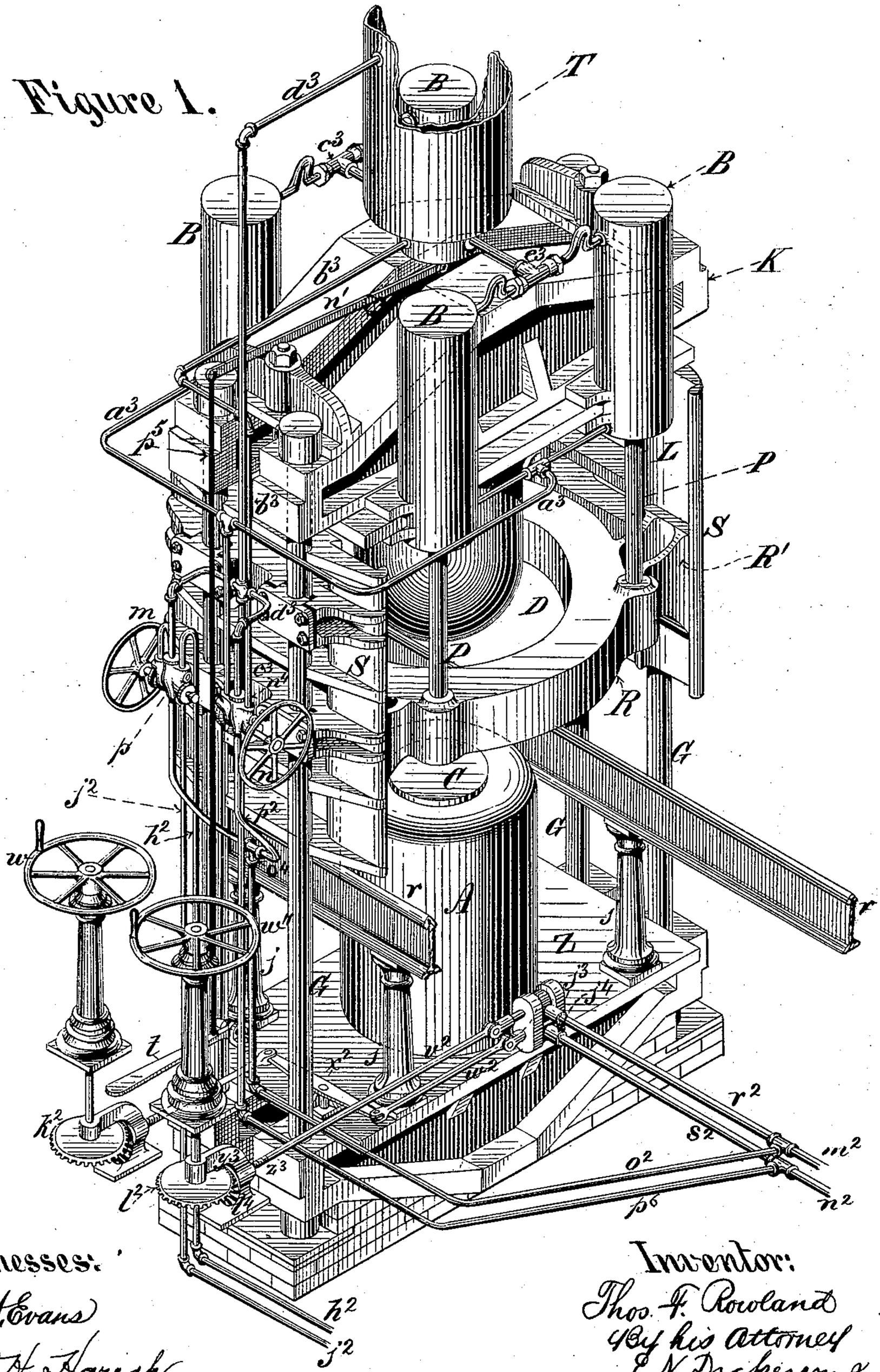
9 Sheets—Sheet 1.

T. F. ROWLAND.

Machine for Forming Iron-Vessels.

No. 206,486. **Patented July 30, 1878.**

Figure 1.



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T. H. Parish.

Inventor:
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By his Attorney
E. N. Dickerson Jr

9 Sheets—Sheet 2.

T. F. ROWLAND.

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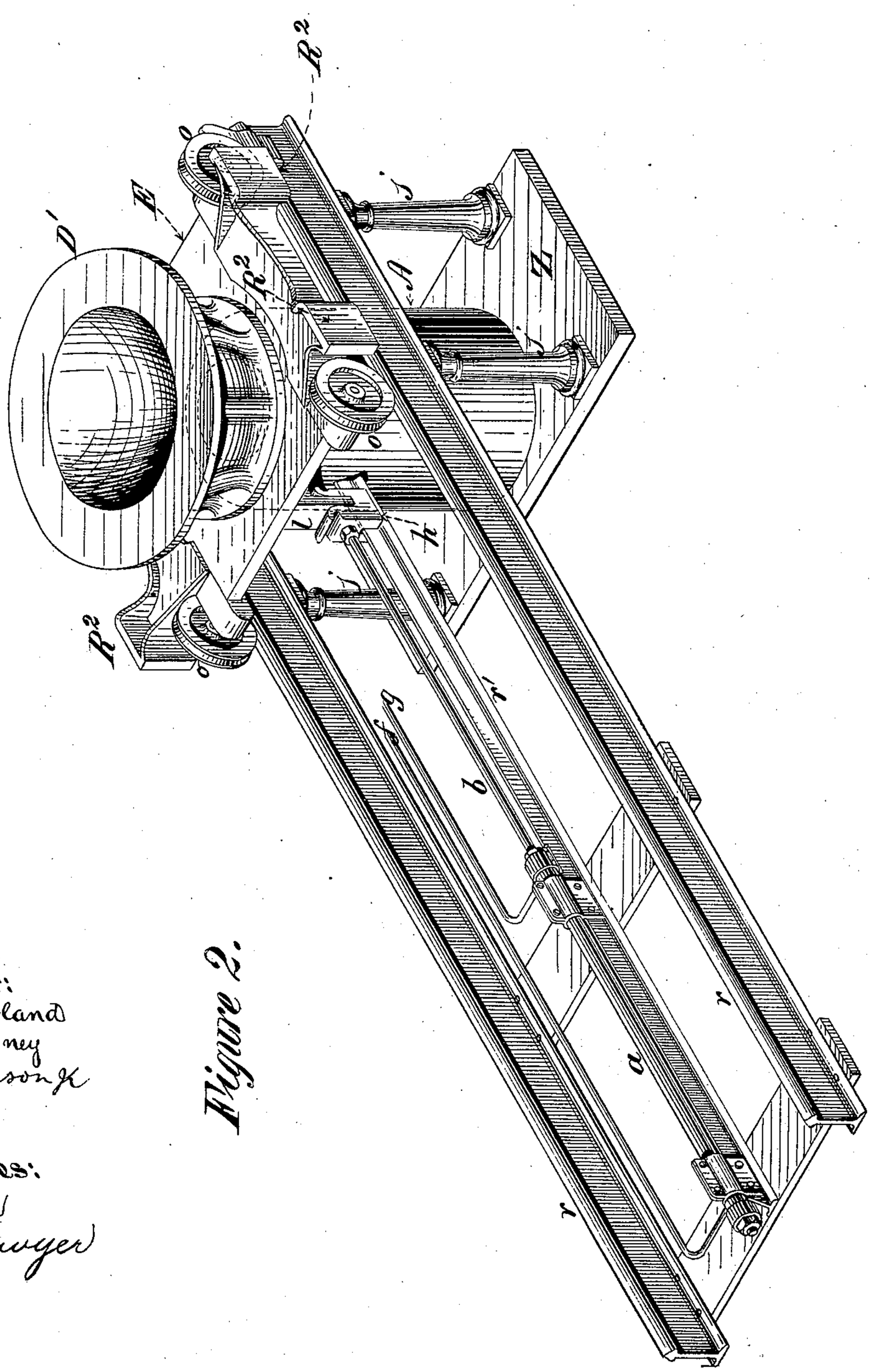

Figure 2.

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9 Sheets—Sheet 3.

T. F. ROWLAND.

Machine for Forming Iron-Vessels.

