J. H. TAYLOR.

SPIRAL PIPE FORMING MACHINERY.

APPLICATION FILED JUNE 9, 1902.

972,731.

Patented Oct. 11, 1910.

6 SHEETS—SHEET 1.

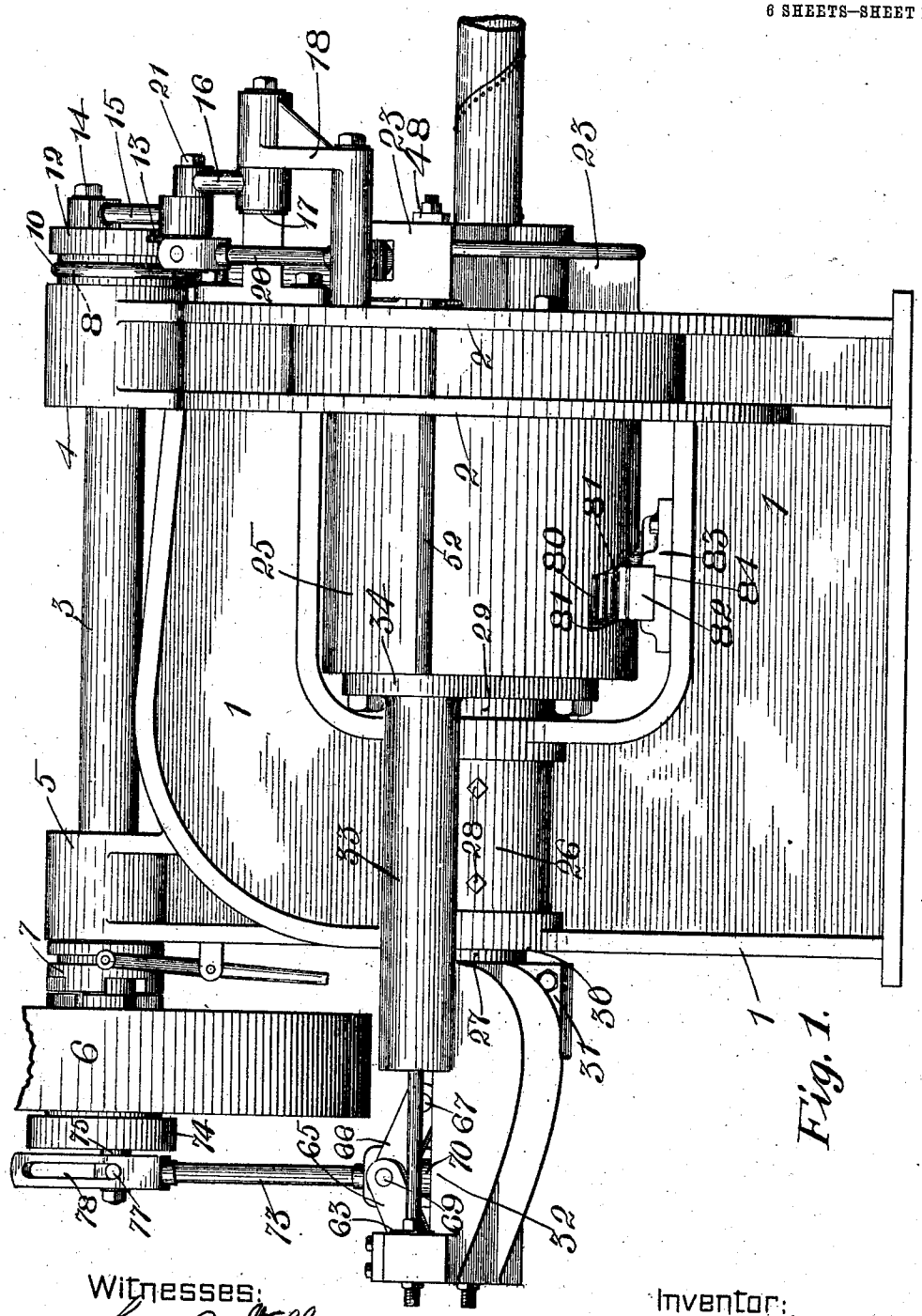

Fig. 1.

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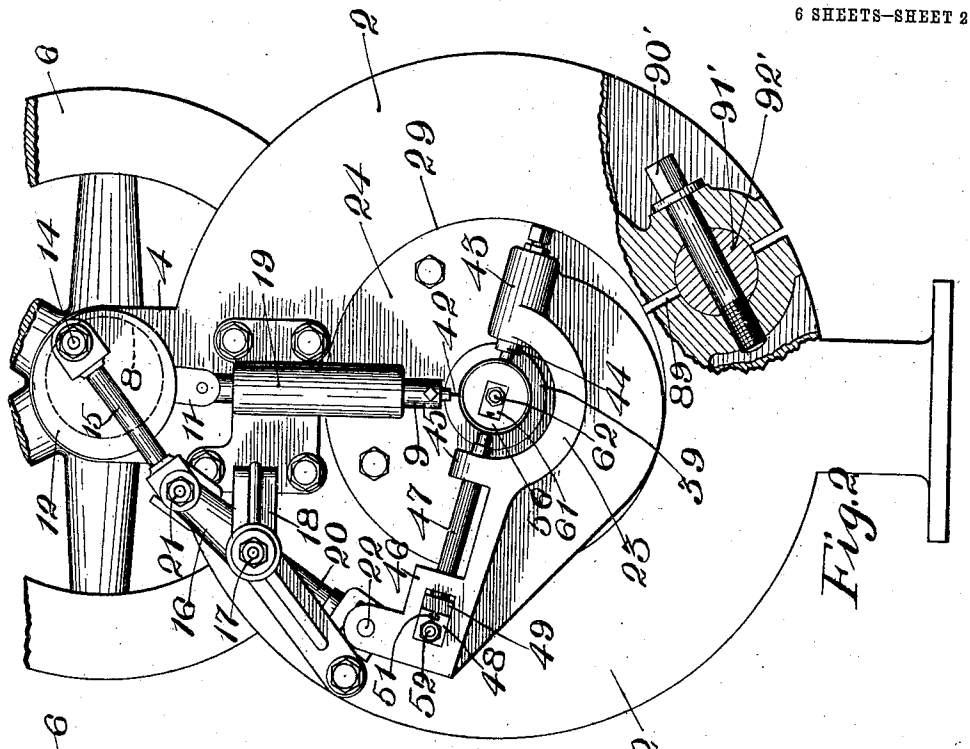

Fig. 2.