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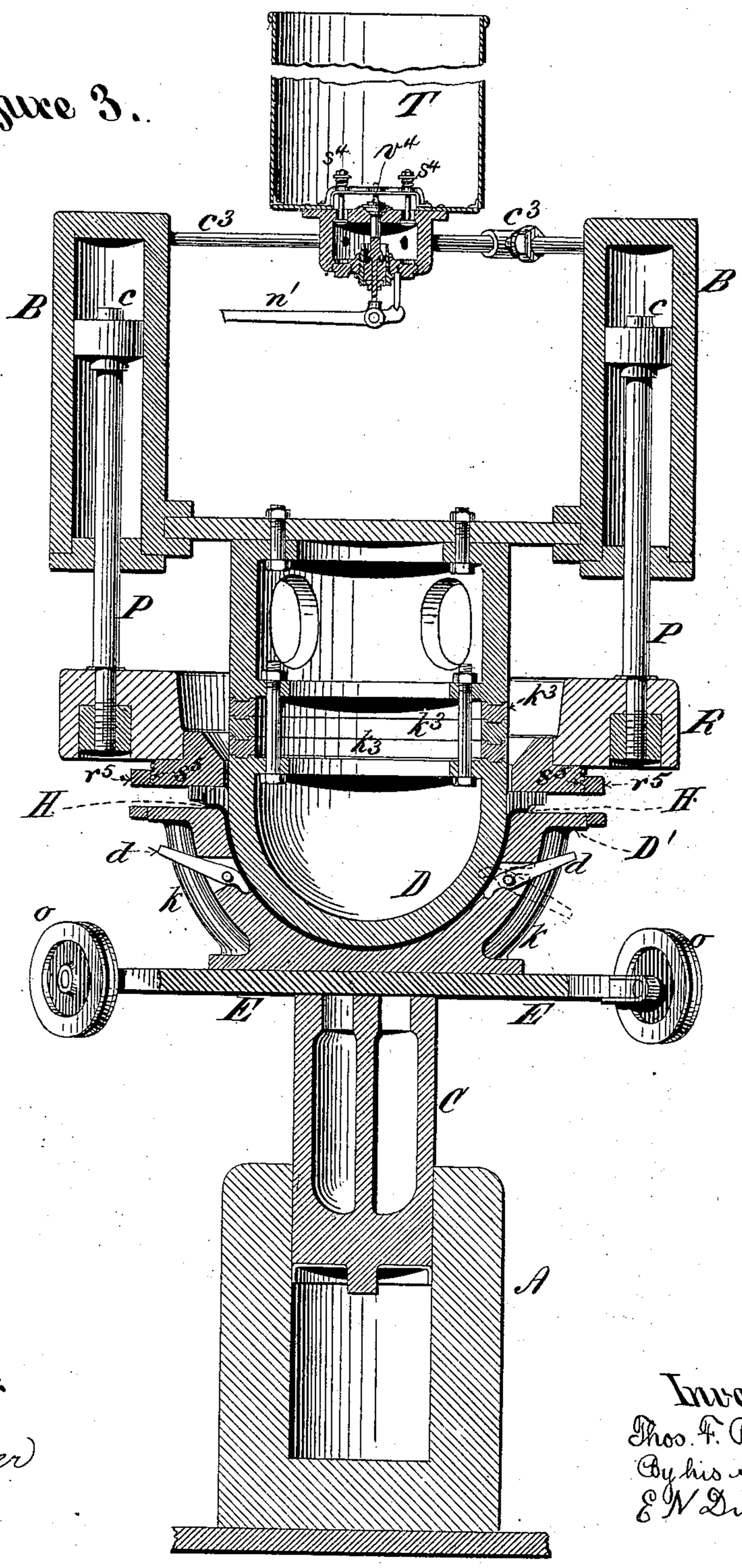
Figure 3.



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9 Sheets—Sheet 4.

T. F. ROWLAND.

Machine for Forming Iron-Vessels.

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Figure 4.

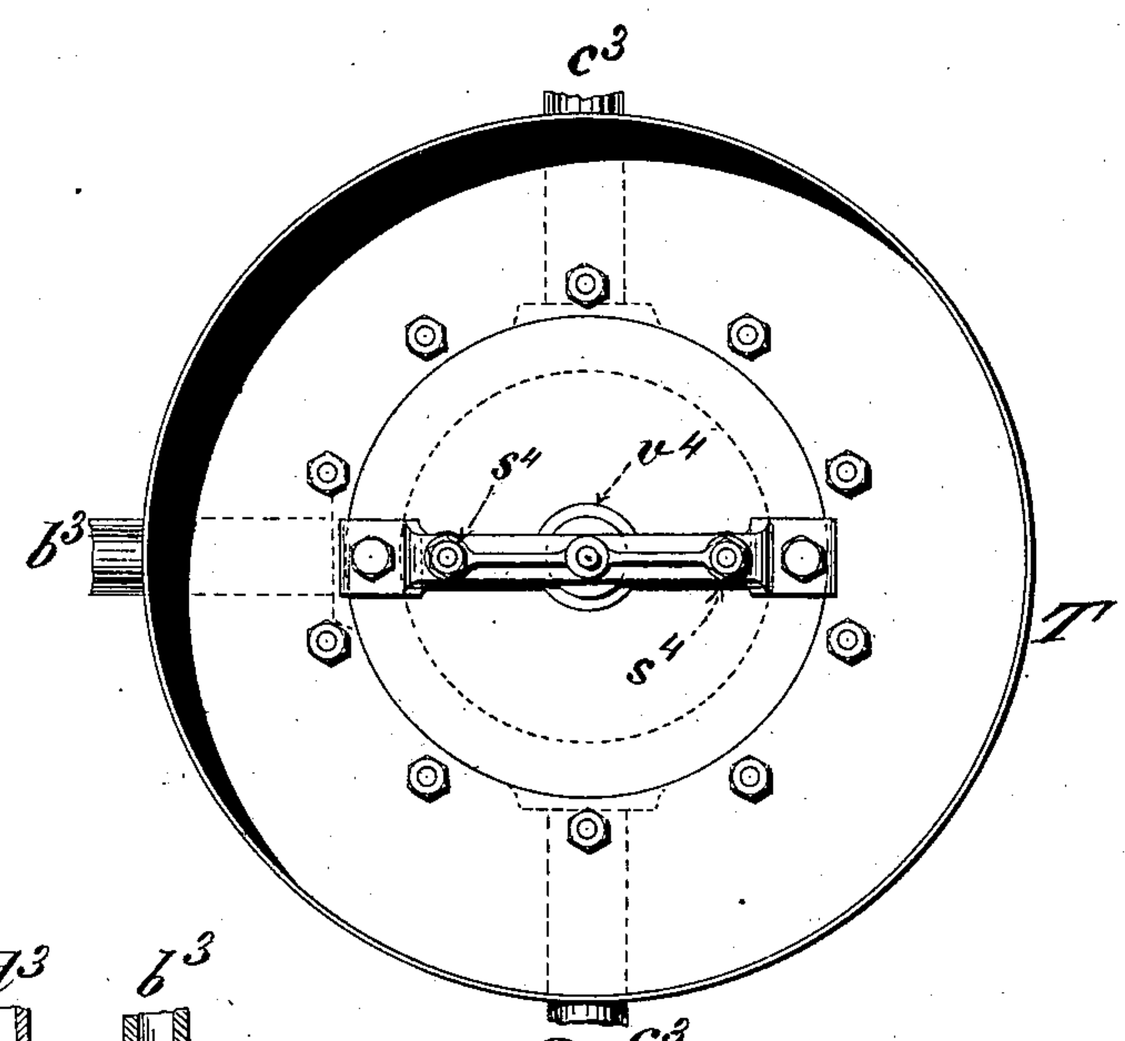


Figure 6.

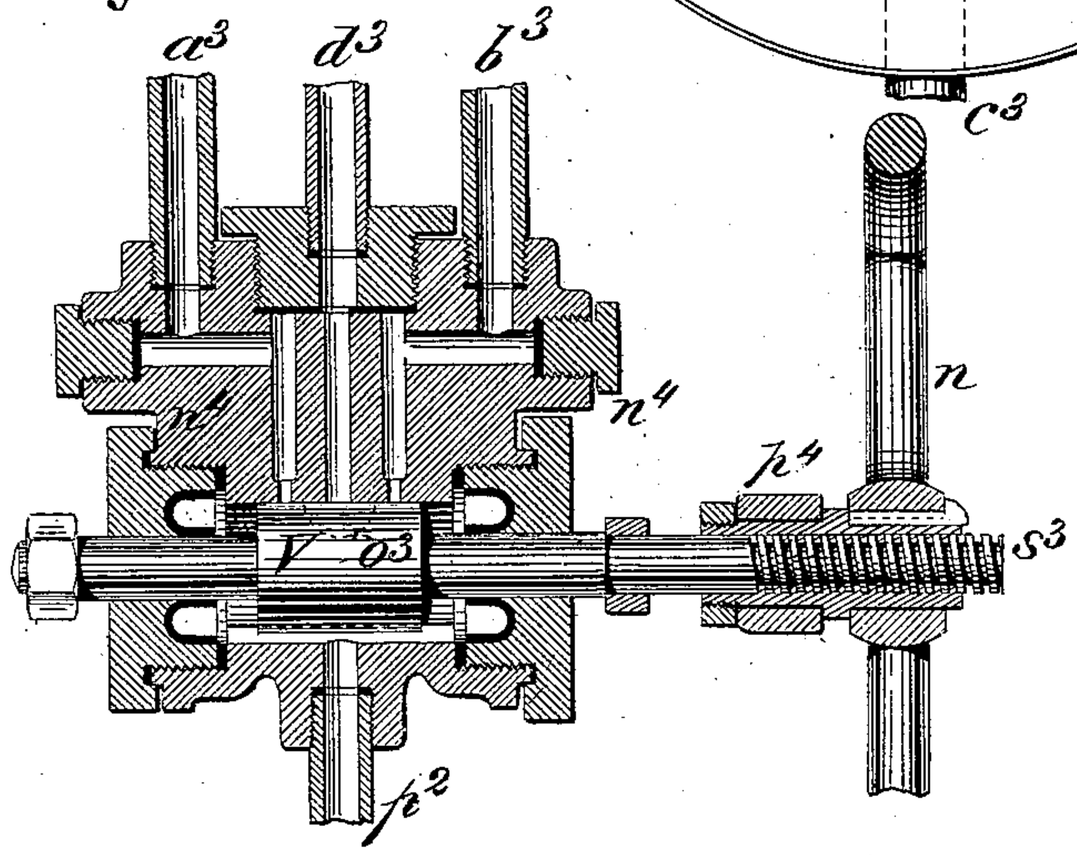
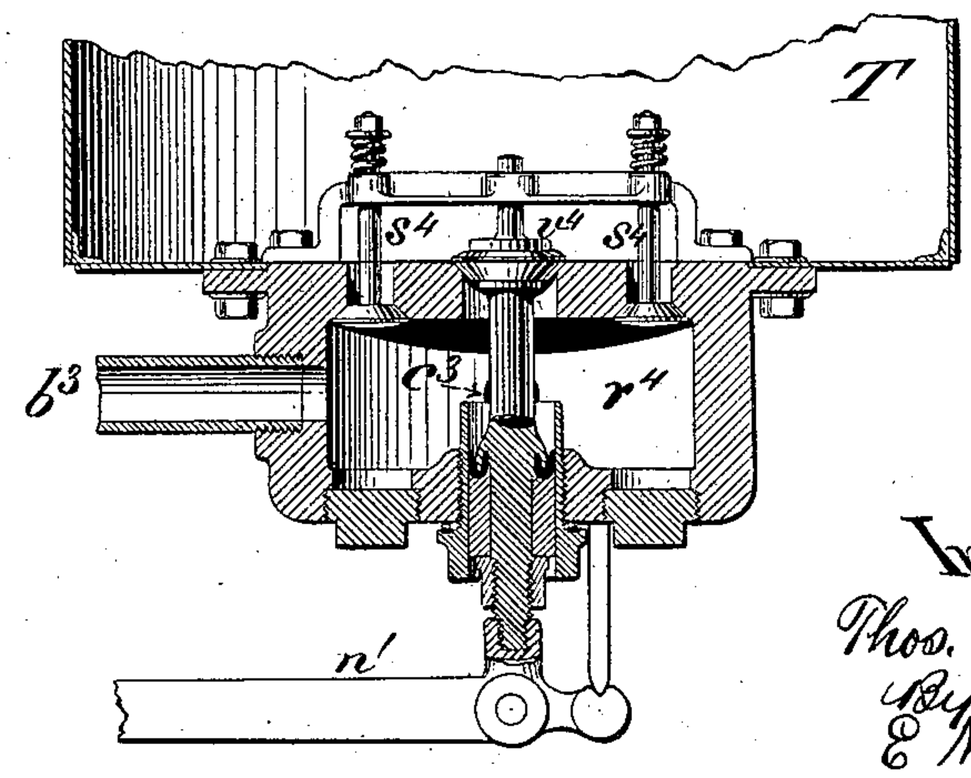