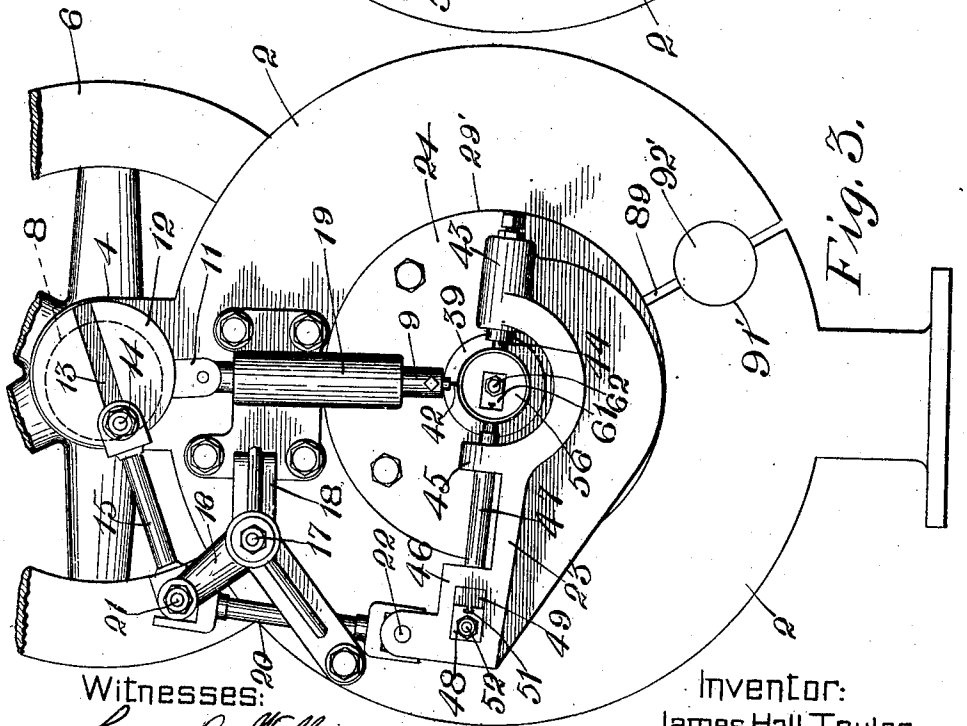

Fig. 3.

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6 SHEETS—SHEET 3.

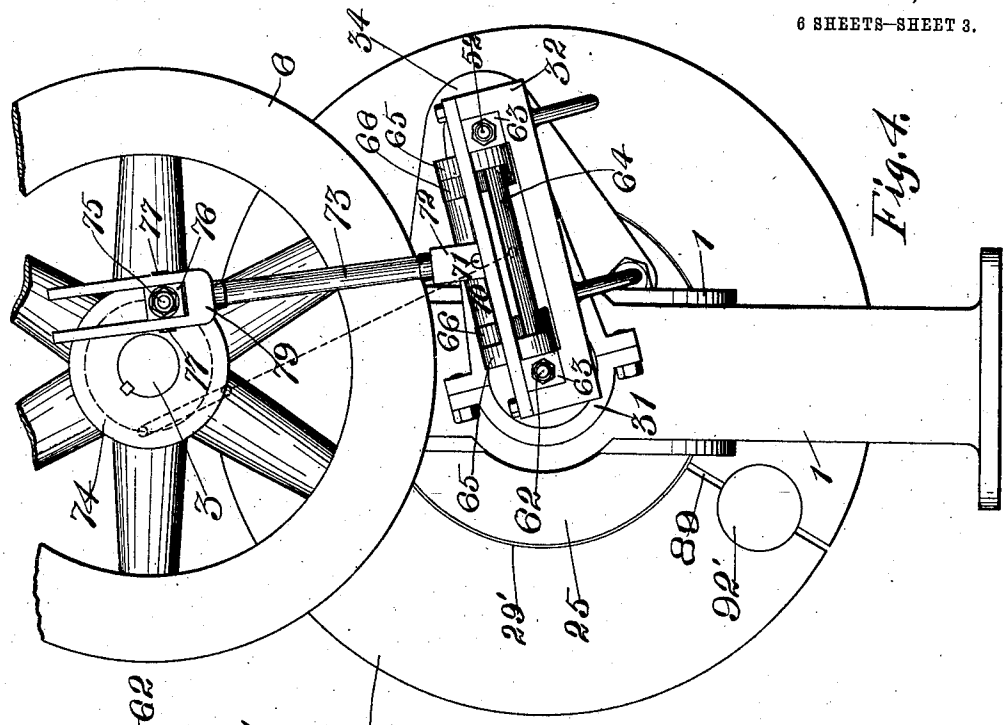

Fig. 4.

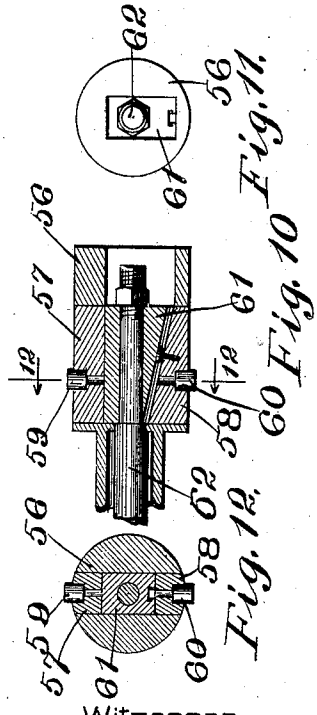

Fig. 11.

Fig. 10

Fig. 12.

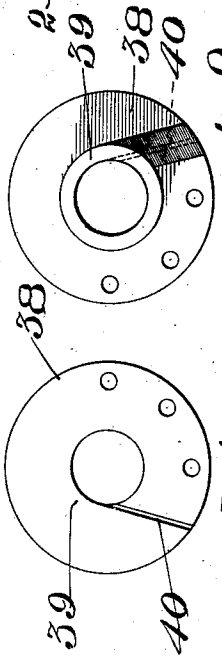

Fig. 9

Fig. 8.

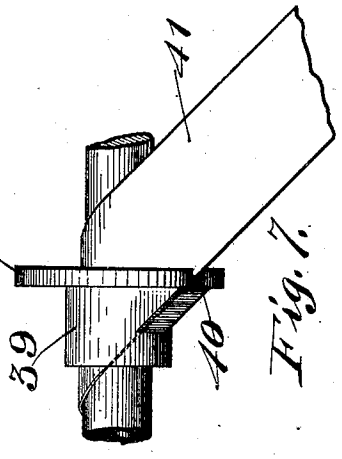

Fig. 7.

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6 SHEETS—SHEET 4.