Figure 5.



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9 Sheets—Sheet 5.

T. F. ROWLAND.

Machine for Forming Iron-Vessels.

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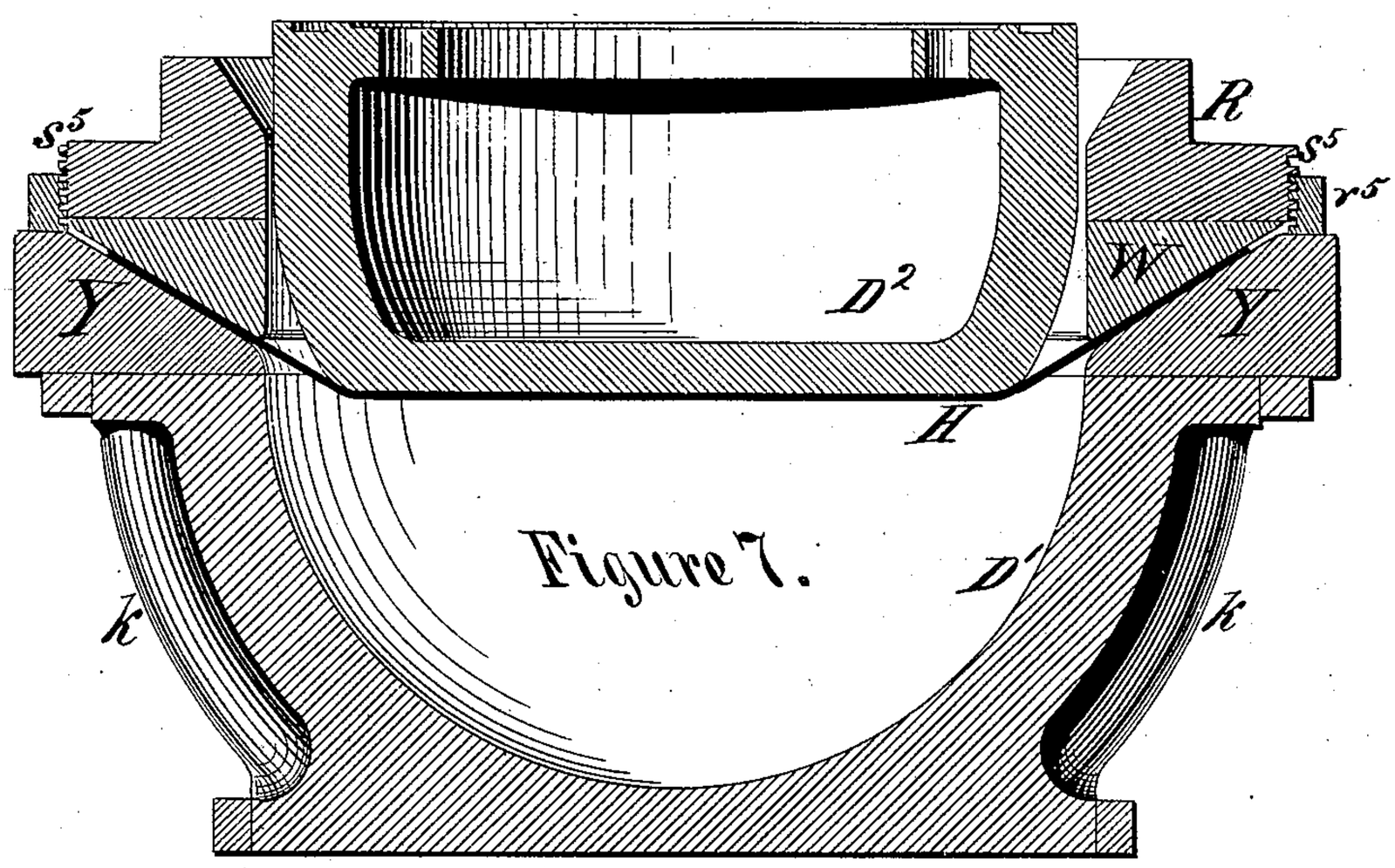
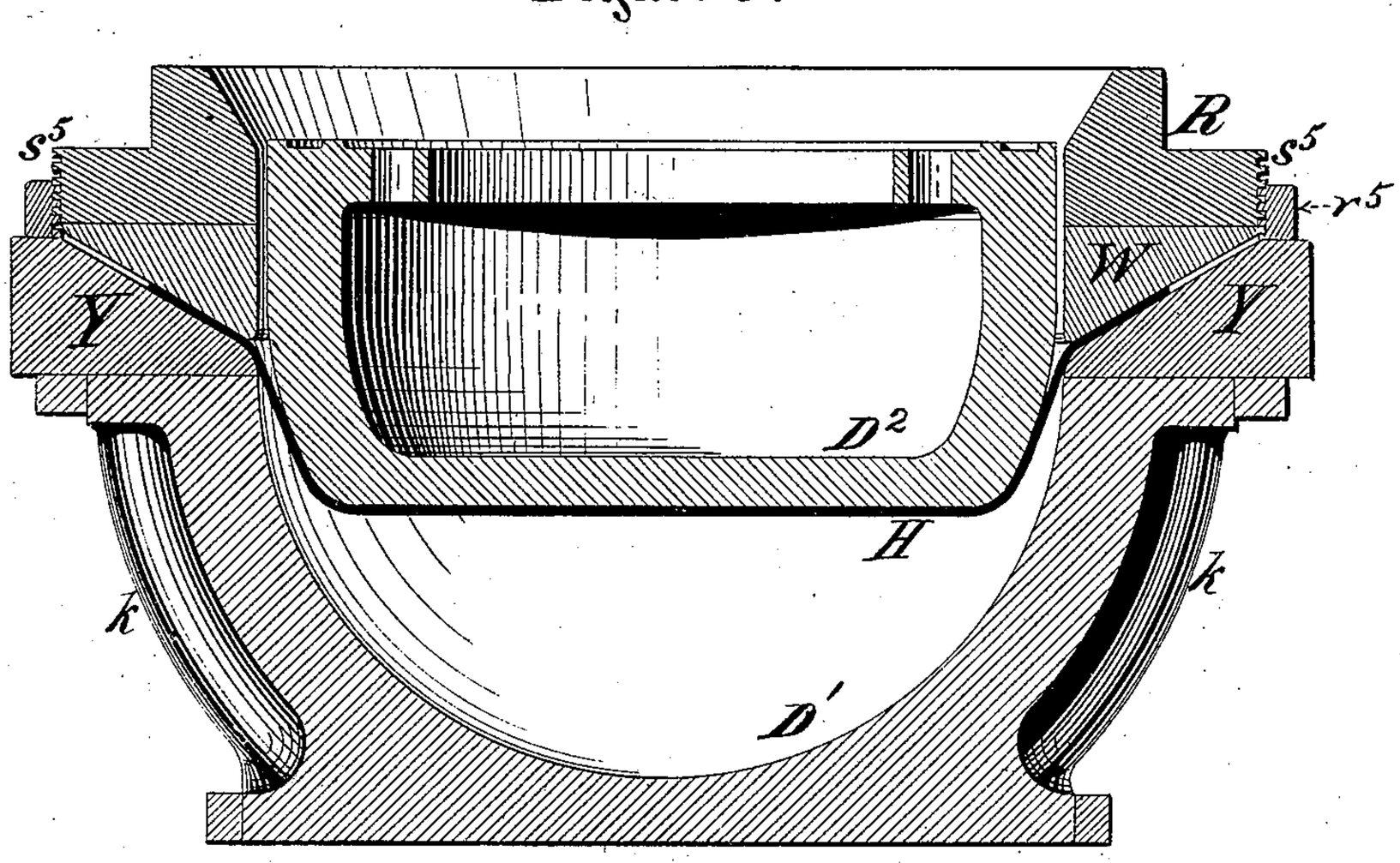


Figure 7.

Figure 8.



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9 Sheets—Sheet 6.

T. F. ROWLAND.

Machine for Forming Iron-Vessels.

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Figure 9.