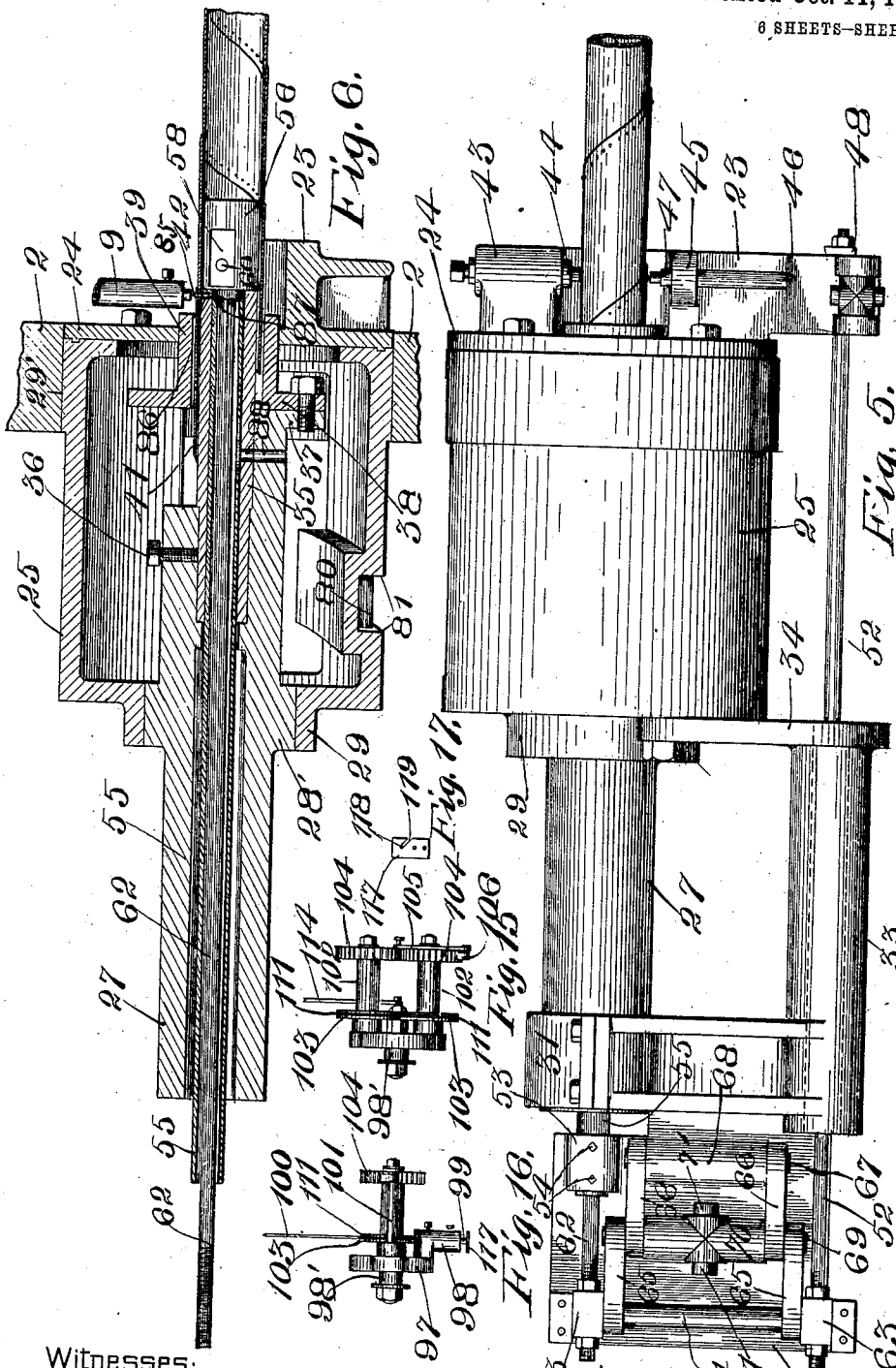

Fig. 6.

Fig. 5.

Fig. 17.

Fig. 15.

Fig. 16.

Witnesses:

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6 SHEETS—SHEET 5.

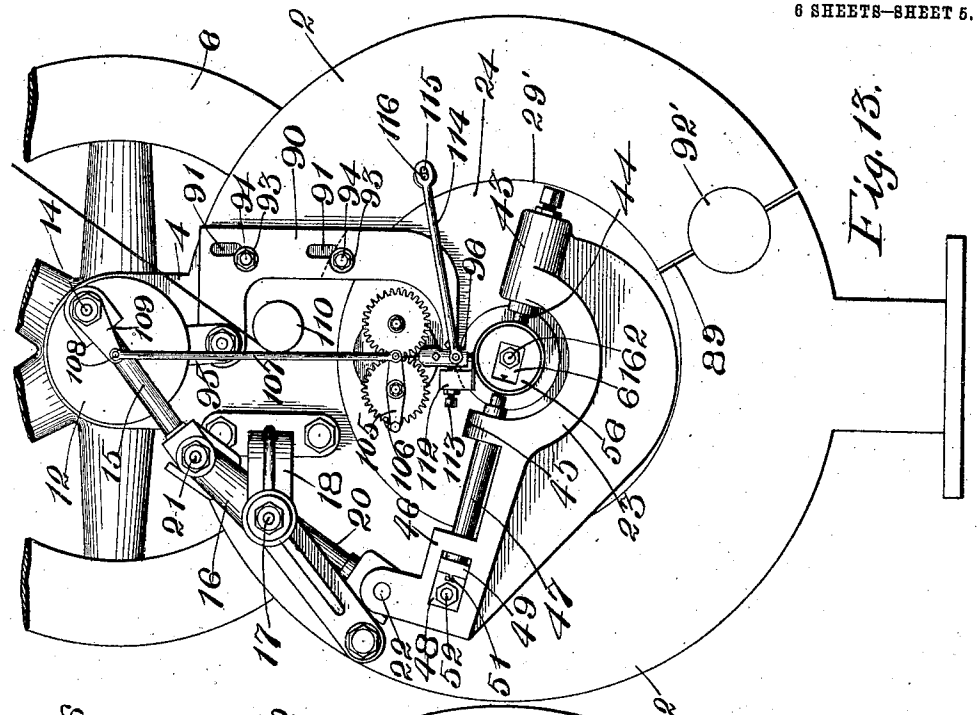

Fig. 13.

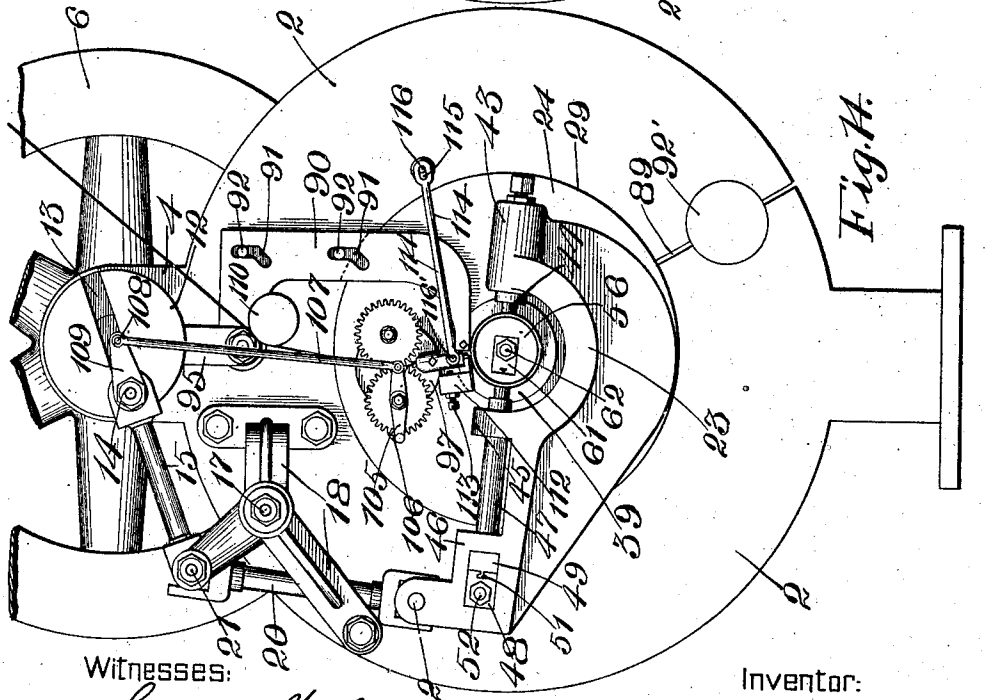

Fig. 14.

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6 SHEETS—SHEET 6.

Fig. 17.

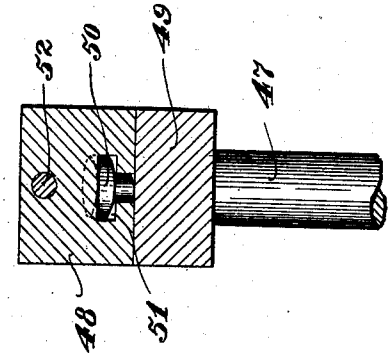
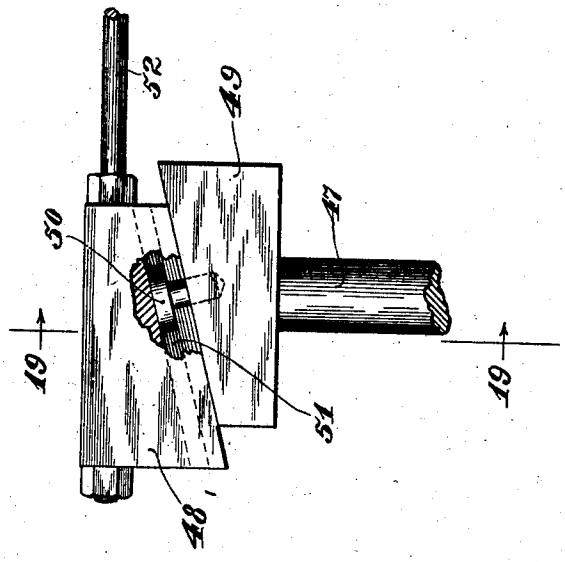


Fig. 18.



Witnesses

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UNITED STATES PATENT OFFICE.

JAMES HALL TAYLOR, OF CHICAGO, ILLINOIS, ASSIGNOR TO AMERICAN SPIRAL PIPE WORKS, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

SPIRAL-PIPE-FORMING MACHINERY.

972,731. Specification of Letters Patent. **Patented Oct. 11, 1910.**

Application filed June 9, 1902. Serial No. 110,846.

To all whom it may concern:

Be it known that I, JAMES HALL TAYLOR, 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 Spiral-Pipe-Forming Machinery, (Case No. 6,) 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 forming machinery, and particularly to that class of forming machinery used for forming spiral riveted pipe.

My invention has for its object the provision of an improved construction for machines of this class and to increase the general efficiency and effectiveness of operation thereof; more particularly, to provide a machine in which there shall be a decreased number of rapidly moving parts, and these combined in a more substantial and mechanically perfect machine, whereby I am enabled to wind a strip of sheet metal in a spiral manner to form a hollow cylindrical pipe, the necessary rigidity, as well as the provision of a water tight joint being secured by punching holes in a spiral seam and riveting the same together.

It is desirable, in machines of this class, to make them as nearly automatic in their operation as possible, and to provide a machine which can not readily get out of repair. My invention contemplates the provision of a machine which shall embody these desirable features.

In order that the weight of the reciprocating parts of the machine may be decreased, I preferably provide a reciprocating shell and associated parts which are adapted to firmly grip the formed pipe and advance it spirally in a direction corresponding to that of the riveted seam, at the same time drawing the unformed blank into the former. I provide for this former an inside cylindrical mandrel, slightly smaller than the inside diameter of the finished pipe, and an outside hollow cylindrical former roughly corresponding to the outside diameter of the pipe to be formed. The above mentioned shell advances the pipe through the agency of outside and inside riveting heads which rivet the seam and then retain their grip upon the rivets as the pipe is pulled into and through the former, releasing their hold at the end of the forward movement (equal to the pitch of the rivets), upon the completion of which the shell returns to again grip the pipe and pull it forward.

It is a further object of my invention to provide means for punching the rivet holes in the newly formed seam during the return or backward stroke of the shell, while the pipe is stationary in the former. As it is necessary that the shell should have a combined rotary and longitudinal movement corresponding to the seam of the pipe, it becomes one of the objects of my invention to provide a novel and efficient means of imparting to the shell such a motion.

In drawing the sheet metal blank into the former, the metal intervening between such former and the gripping mechanism is subjected to various strains, which are apt to cause a greater or less relative movement of the two lapped edges forming the seam of the pipe. Therefore, after the rivet holes have been punched, it is necessary to feed in the rivet wire before the pipe has been drawn forward, because if it were not fed until later the holes in the seam would be pulled out of register, due to the unequal straining above referred to.

It is one of the objects of my invention to provide means whereby this rivet wire is fed into the holes before they are thus drawn out of register.

Other objects of my invention are to provide an improved wire shearing mechanism which cuts off the proper length of wire in the rivet holes, to provide improved guiding means for guiding the rivet wire into the holes, to provide improved ratchet mechanism for feeding such rivet wire, and to provide improved and efficient riveting means and the associated actuating mechanism.

Further objects of my invention will be apparent from a consideration of the preferred embodiment thereof shown in the accompanying drawings. I have also shown in the drawings a simplified embodiment of my invention in which it is intended that headed rivets shall be manually fed into the rivet holes in place of providing the auto-

matic rivet feeding mechanism which comprises a part of the preferred embodiment of my invention.

For the sake of clearness I shall first describe my machine in its simplified form.