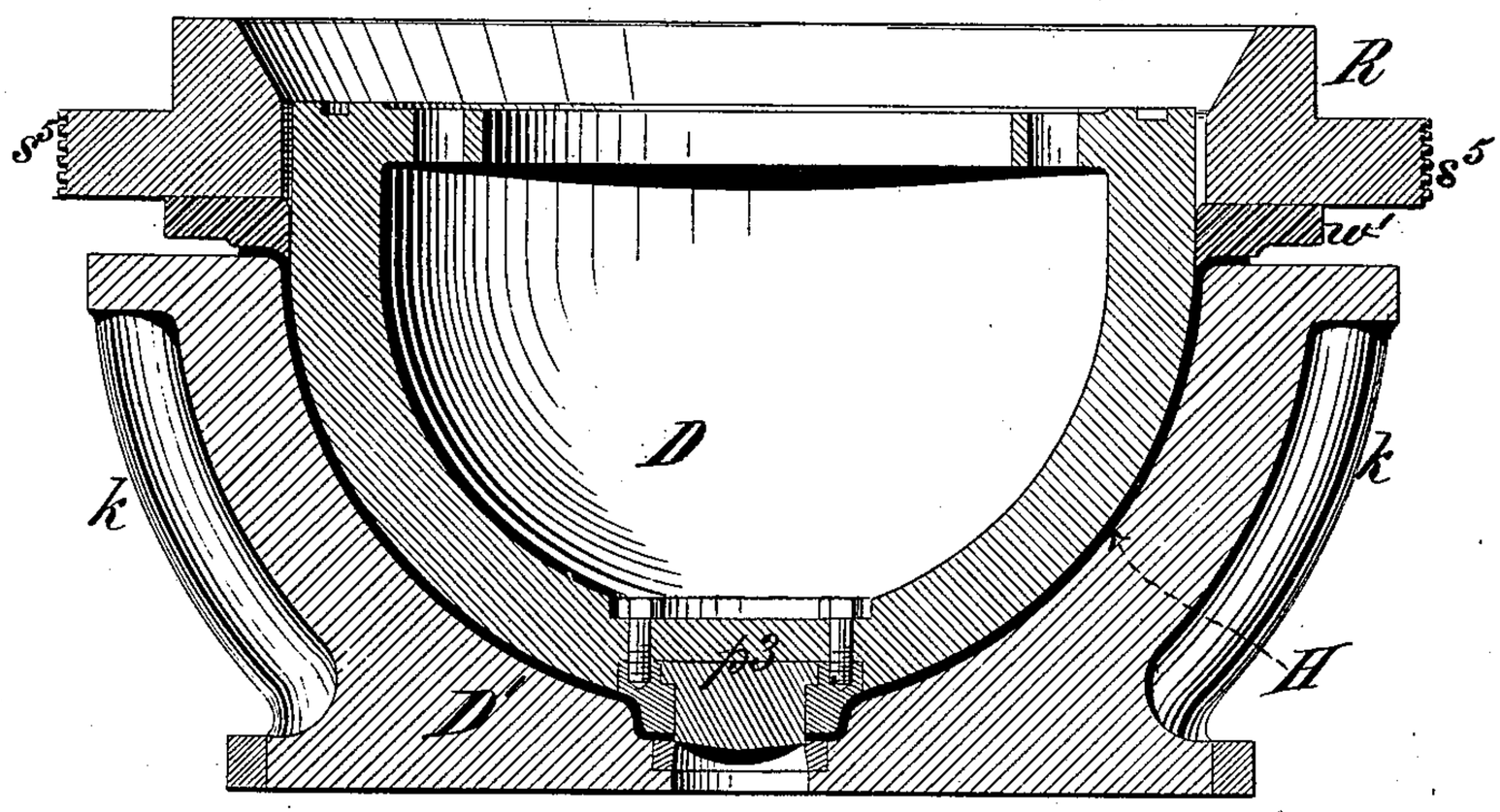
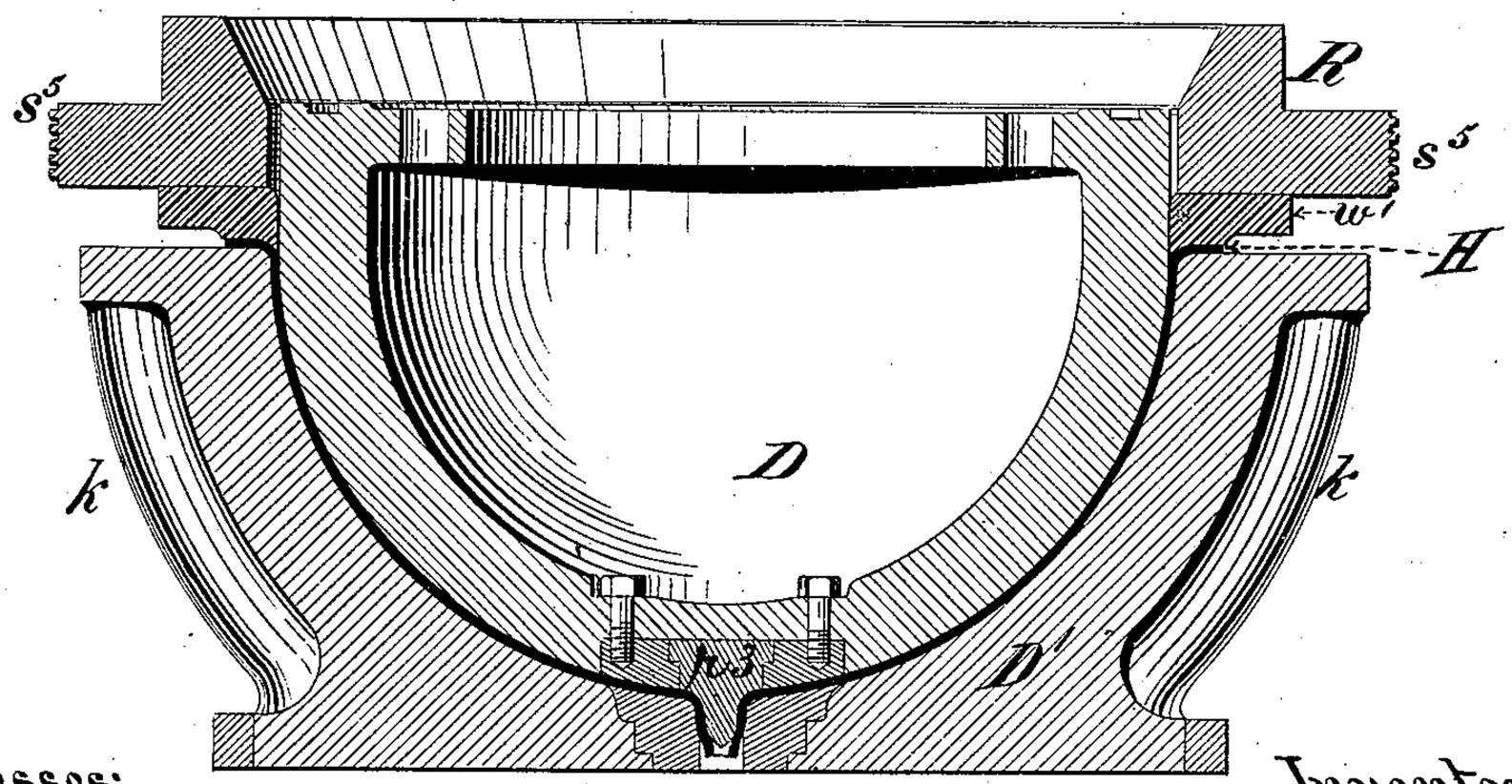


Figure 10.



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9 Sheets—Sheet 7.

T. F. ROWLAND.

Machine for Forming Iron-Vessels.

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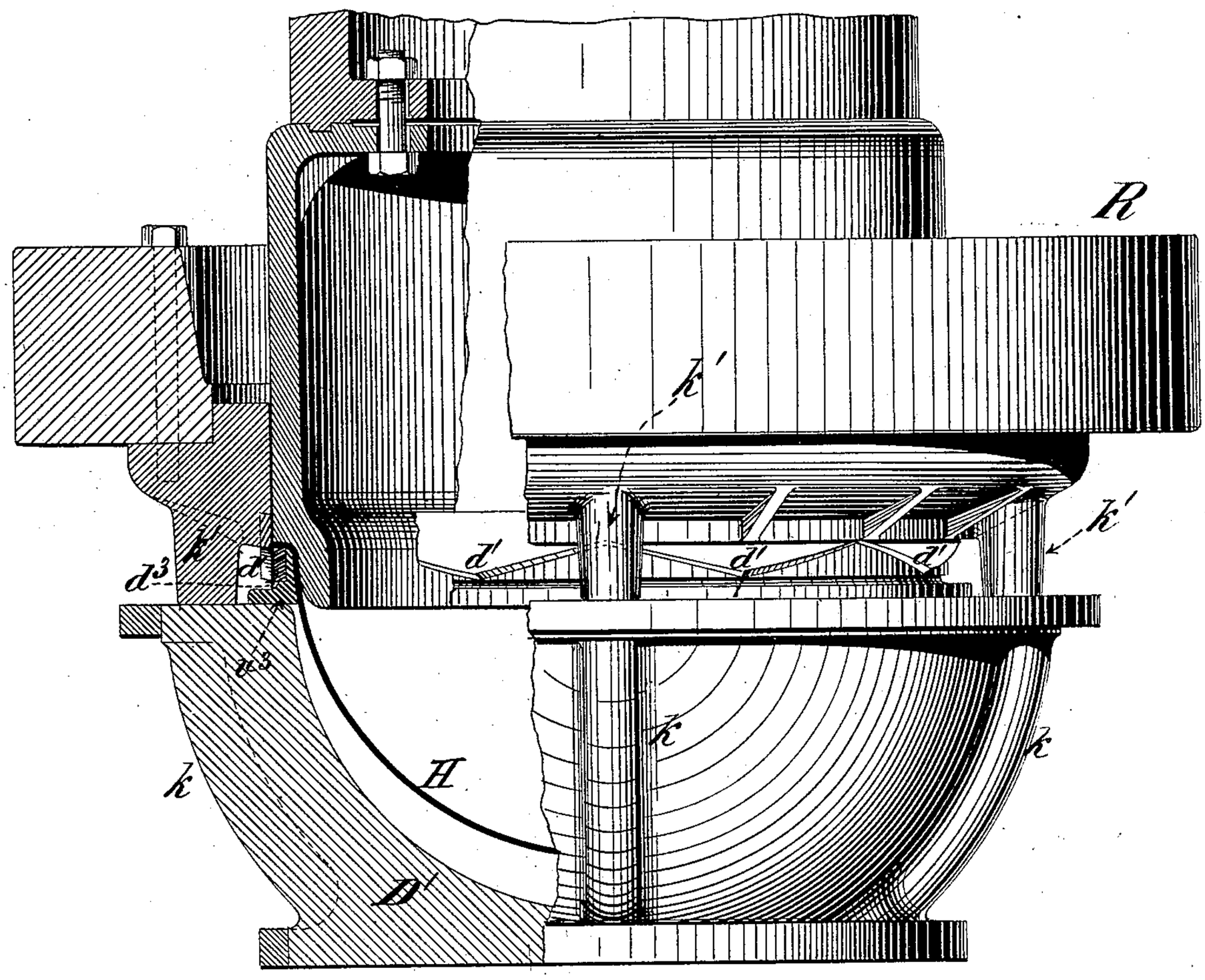
Figure 11.