In the accompanying drawings, Figure 1 is a side elevation of the simplified embodiment of my invention; Fig. 2 is a front view of the same, showing the principal moving parts at one end of their stroke; Fig. 3 is a similar view, showing these parts at the other end of their stroke; Fig. 4 is a rear elevation of my machine; Fig. 5 is a plan view of the oscillating shell and the associated parts; Fig. 6 is a sectional view of the former and the oscillating shell and associated mechanism; Fig. 7 is a side elevation of the outside former as it appears when forming the metal blank; Fig. 8 is a rear elevation of the outside former; Fig. 9 is a front elevation of the same; Fig. 10 is a sectional view of the inside riveting and gripping mechanism; Fig. 11 is a front elevation of the same; Fig. 12 is a sectional view of the same on line 12—12 of Fig. 10; Fig. 13 is a front elevation of the preferred embodiment of my machine in which is shown the automatic riveting mechanism; Fig. 14 is a similar view showing the principal parts in another position at another point in their movement; Fig. 15 is a plan view of the automatic wire feeding mechanism; Fig. 16 is a side elevation of the same, in which some of the parts have been removed; and Fig. 17 is a plan view of the shear used for cutting proper lengths of the rivet wire, in all of which figures like characters of reference have been used to designate similar parts; Figs. 18 and 19 are a plan and cross-sectional view illustrating details of construction.

In a simplified embodiment of my invention, I provide a C-shaped frame 1, similar to that usually employed in punching machine frames, except that I join the upper and lower limbs of the C with a circular yoke 2.

There are in my machine two principal horizontal axes of rotation, the lower one being coincident with that of the pipe and the upper one being the axis of rotation of the main driving shaft 3 for the accommodation of which the frame is provided with bearings 4 and 5. The shaft carries a loosely mounted driving pulley wheel 6, which may be engaged to drive the machine by the operation of the clutch 7. In front of the bearing 4 the shaft carries an eccentric 8, which operates the punch head 9 through the agency of an eccentric strap 10 and the connecting rod 11. In front of the eccentric the shaft is provided with a crank disk 12 in which a dovetailed T slot 13 is adapted to receive the adjustable eccentric crank pin 14. Through the agency of the connecting rod 15 this crank pin causes an oscillation of the crank 16 about a stud 17, rigidly supported by the frame 18, which frame also provides a sliding bearing 19 for the punch head 9. A second connecting rod 20, having universal joints at the ends, connects the common crank pin 21 with the wrist pin 22, rigidly connected to the oscillating table 23. This table is preferably cast integral with a disk or plate part 24, which is bolted to the end of the cylindrical shell 25. It is provided with lugs and recesses to accommodate and carry the riveting mechanism, which will hereinafter be more fully described.

It will be seen that the body of the C-shaped frame is provided with an enlargement at 26 through which there is a hole adapted to tightly fit and hold a hollow cylindrical former carrier 27, whose axis coincides with the axis of the pipe above referred to. This carrier is rigidly held in place in the frame by two set screws 28, 28. Just within the frame the carrier is provided with an enlargement 28′ in the nature of a collar, which forms a journal, about which the bearing 29 of the cylindrical shell 25 may turn. It will also be seen that the yoke 2, which joins the two arms of the C frame, is provided with a circular opening 29′, which forms a bearing for the front end of the cylindrical shell. It will be seen that the carrier 27 extends through the back of the frame at 30, and here forms a journal for the split bearing 31 associated with the toggle bed 32. A hollow cylindrical arm 33 extends forward from the toggle bed around the outside of the C frame, and is provided with an enlarged end 34, by which it is securely bolted to the end of the shell 25.

Referring again to the link mechanism at the front of the machine, it will be seen that as the crank disk revolves the connecting rod 15 will be actuated to oscillate through an arc of a circle, the limiting positions being shown one in Fig. 2 and the other in Fig. 3. By adjusting the eccentricity of the pin 14 the swing of the crank 16 may be varied as desirable. As the crank oscillates the connecting rod 20 will transmit to the table 23 an oscillatory motion, its two extreme positions being shown in Figs. 2 and 3. As best shown in Fig. 5, the table 23 and the shell 25 and the arm 33 and the toggle bed 32 are all rigidly fastened together, so as to move as a single piece, and as the bearings at 29, 29′ and 31 are all in line, it is clear that when an oscillatory movement is imparted to the table by the link mechanism, the parts 25, 33, 32, etc., will participate in the same swinging motion.

Referring now more particularly to Fig. 6, it will be seen that the front end of the former carrier 27 is bored to receive the forming mandrel 35, which is securely held

by the set screw 36. A segment of a circular flange 37 is formed at the end of the carrier, to which is bolted the flange 38 of the outside former 39, which is illustrated in Figs. 7, 8 and 9. A slot 40 in a plane tangential to the surface of the forming mandrel is adapted to guide the sheet metal blank 41 on to the mandrel and inner lap of the formed pipe and at the proper angle. As will be seen in Fig. 7, if the formed pipe to the left were pulled forward and at the same time given a twisting motion, it would draw the unformed blank into the former, where it would be wound into a spiral to conform to the opening through the former. To pull this blank into the former and to rivet the seam thus formed are the principal functions of the oscillating table 23 and the toggle bed 32 and their associated mechanism and connecting parts. It should here be clearly understood that the outside former 39 and inside mandrel 35 have no motion, either relative or absolute, but remain in fixed, rigid relation to the machine frame.

It will be seen that as the formed sheet of metal emerges from the front of the former 39, the last layer of the strip laps over the previous layer, thus forming a lap seam, which must be fastened by riveting. A hardened punch 42 is carried by the punch head 9, and its movement is so timed that it descends and punches a hole through the seam during the interval in which the pipe is not being advanced forward.

Coming now to the riveting and gripping mechanism, upon the table 23 there is cast a lug 43, which supports the adjustable anvil or back stop 44, the end of which bears on the adjacent surface of the pipe. Caps 45 and 46 cast upon the table 23 serve to guide the longitudinal motion of the riveting head 47. Such motion is imparted to the riveting head by a wedge 48, acting upon a slide 49, fastened to the end of the riveting head and provided with a T-headed screw or bolt 50, riding in a dovetailed slot 51 of the wedge. The wedge is adapted to be operated by a long rod 52, which passes through a hole in the wedge and is securely fastened thereto. As will be hereinafter more fully explained, this rod is adapted to draw the wedge into engagement with the slide 49, thus forcing the riveting member outward.

Looking at Fig. 5 there will be seen cast upon the toggle bed 32 a hollow cylindrical lug 53, having set screws 54, 54, which impinge upon a long hollow tube 55, thus securely fastened to the toggle bed. As will be seen, this tube extends forward through the carrier 27 and the mandrel 35, and carries upon its end a cylindrical enlargement 56, slightly smaller in diameter than the inside of the pipe. This enlargement is most clearly shown in Figs. 10, 11 and 12. A slot is cut diametrically through the enlargement to accommodate the blocks 57 and 58, into which the inside riveting heads 59 and 60 are tightly fitted. The inside riveting head 60 is adapted to be forced out into engagement with the rivet by a sliding wedge 61, actuated by the rod 62, which passes through the tube 55 to the toggle bed at the rear of the machine. The inside riveting mechanism is so adjusted that the riveting heads 59 and 60 inside the pipe are directly in line with the back stop 44 and the riveting head 47 on the outside of the pipe. The two rods 52 and 62 are adjustably fastened into a pair of sliding blocks 63, which are provided with guideways upon the toggle bed, and which are connected together by the shaft 64. A pair of toggle joints, each comprising two toggles 65 and 66, are provided with a stationary shaft 67, passed through a lug 68 cast upon the toggle bed 32, and at the other end are adapted to act upon the connecting shaft 64. The knuckle pin 69 of the two toggles, carries the sleeve 70, whose pins 71, 71 fit holes in the forked end 72 of the connecting rod 73. Upon the back end of the main shaft 3 there is keyed a crank disk 74, carrying a crank pin 75, which fits through a bearing in a sliding block 76, provided with projecting pins 77, 77, which are adapted to slide in the slots 78, 78, in the forked end 79 of the connecting rod.

The operation of the machine now becomes apparent. Supposing the table 23 and toggle bed 32, etc., to be in their upper positions, as shown in Figs. 2 and 4, it will be seen that the crank pins 14 and 21 are both passing over a dead center with reference to the connecting rods 15 and 20, respectively. In practice I find that by this arrangement of links I can get a rotation of the main shaft through an angle of more than ninety degrees, during which rotation it will cause practically no motion whatever of the table 23. The position of the crank pin 75 on its disk 74 and the length and position of the slots 78 are so fixed that just as the oscillating table gets to its upper position the pins 77, 77 strike the bottom of the slots 78, 78, and through the agency of the connecting rod 73 force the toggle joints down into their extended position. As the knuckle passes down slightly below the center line, it will be seen that the toggles will retain their extended position unless positively released by the knuckle. When the toggle joints are extended, they force back the rods 52 and 62, thus drawing back their associated wedges and forcing the inside riveting head outward and forcing the outside riveting head inward. It will be understood that after the operation of the machine has been continued some little time, the formed

sheet metal approaches these riveting heads already lapped to form a seam, and this seam is already perforated with holes, and the operator has placed rivets in these holes before they reach the riveting heads, which are so placed as to close down upon the rivet in place in the hole. As the riveting heads close in upon the rivet with a very great pressure, due to the powerful leverage of the toggle joint and wedges, the rivets are upset or riveted in place, thus closing the lapped edges of the pipe in a very tight joint. It will be seen that there is no positive motion of the riveting heads on the opposite side of the pipe from the rivets, but these two heads grip the pipe at this point on account of the pressure transmitted from the movable heads and the back stop 44 thus receives the pressure of the riveting head 47. It will be seen that the pipe is now gripped very tightly and firmly by the riveting heads and that these will retain their grip upon the pipe until the knuckle of the toggle joint has been raised. Shortly after the pipe has been thus gripped, the crank pin 14 will have reached such a position that it begins to impart a downward motion to the wrist pin 22 on the table 23. Now since the pipe is gripped to the moving table it will participate in the downward motion of the table, but it will be remembered that the pipe, in order to be properly drawn into the former, must receive, in addition to the turning motion, a longitudinal motion. In order to have the pipe advanced with this combined rotative and longitudinal motion, I provide mechanism which longitudinally advances the entire table, shell and toggle bed when it is turned. I have shown one embodiment of such mechanism, which consists of a segment of a cut or cast gear 80 fastened in a suitable recess, which has side walls 81, 81 passing spirally about the cylindrical recess. A short piece of rack 82, adapted to mesh with the segment of the gear, fits snugly into the diagonal slot in the shell. A block 83 is bolted to the machine frame and has upon its upper side a slot 84 running at the same angle as the slot in the shell 25, and adapted to make a sliding fit with the rack. It will be seen that as the shell rotates, the gear segment 80 slides the rack across the slide in the block 83. This causes the side of the rack to press against the side wall 81 of the recess in the shell, and thus causes the shell and parts associated therewith to be advanced along the line of the pipe. It will now be apparent that the reason for providing the universal stub ends on the connecting rods 20 and 73 was to allow for this relative longitudinal motion of the connected parts. The angle of the walls 81 and slot 84 is such as to make the longitudinal movement combine with the rotative motion of the shell to give the grippers a motion corresponding to the direction of the seam of the pipe, thus advancing the pipe and drawing the blank into the former until the table has reached the end of its downward stroke. At this point the crank pin 75 has reached a point at which the pins 77, 77 strike the top of the slots 78, 78, thus raising the knuckle of the toggles and releasing them. This, of course, loosens the grip of the riveting heads upon the pipe, allowing it to remain in position while they travel upward and backward into position to grip the next rivet. During this return movement of the table, and while it is stationary at the upper end of its travel, the eccentric 8 drives the punch down through the seam and into the die block 85, set into the end of the arbor 35, thus punching the rivet holes above referred to. The wads punched out pass through a hole 86 in the mandrel and a hole 87 in the tube 55 and then through the registering holes 88 in the tube, mandrel and former holder. As the operation of the machine continues, it will be seen that by a series of intermittent advances and stops the sheet metal blank is drawn into the former and the finished spiral riveted pipe turned out at the front of the machine.

As it is sometimes desirable to remove the cylindrical shell from the frame of the machine, I provide a gap 89 in the yoke 2 of the frame. This gap is retained in its closed position by means of a retaining bolt 90′, which passes through a hole in one side of the gap and into a screw-threaded hole in the other side. A cylindrical hole 91′ is provided in the middle of the gap and a cylinder 92′ is provided, the cylinder being of such size that when the two sides of the gap are tightly drawn together by the retaining bolt 90′, they will clamp this cylinder in position. When thus clamped in position, the circular opening 29′ is of the proper size to fit the bearing of the shell 25.

Having thus described the simplified embodiment of my invention, in which the rivets are fed by hand, I will now proceed to describe the preferred embodiment thereof in which rivet wire is automatically fed into the rivet holes and sheared off in proper lengths to form rivets. As there is a tendency to more or less slipping in the lapped seam between the point at which the rivet holes are punched and the point at which the rivets are headed, it is necessary that the rivet blanks be fitted into the holes immediately after the holes are punched, and before the pipe has been pulled and advanced by the grippers. As the pipe is stationary during the return or upward motion of the table 23, I find it desirable to punch the rivet holes during this interval. In this embodiment of my invention, whose changes from the simplified embodiment thereof are

best shown in Figs. 13 to 17, inclusive, the punching head 90 is provided with slots 91, 91, which fit over studs 92, 92 screwed into the yoke of the frame, and which are provided with washers 93, 93 and retaining nuts 94, 94 to hold the punching head up to the machine frame. The eccentric 8 imparts motion to the punching head by means of the connecting rod 95. The punching head is shown in Fig. 13 at the upper end of its stroke. As the eccentric forces it downward, it is apparent that the first part of the motion is not a directly up and down motion, because the lower parts of the slots 91, 91 have an angular direction. This causes the punching head to move downward and sidewise during the first part of the stroke and until the vertical parts of the slots have reached the studs 92, 92. This carries the punch 96 from its position above and to the side, as shown in Fig. 13, down to a position in the central plane in which the hole is to be punched. From this point the punch moves straight downward, punching a rivet hole through the seam of the pipe and then returning with a reverse motion to its initial position. While I have shown a punch head whose peculiar motion is guided by slots and studs, it might be desirable, in some cases, to provide other guiding means, which, for instance, might have a greater area of sliding contact, and I do not, therefore, wish to limit myself to the particular mechanism shown and described.