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9 Sheets—Sheet 8.

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Machine for Forming Iron-Vessels.

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Figure 12.

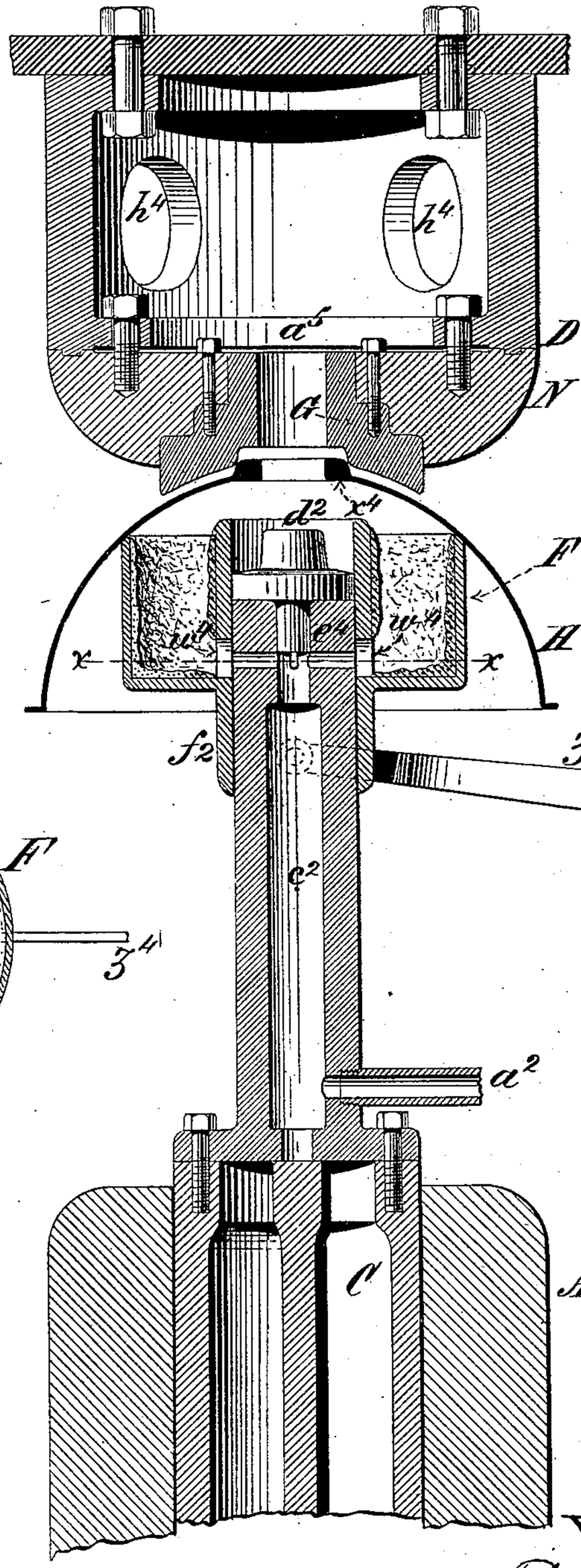


Figure 13.

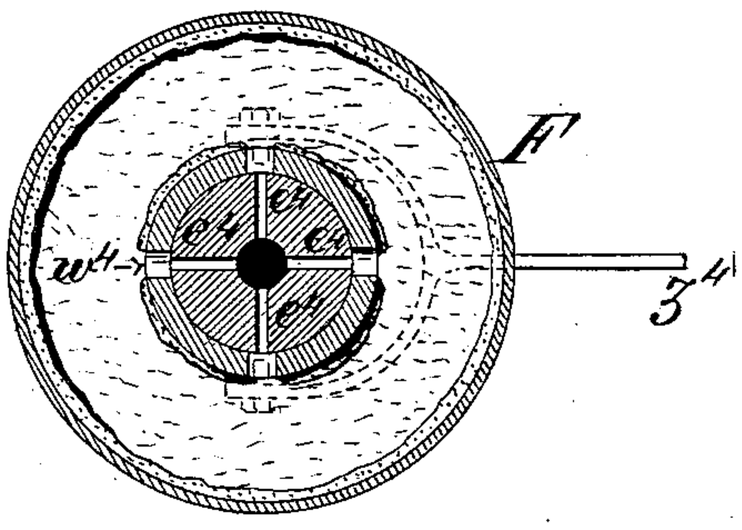
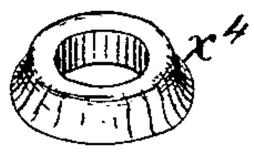


Figure 14.



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9 Sheets—Sheet 9.

T. F. ROWLAND.

Machine for Forming Iron-Vessels.

No. 206,486. **Patented July 30, 1878.**

Figure 15.

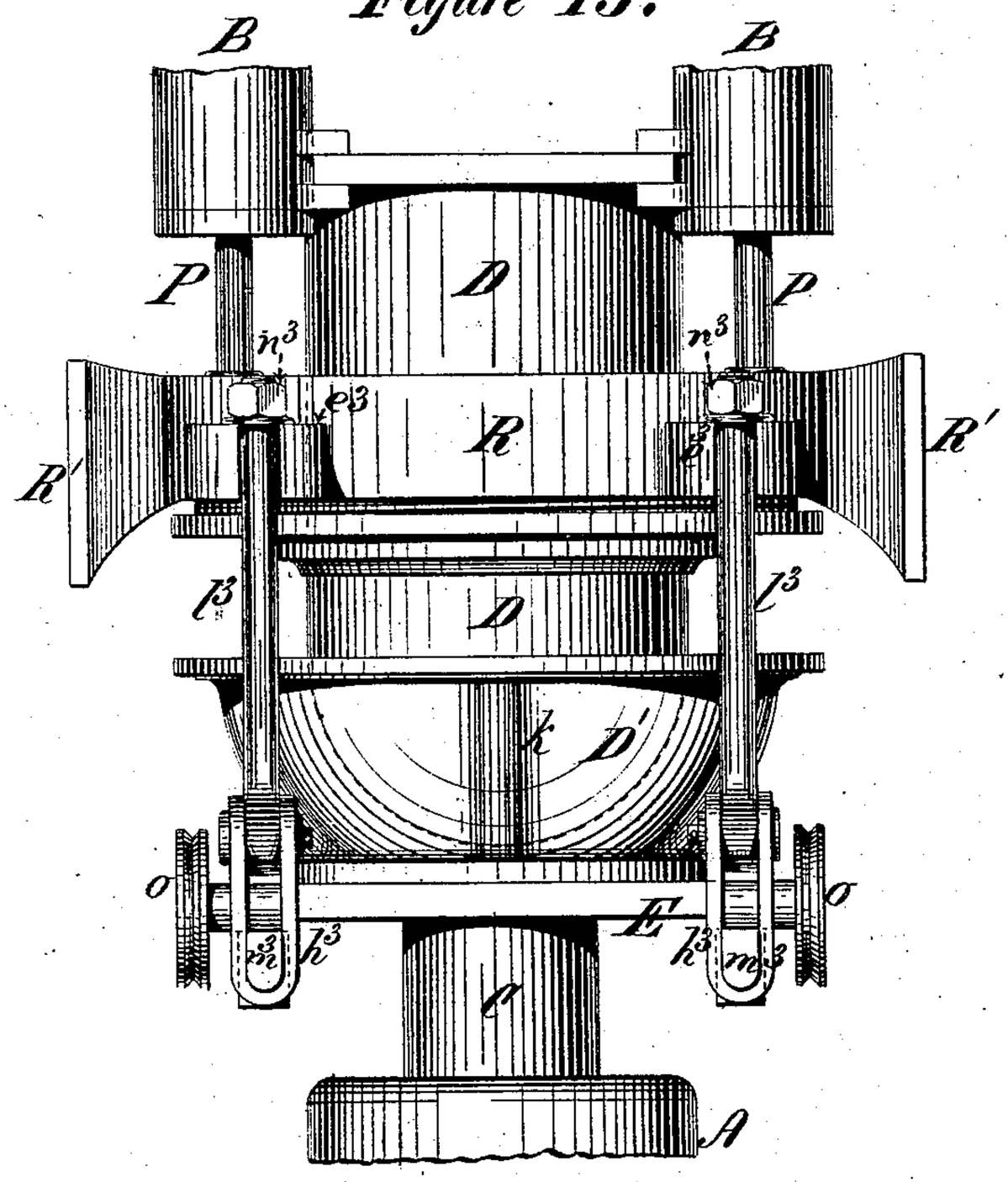
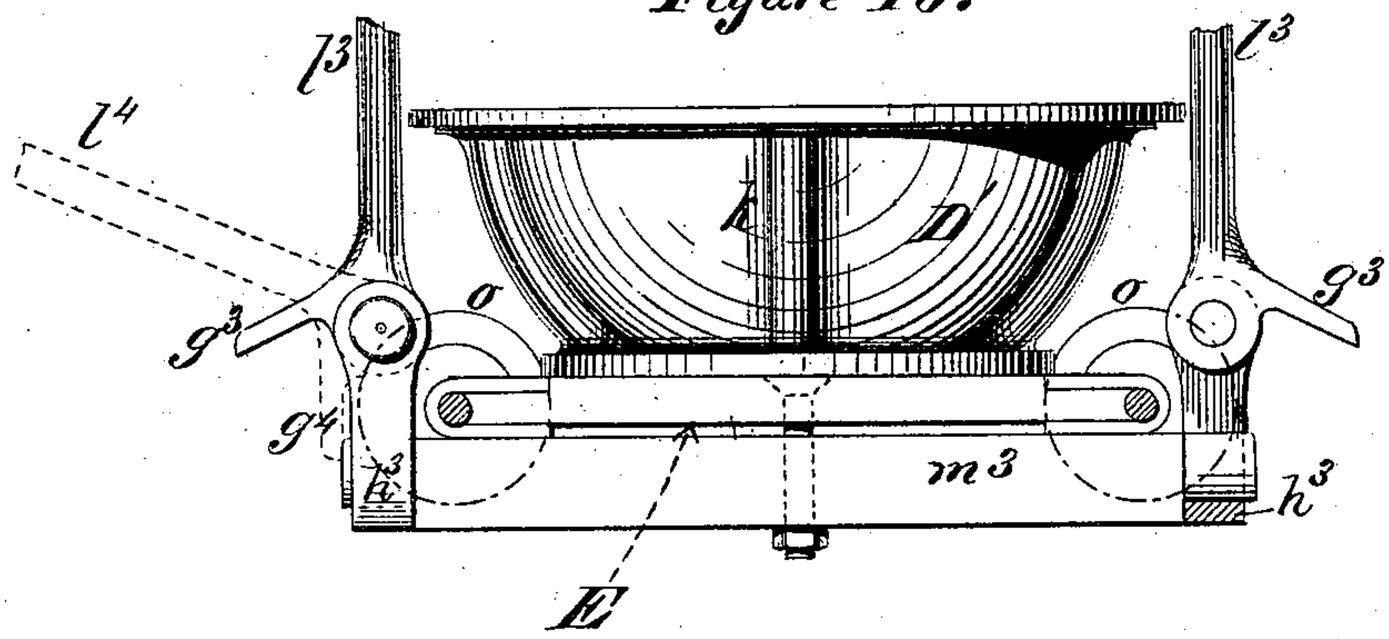


Figure 16.



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Inventor:
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UNITED STATES PATENT OFFICE.

THOMAS F. ROWLAND, OF GREEN POINT, BROOKLYN, NEW YORK.

IMPROVEMENT IN MACHINES FOR FORMING IRON VESSELS.

Specification forming part of Letters Patent No. **206,486,** dated July 30, 1878; application filed October 10, 1877.

To all whom it may concern:

Be it known that I, THOMAS F. ROWLAND, of Green Point, city of Brooklyn, and State of New York, have invented a new and useful Improvement in Machines for Forming Iron Vessels, of which the following is a full, true, and exact description, reference being had to the accompanying drawings.

My invention has for its object the forming of hollow vessels, especially those composed of iron; and it consists, generally, of a hydraulic press operating by means of dies to form the vessels into the shapes desired.

It is especially applicable to the formation of vessels similar to those previously patented to me on the 30th day of May, 1876, No. 178,193; but it is equally useful in forming other vessels of a similar nature.

My process consists, generally, in taking a sheet of metal of the proper size and shape, and by successive steps forcing or compressing it into the shape desired; and my apparatus is designed to accomplish this more readily and with a less expense of time, labor, and material than has heretofore been done.

In my invention I use two presses acting against one another, or, under certain circumstances, acting together, and the sheet of metal, placed between male and female dies, is, by means of the force exerted by these hydraulic presses, forced into the desired shape.

The object which I have in view in this apparatus and the processes herein described is to form rapidly and surely a hollow vessel of wrought-iron, and to be able to form as many of such vessels as I desire, each vessel corresponding exactly with those previously formed upon the machine.

I am aware that attempts have before now been made to accomplish this result, but none, so far as I know, have been successful, and in none has a practical vessel been formed of sufficient thickness to serve the purposes of a sea-buoy, or a torpedo, or other similar vessels for other similar purposes, for which I design the vessel here formed; and in none, so far as I know, have opposing hydraulic presses been used to form flanges.

It is obvious that the mere forcing together of a corresponding male and female die will not make a perfect flange or an absolutely true and smooth vessel if the iron is of considerable thickness, for the reason that the bending of the edges and the tearing of the flange necessarily produce corrugations or scallops in the metal, or even destroy the fiber of the metal itself.

In my drawings similar letters refer to similar parts.

Figure 1 represents a general perspective elevation of my press. Fig. 2 represents a view of the lower press, the railway, and the carriage. Fig. 3 represents a diagonal cross-section through my apparatus, showing the upper and the lower presses in section and the iron vessel in the process of formation. Fig. 4 represents a plan of the tank F. Fig. 5 represents a section of the valves situated in the bottom of said tank. Fig. 6 represents a section of the valves operated by the wheels *m* and *n* in Fig. 1. Fig. 7 shows a view of my vessel in the process of formation, showing the upper and the lower die. Fig. 8 shows the same vessel still further shaped, with the upper and the lower die in position. Fig. 9 represents the completed half of my vessel and a punching arrangement for removing part of the vessel, for the purpose of forming an opening in the same. Fig. 10 shows another modification in my die, with a punch attached, for the purpose of making a small hole in half of my vessel, in which a ring is to be welded. Fig. 11 is a view of the shearing portion of my apparatus. The left side of this view is broken away to show the vessel in process of formation. Fig. 12 represents a cross-section through part of my apparatus, showing the welding operation. Fig. 13 is a plan view of my fire-box for the purpose of welding in the ring. Fig. 14 shows the ring which is welded in by means of the apparatus shown in Fig. 12. Figs. 15 and 16 show an attachment to my apparatus, for the purpose of doubling the pressure exerted upon the vessel.

The apparatus shown in Fig. 1 consists, generally, of a frame upon which the different parts of the apparatus are mounted. This frame is represented by the letter S. Attached firmly to the sides of the frame S is the die-supporting frame K, to which is attached the male die D. Directly below this die is the main press A, having a piston, C, which piston

serves to raise the sheet of metal and to shape the vessel by means of the upper die, D. Sliding in the frame S is the ring R. To this ring R the four smaller presses B B B B are attached, the combined area of which is equal to the area of the large press A. This ring traverses the ways L, and is supported in them by the slides R′, so that the ring R rises and falls in the ways L constantly parallel to itself, and is supported by means of the presses B. Between the upper and the lower presses are situated the rails *r r*, upon which runs the carriage E by means of the wheels *o o o o*. This carriage has upon it the lower female die, D^1, which die is situated above the center of the carriage, as is plainly shown in Fig. 2.

The rails *r* are supported by means of the pillars *j j j j*, which rest upon the plate Z, which plate Z serves as a support for the lower press A, and is attached to the upper framework S by means of the connecting-rods G G G G.

The power to operate the different parts of this apparatus is supplied by a separate engine, which forces water to a high pressure, which water is supplied to the machine by means of the pipe m^2. (Shown clearly in Fig. 1.) The pipe n^2 is the return-pipe for the water after it has been used to operate the machine. The sheet metal, cold or hot, to be operated upon is placed upon the carriage E. This carriage traverses the rails or track *r*, and by means of said carriage the sheet to be operated upon is brought immediately over the lower press, C. The lower press, C, is then operated, and the carriage is raised directly from the track, supporting on the die D^1 the sheet which is to be formed. The raising of the lower press brings the male die D in contact with the center of the sheet, and thereby forces it down into the hollow of the female die D^1. The piston C of the press A is then lowered until the carriage rests upon the track, when it can be withdrawn. Motion is given to the carriage by means of the hydraulic cylinder *a* operating upon the piston and piston-rod *b*. This piston and rod are supported upon a central beam, r^1. Attached to the piston-rod *b* is the hook *h*, which slides upon the beam or rail r^1. This hook is arranged for the reception of the lug *l*, attached to the carriage E, so that when the carriage E rests upon the rails *r* the lug *l* enters the hook *h*, and the movement of the piston-rod *b* controls the position of the carriage E.

Water can be admitted to either end of the cylinder *a*, and thereby the piston-rod *b* can be forced out or withdrawn. The water to operate this piston *a* is admitted by means of the pipes *f* and *g*, (shown in Fig. 2,) which pipes communicate with the pipes h^2 f^2. (Shown in Fig. 1.)

The die D^1 (shown on the carriage E) corresponds with the upper male die D. Therefore, if a sheet of metal be laid upon the die D^1 while the carriage is withdrawn from the apparatus, and the carriage be then forced forward by means of the cylinder *a* until it rests immediately over the piston C, the raising of this piston will bring the male die D in contact with the center of the sheet, for the reason that the axis of the male die D, and of the press A and the carriage E, when in position, are in the same vertical line.

After the carriage E has been brought in position over the center of piston C power is supplied to the press by means of apparatus presently to be described. Thereby the carriage E is raised, the die D comes in contact with the center of the sheet of metal resting on the die D^1, and the first process of the formation of my vessel is accomplished.

The male die represented in Figs. 1 and 3 is not the one first used, but a die having the shape of that, D^2, shown in Figs. 7 and 8.

Surrounding the male die D or D^2 is the ring R, previously described. This ring has attached to it a smaller concentric steel ring, (represented by W in Figs. 7 and 8,) which is of about the same diameter as the male die used in the first process. The female die, supporting the sheet metal as it is raised by means of the cylinder A, comes in contact with this ring R and the steel ring W, after which the ring R and female die D^1 rise together, as is shown in Figs 7 and 8.