A disk 97 having a downwardly projecting cylindrical part 98, is pivoted to the front plate of the shell 25 by means of the stud bolt 98′. A cylindrical tube 99, preferably of hardened steel, is securely held in the cylindrical projection 98, and is provided with a hole through its center of a size suitable to accommodate the rivet wire, 100. Studs 101, 101, project from the opposite sides of the front of the disk 97 and carry sleeves 102, 102 upon the inner ends of which are mounted the wire feeding rollers 103, 103, while upon their outer ends they carry the intermeshing gears 104, 104. One of these studs also provides a fulcrum for the ratchet lever 105, which has at one end a ratchet pawl 106, adapted to engage the teeth of the adjacent gear wheel, and which at the other end is attached to the connecting rod 107. The upper end of this rod is actuated by the eccentric crank pin 108 carried upon the crank 109, mounted on the outside of the crank pin 14. The rivet wire 100 is led over the guiding sheave 110 to the grooves 111, 111, between the feeding rollers 103, 103. These rollers grip the wire very tightly and as the top of the tube 99 comes up between them as far as possible, the rollers are adapted to force the feed wire down through the tube and into a rivet hole in the seam of the pipe. As the disk 97, which carries all of these parts, is free to swing on the stud bolt 98′, some means must be provided for guiding the tube 99 and its contained wire so that it may register with the previously punched rivet hole. To this end, a projecting lug 112 is cast upon the end plate of the shell 25 and provided with an adjustable stop 113. I also provide a connecting rod 114 having at one end a slot 115, which slides upon the pin 116, projecting from the frame, and at the other end having universal connection with a pin 116′ on the front of the tube holder 98. When the table 23 comes up into its proper position, as shown in Fig. 13, the pin 116 strikes the inner end of the slot 115, pressing the lower end of the tube holder 98 over into contact with the stop 113, thus effectively and firmly holding it in place so long as the table remains in this upper position.

A thin shearing plate 117 preferably of hardened steel, is secured to the lower side of the lug 112 and projects out underneath the tube 99, where it is provided with a hole 118 of the size of the rivet wire, and this hole is connected to the edge of the plate by an opening 119, as best illustrated in Fig. 17. As soon as the table has reached this upper point in its stroke, and while it remains stationary in this position, due to the design and construction of the previously described link mechanism, the wire feeding rollers 103, 103 are actuated to force the rivet wire down through the tube 99, through the registering hole 118 in the shearing plate 117 and through the previously punched rivet hole in the seam of the pipe, with which the rivet wire has been brought into perfect alinement. It will be understood that the stroke of the connecting rod 107 is made such as to cause the wire to be fed far enough through the hole in the seam to provide a small amount of metal on the inside to be later upset by the riveting heads. At about the time the wire has been fed into the rivet hole, the crank pin 14 has reached a point at which it causes the beginning of the downward movement of the table 23. As the table swings downward, carrying with it the pipe, the wire feeding mechanism turns with the table also, the end of the wire remaining in the rivet hole. But after the tube 99 has turned a short distance with the pipe and table, the outer end of the slot 115 strikes the pin 116. This, of course, detains the tube 99 and prevents its further rotation with the pipe and table, but as the thin steel shearing plate 117 is secured to the lug 112, its hole 118 will remain in register with the rivet hole below and the two will turn together until the table 23 has reached the end of its downward stroke. Now when the tube 99 has been detained in its movement by the rod 114, it turns upon its stud 98′ and, as best shown in Fig. 14, the wire is sheared off at a point just flush

with the top of the shearing plate 117, the thickness of the plate being such as to allow sufficient wire to project outside of the seam for the purpose of forming a rivet head. When the table is swung down into its lower position, it will be seen that the wire feeding tube and its associated parts are out of the way of the punch 96, so that the punch may move down and punch the rivet hole, as previously described. The punch then moves out of the way to allow the wire and feeding tube to come up into register with the newly punched hole. As the table swings upward again into its stationary position, the shearing plate 117 disengages itself from the wire, the projecting end of the wire passing through the opening 119 to the side. Thus it will be seen that, as the seam advances to the point at which it is to be riveted by the riveting heads, all the holes have been supplied with rivet blanks, having both inwardly and outwardly projecting ends suitable to be formed into rivet heads.

While I have herein shown and particularly described one embodiment of my invention, it is clear that many other embodiments thereof and changes therein might be advantageously employed, without departing from the spirit of my invention; and I do not, therefore, wish to be limited to the precise disclosure herein set forth, but

Having described my invention I claim as new and desire to secure by Letters Patent:—

1. In a spiral pipe machine, the combination with means adapted to grip the pipe and to head rivets inserted in the overlapping edges of the sheet metal forming the pipe, of means for oscillating the gripping mechanism to bring the metal of the pipe in position to receive a fresh rivet and permit said gripping mechanism to head such fresh rivet, substantially as described.

2. In a spiral pipe machine, the combination with means adapted to grip the pipe and to head rivets inserted in the over-lapping edges of the sheet metal forming the pipe, of means for forming rivet holes through over-lapping edges of the metal of the spiral pipe, and means for oscillating the gripping mechanism as a whole with respect to said means for forming the rivet holes to bring the metal of the pipe in position to receive a fresh rivet and permit the said gripping mechanism to head the fresh rivet.

3. In a spiral pipe machine, the combination with means adapted to grip the pipe and to head rivets inserted in the over-lapping edges of the sheet metal forming the pipe, of means for forming rivet holes through over-lapping edges of the metal of the spiral pipe, means for oscillating the gripping mechanism as a whole with respect to said means for forming the rivet holes, and means causing the bodily reciprocation of the gripping mechanism, each reciprocal movement being concurrent with an oscillatory movement, whereby the pipe may be fed for each riveting and whereby the pipe may be drawn into position to receive fresh rivets to be headed by the gripping and heading mechanism.

4. In a spiral pipe machine, the combination with combined gripping and rivet-heading mechanism having jaw members, of a rivet-inserting device, means for first causing movement of the rivet-inserting device, to insert a rivet through the parts to be riveted together, means for then causing movement of the jaw members to cause the gripping and heading mechanism to engage and head the inserted rivet, means for causing a bodily advanced movement of said mechanism following each relative movement thereof to head and rivet, means for causing relative return movement of the jaw members to release the gripping and heading mechanism from the rivet, and means for then causing a bodily return movement of said jaw members and the gripping and heading mechanism to the normal position.