By means of this arrangement a constant pressure is maintained between the ring W and the die D^1. The purpose of this is to prevent any corrugations in the metal of the vessel H. The ring R is held against the female die by means of the water-pressure in the four cylinders B B B B, which cylinders being equal in area to the cylinder A, it is obvious that the upward motion of the carriage would be stopped, and therefore the pressure in the cylinders B B is gradually relieved by means of a relief-valve, subsequently to be described. After the ring R has been brought in contact with die D^1 the two continue to rise together until the male die D, which in the first operation is flat, as is shown at D^2, Figs. 7 and 8, causes the metal sheet H to enter the female die D^1, when the vessel takes the shape shown in Fig. 7. The plate thus far has been cold. The lower piston C is then withdrawn, and the carriage follows with it until it rests upon the rails *r r*, when it is withdrawn by means of the cylinder *a* and the hook *h*. The sheet H is then heated and placed in the press. The same operation is repeated until it takes the shape shown in Fig. 8, when the carriage E is again removed, the vessel H reheated and placed again in the die, and the carriage E advanced over the press as before; but the die D has now been substituted for the upper die, D^2, as is shown in Figs. 9 and 10. Attached to this upper die D is a punch, which may either have the shape shown in Fig. 9, where it is marked p^3, or that in Fig. 10, where it is marked r^3, according as it is desired to remove a large portion of the center of the vessel or only to punch a small hole therein. In these three processes the vessel is again heated. The

flange of the vessel is here turned at a right angle, as will be clearly seen in Figs 9 and 10. This is done by substituting for the steel ring W the ring w', and by removing the shaping-ring Y, which has been previously attached to the female die D^1. The flange is thereby turned at right angles. It now becomes necessary to shear the edges of this flange perfectly round. This is done by attaching to the ring R the shears d^1 d^1, which are shown clearly in Fig. 11. This shearing-ring is of the exact diameter to which it is desired to reduce the vessel H, and the shearing-edges d^1 and d^3, passing closely by each other, shear off any projecting edge of the vessel H.

Attached to the ring R are the abutments k^1 k^1, which are set opposite to the four supporting-ribs k k k k, which surround the lower die.

The shearing operation is thus performed: The shearing-edge d^3, Fig. 11, is first attached to the female die D^1. This die D^1 is raised by means of the large press A until it comes in contact with the lower edge of a male die, (shown clearly in Fig. 11,) which is shaped to correspond with the shearing-ring v^3. Thereby the vessel H is held firmly in position between the male and female dies. Then the ring R is forced down, and its shearing-edges d^1, passing close to the projecting edges of the flange of vessel H, shear off such projecting edges and leave the flange perfectly circular.

The apparatus for performing these operations will now be described more in detail.

Reference is first had to Fig. 1. The power to operate the different parts of this machine is supplied by means of the pipe m^2, which has two branches, r^2, and o^2. r^2 passes directly to the valve j^3. This valve communicates with the under surface of the piston C in the cylinder A. This valve is operated by means of the wheel w''. This wheel w'' rotates the miter-gear l^2, whereby the connecting-rod v^2, which is attached to the valve j^3, can be operated in either direction. This valve-stem v^2 has a screw-thread, (shown at z^3,) which engages in a thread cut in the miter-gear l^4, which is supported by a collar attached to the supporting-frame y^3. Therefore the rotation of the miter-gears l^2 and l^4 will force the valve-stem v^2 forward or backward, and thereby open and close the valve j^3. The wheel w'' is first operated in a direction to open the valve j^3. Water then passes, by means of the pipe r^2, through the valve j^3 into the bottom of the cylinder A; thereby the piston C is raised. When it is desired to lower the piston C the wheel w'' is turned, thereby shutting off the pressure of the water which has been supplied by the pipe m^2. The wheel w is then revolved. This wheel, by means of the miter-gears k^2 and connecting-lever x^2 and valve-stem w^2, opens the valve j^4 in the same way as the wheel w'' opens the valve j^3. The valve j^4 communicates with a pipe, s^2, which enters the return-pipe n^2, which has the branch p^6 parallel with the branch o^2. The water which has held up the piston C being thus withdrawn, the piston and carriage fall, as has been previously described. The valve j^4 communicates with the bottom of the piston C.

It will thus be seen that by the revolutions of the wheels w and w'', the piston of the main press A can be caused to rise and fall at will.

I will now trace the connections necessary to operate the four equal presses B B B B, which are connected together. These presses are connected to the ring R, which travels in the ways L, by means of the pistons P. The supply-pipe m^2, as has been previously described, has two branches. The branch o^2 again divides at the point o^4, one of its branches connecting to the valve n^4, the other to the valve p. The valve n^4, which is operated by the wheel n, is shown more clearly in detail at Fig. 6, where the pipe o^2 is shown entering the valve by means of the branch p^2. The valve n^4 is arranged with the connections clearly shown in Fig. 6. The valve itself consists of a cylinder, V, which traverses a cylindrical valve-seat. This cylinder V has on its upper side a port, o^3, (shown by the dotted lines,) and consists, in fact, in a modification of the ordinary D slide-valve. The water under pressure enters by means of the pipe p^2, and surrounds the cylinder V. This valve-chest, together with the entering tubes, is thoroughly packed by means of leather and U-packing, as may be seen by the drawing. The valve-cylinder V is moved by means of the wheel m, which wheel, supported in a collar, p^4, operates the valve-stem by means of the screw-thread s^3 cut in the same. This valve-stem enters the valve-chest through U-packing. On the upper part of the valve-chest are three tubes, a^3, b^3, and d^3. a^3 communicates with the lower sides of the pistons traveling in the presses B B B B. b^3 communicates with the upper sides of the pistons c in these presses by means of the chamber r^4, (shown in Fig. 5,) whence it passes to the upper sides of the presses B B B B by means of the communicating pipes c^3. If, now, the valve-cylinder V be thrown to the right, it is evident that the pipe a^3 will be put into communication with the pipe p^2, and the presses B B B B and ring R will be raised, provided the water on the upper sides of the pistons of the presses can escape. This escape or exhaust occurs through the pipe b^3, which is then put in communication, by means of the port o^3, with the escape or return pipe d^3, which communicates with the pipe p^6 and the return-pipe n^2. It is evident that, if valve-cylinder V be thrown to the left, the contrary effect will be produced, and therefore, by means of the wheel n, the pistons of the presses B B B B can be raised and lowered.

The tank T and chamber r^4, as shown in Figs. 3, 4, and 5, will now be explained: Above the frame-work of the machine is supported a tank, T, for the purpose of receiving the overflow from the upper chambers of the cylinders

B B B B. These upper chambers communicate by means of the pipe c^3 with the chamber r^4, Fig. 5. Above this chamber r^4 there are three puppet-valves, s^4, s^4, and v^4. s^4 and s^4 open downward or into the chamber r^4. v^4 opens upward. v^4 is operated by means of the lever n^1, which enters the chamber r^4 through U-packing, as is shown.

Whenever the lever n^1 is depressed, it is evident that the valve v^4 will be closed, while, if the pressure on this lever be released, the pressure within the chamber r^4 will open the valve v^4 and allow the escape of the water under pressure, which fills the chamber r^4 and the upper chambers of the presses B B B B into the tank T. The lever n^1 is controlled by means of the connecting-rod p^5, which is actuated by means of the treadle t. (Shown in Fig. 1.) Pressure upon the treadle t, owing to the great leverage, will readily close the valve v^4.

The valves s^4 serve to allow the water which may collect in the tank T to flow back into the chamber r^4 in case the pressure there is relieved, as will be hereinafter explained. The tank T communicates with the return-pipe n^2 by means of the overflow-pipe d^3.

The carriage which supports the female die D^1 is operated by means of the hand-wheel m, which wheel controls a valve, p, which is precisely similar in construction to the valve n^4, which has been just described. The supply-pipe o^2 sends one branch to this valve, the other branch connecting to the valve n^4, as described.

The ports are precisely similarly arranged. One of the connecting-pipes is marked h^2, the other j^2, and either of these pipes, h^2 or j^2, can be put in connection with the supply-pipe o^2 or with the exhaust-pipe p^2 by means of the revolution of the wheel m. The pipes h^2 and j^2 connect directly with the pipes f and g, (shown clearly in Fig. 2, and which have been heretofore described,) so that by means of the revolution of the wheel m the carriage E can be advanced or retired on its rails r r and its wheels o at the will of the operator.

I will now describe more fully the process of forming the hollow iron vessel which this machine is intended to form. A sheet of iron, cold, is first laid upon the surface of the female die D^1, supported on the carriage E. The wheel m is then turned, whereby the water-supply is admitted behind the piston traveling in the cylinder a by means of the pipe f, while the pipe g is put in communication with the exhaust by means of the pipe h^2 and valve p. The pressure of the water in the cylinder a therefore advances the carriage E on the track r until it rests over the center of the piston C, its motion being arrested at this point by means of a chock. The slides R^2 are now immediately under the ways L, so that when the carriage is elevated these slides will enter the ways L below the slides R^1, which are attached to the ring R, whereby the female die D^1 and the ring R are kept concentric. The wheel n being in the central position shown in Fig. 6, the ring R is in the position shown in Fig. 1, at the lower end of its travel, the upper chambers of the presses B being filled with water. A male die of the shape shown in Fig. 7 is first used. This die D^2 is substituted for the die D shown in Fig. 1. Attached to the ring R and to the female die D^1 are corresponding shaping-rings W and Y, (shown clearly in Figs. 7 and 8,) for the purpose of holding the edges of the metal sheet H, as will be now described.

The valve j^4 is closed by means of the wheel w. The valve j^3 is opened by means of the wheel w''. Thereby the water-supply is admitted under the piston C. This piston therefore rises, carrying with it the female die D^1, supported on the carriage E, which carriage, with its supporting-wheels O, leaves the track r, and the lug l rises out of the hook h. The edges of the flat sheet of metal resting upon the surface of the ring Y first come in contact with the lower surface of the shaping-ring W, attached to the ring R. Cut around the ring is the screw-thread s^5. (Shown clearly in Figs. 3, 9, and 10.) Upon this may be screwed the abutment-ring r^5, which ring can be adjusted so as to determine the distance between the ring R and die D^1.

It is evident that the upward motion of the die D^1 would now be arrested, owing to the fact that the water in the cylinders B B B B cannot escape. The operator, therefore, who has closed the valve v^4, Fig. 5, by means of the treadle t, raises his foot and allows the escape of the water contained in the upper chambers B into the overflow-tank T. By releasing the pressure of water in the presses B gradually, he allows the lower piston C to rise gradually until the sheet of metal which is held between the ring R and the die D^1 comes in contact with the male die D^2, when the upward motion of the die D^1 and the ring R, moving together, is continued until the flat sheet of iron takes the shape shown by H, Fig. 7. The edges of the circular sheet of iron, being held firmly under the immense pressure between the shaping-rings W and Y, are kept flat and free from corrugations. The wheel w'' is then revolved so as to close the valve j^3. The wheel w is revolved so as to open the valve j^4, and therefore the piston C and female die D^1 fall until the carriage E rests upon the track r and the lug l enters the hook h. As soon as the force tending to raise the ring R ceases the weight of this ring causes the ring to descend again through the ways L to its downward position, which falling is possible, because the water which has been previously forced into the overflow-tank T is now allowed to enter again into the upper chambers of the presses B by means of the inlet-valves s^4 s^4 and connecting-pipes c^3, as is clearly shown in Figs. 1 and 5. The wheel m being now revolved, the carriage is withdrawn, and the sheet H is heated and again placed in the carriage. The carriage again

advances, and the same process repeated, excepting that the die D^1 is raised higher than before, until the vessel H takes the shape shown in Fig. 8, when the carriage is again lowered, and the vessel H is again heated.

A male die, D, Figs. 9 and 10, corresponding in shape with the female die D^1, is now substituted for the male die D^2. The shaping-ring Y is removed from the female die D^1, and a new clamping or shaping ring, w' is substituted for the ring W, which has previously been attached to the ring R. These alterations are clearly shown in Figs. 9 and 10. Attached to the lower part of the die D may be a punch, either such as is shown in Fig. 10, where it is marked r^3, or such as is shown in Fig. 9, where it is marked p^3, depending upon how large a quantity of the metal sheet it is desired to remove. The female die D^1 has a corresponding portion of its bottom removed to allow of the passage of the punch, as may be readily seen from Figs. 9 and 10.

The process previously described is now repeated. The vessel H, in the shape shown in Fig. 8, resting upon the female die D^1, is raised, coming in contact with the ring R. Its edges are clamped between the die D^1 and the shaping-ring w'. The ring R and the die D^1 rise together until the die D^1 has been forced to the position shown in Figs. 9 and 10, and the vessel takes the shape there shown at H. By this process the flanges are turned at right angles, as is clearly shown.

It is obvious that these flanges may not be exactly of the proper width at all points, owing to the fact that the sheets of metal from which the vessel H is formed may have been of slightly different diameters, or from the fact that they were not placed exactly central upon the die D^1. It therefore becomes important to shear these edges so as to make them all of the same diameter. This is done by means of the apparatus shown in Fig. 11, where a shearing apparatus has been attached to the ring R as a substitute for the shaping-rings W and w' previously described, and the corresponding device d^3 has been attached to the die D^1. These devices, clearly represented in Fig. 11, both have corresponding angular cutting-edges d^1 and d^3, which pass close by each other, and thereby shear off any projecting edges of the flanges of the vessel H. The shape of the male die has also been changed, and a die of the shape shown in Fig. 11 is used. The downward motion of the ring R is arrested when the supporting-ribs k come in contact with the abutments k^1, attached to the ring R, which are also clearly shown.

The vessel H is taken from this last process perfectly shaped, and it remains only to weld such connections as may be desired in the holes in the central lower portion which have been formed by means of the dies previously described. This operation may be done in the following machine; but I prefer to do it in a separate machine. I will, however, describe an attachment by which it can be readily accomplished in connection with this press. Such apparatus is shown in Figs. 12, 13, and 14.

The press A and its piston C remain as before, and also the upper die, D. This has attached to it a smaller inverted or female die, G, which is fastened to the die D by means of the piece N and the screw-bolts, which screw-bolts allow of the alteration of the die which has previously been described. Attached to the piston C is the tube c^2, carrying the male die d^2, corresponding in shape to the female die G. The tube c^2 is pierced with four transverse holes, e^4, and carries also the tube a^2, through which compressed air can be admitted to it. Surrounding the hollow tube c^2 is the fire-box F, supported by means of a collar, f^2, and an arm, z^4, and rising and falling freely on the tube c^2. The inverted vessel H is laid upon this fire-box in the position shown in Fig. 12, and a ring, x^4, Fig. 14, is placed in position in the space formed by the die shown in Fig. 9. The fire-box F has transverse holes w^4, corresponding to the holes e^4. A fire is first kindled in this box, when it is lifted to the position shown in Fig. 12. The draft-holes correspond, as shown in Fig. 13, which is a cross-section through Fig. 12 on the line $x\ x$.

Compressed air is forced through the tube a^2, passes through the tube c^2, through the holes $e^4\ w^4$, through the fire-box, thence through the tube a^5 in G, and thence escapes by the holes h^4 in the upper die, D. Thereby a rapid combustion is produced in the fire-box, and the parts are thoroughly heated. After the vessel H and ring x^4 have been thoroughly heated, the piston C is raised, thereby forcing the die d^2 into immediate contact with the ring and vessel, which are thereby raised into the female die G, and a thorough welding takes place between the ring x^4 and the vessel H.

The difficulty with this arrangement is that it has a tendency to more or less destroy the press, owing to the great heat necessarily employed.

In Figs. 15 and 16 is shown an arrangement by which double power can be applied to shape sheet metal. In this arrangement the upper presses B B B B assist in raising the carriage E, instead of opposing its motion. The construction will be readily seen from the figures. Attached to the ring R are double ears e^3. Underneath the carriage E are the cross-beams m^3, attached to which, by means of the links h^3, are the connecting-rods l^3, having the lugs g^3. Attached to the upper ends of these arms l^3, of which there are four, are the nuts n^3.

When the rods l^3 are lowered they rest against the carriage-frame in the position shown by the dotted lines in Fig. 16, represented at l^4 and g^4. When raised, the connecting-rods l^3 pass between the ears e^3, and the nuts l^3 rest above the ears. If, now, power be applied, by means of the wheel n, to the

lower sides of the pistons *c*, Fig. 3, of the cylinders B, it is obvious that such power will raise the piston-rods P, the ring R, and the carriage E, and female die D^1, such power being communicated to the carriage by means of the ears e^3, rods l^3, links h^3, and cross-beams m^3, while if, at the same time, the piston C be raised it is obvious that twice as much power can be utilized in forcing a sheet of metal into the female die D^1 as by the previous arrangement of the apparatus.

In Fig. 3 are shown hand-levers *d*, by which the vessel can be removed from the female die D^1. Adjusting-rings k^3 are also shown, by means of which the position of the die D can be varied.

By means of the arrangements here shown it is obvious that the presses need be operated only half as far as is the case where a carriage forming the female die of the apparatus is not employed, for the reason that it is necessary that the male and female dies be separated the full width of the vessel to be placed between them in the ordinary apparatus, while in this apparatus, provided the lower die, D^1, be clear of the upper die, D, the said die D^1 can be readily withdrawn, carrying with it the vessel, which could not, in the other case, be done unless the presses were separated far enough to allow of the raising of the vessel clear of the lower die before it was withdrawn from between the upper and the lower die. This operation is also a very difficult one, owing to the great heat of the vessel and the inconvenient position in which it is situated.

The usefulness of the machine is almost doubled when the time required for its operation is halved, and as the operation of hydraulic presses is necessarily slow, this improvement is a very valuable one.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. A hollow vessel-forming machine, which consists of a movable female die, a fixed male die, and a binding or clamping apparatus acting against the metal blank resting on the female die, the female die and binding-ring being operated by opposing hydraulic presses, the presses operating the binding-ring being provided with apparatus whereby their pressure is gradually released, thereby allowing the advance of the female die over the male die, substantially as described.

2. In an apparatus for forming hollow iron vessels, which consists of a stationary male die, a female die, and a binding-ring operated by independent hydraulic presses, and a carriage operated by a hydraulic ram, for the purpose of causing the entrance and withdrawal of the vessel from the press, the pipes, valves, and connections shown, which connect the presses with the water-pressure, and the escape-pipes, and are so constructed that a single operator can from one position control the opposing hydraulic presses and the carriage-ram, substantially as described.

3. The combination, in a hollow-vessel-forming machine, of a male and female die and a binding-ring, which binding-ring is held against the female die by means of the pressure of water in a hydraulic press or presses provided with a relief-valve controlled by the operator, whereby the pressure between the ring and the die can be gradually relieved during the formation of the vessel, substantially as described.

4. The combination, in a vessel-forming machine, of a female die, D^1, male die D, and binding-ring R, operated by a hydraulic press or presses, B, having the relief-valve v^4 and overflow-tank T, substantially as described.

5. The combination of a female die, D^1, operated by a hydraulic press, male die D, and ring R, operated by hydraulic press or presses B, the said ring being connected with the female die D^1 by connecting-rods l^3, for the purpose of increasing the upward force on the die D^1, substantially as described.

6. A welding apparatus which consists of a die surrounded by a fire-box through which a current of air is forced, the said die being arranged to enter a corresponding die, for the purpose of welding a ring, as set forth.

7. In a hollow-vessel-forming machine, a male and female die and the ring R, the said ring being provided with a cutting or shearing apparatus corresponding in shape to the outline of the vessel to be formed, substantially as described.

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