5. In a spiral pipe machine, the combination with inside gripping and heading mechanisms, complementary outside gripping and heading mechanisms, means serving to cause movement of the members of one of said gripping and heading mechanisms away from each other, means for causing bodily movement of the mechanisms in a forward direction and intervening reverse movements thereof, and means serving to impart oscillatory movement to said gripping and heading mechanisms concurrent with the forward movement thereof.

6. In a spiral pipe machine, the combination with means for forming a strip of metal into a pipe, of a bodily traveling riveting device movable with the pipe, substantially as described.

7. In a spiral pipe machine, the combination with guiding mechanism for guiding a strip of sheet metal to form a lapped spiral coil, of a bodily traveling inside riveting device, means coöperating with said riveting device to react in opposition to pressure exerted thereby, the pipe being gripped upon riveting to be carried with the riveting device.

8. In a spiral pipe machine, the combination with a mandrel and former for guiding a strip of metal to form a lapped spiral coil, of a bodily traveling inside riveting device, and means coöperating with said riveting device to react in opposition to pressure exerted thereby, the pipe being gripped during riveting to be carried with the riveting device.

9. In a spiral pipe machine, the combination of a bodily traveling inside riveting de-

vice and a complementary bodily traveling outside riveting device acting in conjunction therewith, the pipe being gripped during riveting and carried with the riveting device.

10. In a spiral pipe machine, the combination with means for forming sheet metal into a spiral lapped coil, of riveting mechanism, means for causing the mechanism to head the rivets and to simultaneously grip the pipe, and means for effecting bodily travel of the riveting means with the pipe gripped thereby.

11. In a spiral pipe machine, the combination with a former for forming sheet metal into a coiled spiral tube, riveting mechanism consisting of expansible mechanism for heading rivets and means for coöperating with said expansible mechanism to react in opposition to pressure exerted thereby, a toggle joint connected with said riveting mechanism, means whereby the toggle joint may be operated to expand the heading mechanism and actuate the coöperating mechanism to head the rivets and contract said heading mechanism and release said coöperating mechanism after the heading operation, and means whereby the expansible mechanism is advanced when expanded to pull the coiled tube through the former.

12. In a spiral pipe machine, the combination with a former for forming sheet metal into pipe, of riveting mechanism for heading rivets, a toggle joint connected therewith, means whereby the toggle joint may be operated to cause relative movement of members of the heading mechanism to head the rivet and to cause return movement of the members of said mechanism after the heading operation, means whereby the rivet heading mechanism is advanced when the members are in their heading position whereby to pull the pipe through the former, and means whereby the rivet heading mechanism may be oscillated when the members are in their normal relative position to bring the mechanism in position to engage and head a fresh rivet, substantially as described.

13. In a spiral pipe machine, the combination with means for shaping sheet metal into a spiral coiled tube, of an expansible inside riveting device, a complementary riveting device upon the exterior of the pipe, means for extending the inside riveting device to clamp the pipe between the inside and outside riveting devices, and means for effecting the concurrent spiral reciprocation of both of said riveting devices to carry the pipe.

14. In a spiral pipe machine, the combination with means for shaping sheet metal into a spiral coiled tube with lapped edges, of an expansible inside riveting device, means for expanding and contracting said riveting device, outside abutment mechanism for said inside riveting mechanism, said pipe being clamped against the abutment mechanism by the expanded inside riveting mechanism, and means when the pipe is gripped for causing movement of the riveting mechanism to feed the pipe through the machine.

15. In a spiral pipe machine, the combination with a former for shaping a sheet metal blank into a spirally coiled tube, of inside gripping jaws, complementary outside abutment jaws for said inside jaws, mechanism for causing relative lateral movements of the members of said inside jaws to alternately grip and release the tube after formation in said former, and means for causing a spiral oscillation of said gripping and abutment jaws as a whole to advance the tube in said former, said oscillations being synchronized with the movements of said inside jaw members.

16. In a spiral pipe machine, the combination with means for guiding a sheet metal blank to form a spirally coiled tube, of combined riveting and gripping mechanism, means for actuating the mechanisms to head rivets and grip the pipe, a carrier for said mechanisms, a diagonally placed segmental gear on said carrier, a diagonally placed longitudinal, slidable rack meshing with said gear, guides on said carrier engaging the sides of said rack, and means for effecting oscillation of said carrier, said pipe being gripped by the mechanism and caused to be fed spirally through the mechanism upon oscillation of the carrier.

17. In a spiral pipe machine, the combination with means for shaping sheet metal into the form of a spirally coiled tube, of rivet hole punching mechanism, and means for operating the same, gripping and rivet heading mechanism and means for alternately opening and closing the jaws thereof, a rotatably mounted table carrying said gripping and rivet heading mechanism, and means for effecting an oscillatory movement of said table in synchronism with the opening and closing of said jaws, whereby said tube is drawn through said shaping means.

18. In a spiral pipe machine, the combination with means for shaping a sheet metal blank into a coiled spiral tube, of rivet hole punching mechanism and means for operating the same, gripping and rivet heading mechanism and means for alternately causing opening and closing movements of jaw members thereof, a rotatably mounted table carrying said gripping and rivet heading mechanism, a revolving shaft having an eccentric crank pin mounted thereon, a connecting rod adapted to engage the said crank pin, a second connecting rod engaging said table, a crank having a crank pin common to the free ends of said connecting rods, and a mechanical connection between said revolv-

ing shaft and means for operating said rivet hole punching mechanism and said gripping and rivet heading mechanism, whereby the cycle of operations performed by each of these mechanisms shall be completed for each revolution of said shaft.

19. In a spiral pipe machine, the combination with means for shaping sheet metal into the form of a spirally coiled tube, of rivet hole punching mechanism and means for operating the same, gripping and rivet heading mechanism and means for causing alternate opening and closing movements of the jaw members thereof, a rotatably mounted table carrying said gripping and rivet heading mechanism, a rotatably mounted shaft having an eccentric crank pin carried thereby, a rotatably mounted crank intermediate between said eccentric crank having a crank pin and said table, a connecting rod connecting said eccentric crank pin and said intermediate crank, and a second connecting rod connecting said intermediate crank and said table.

20. In a spiral pipe machine, the combination with means for shaping sheet metal into the form of a coiled spiral tube with a lapped seam, of rivet hole punching mechanism, and means for causing the operation thereof, gripping and rivet heading mechanism and means for causing the alternate closure and opening of the jaws thereof, rivet inserting mechanism, a rotatably mounted table carrying said gripping and rivet heading mechanism and said rivet inserting mechanism, and means for effecting an intermediate advance motion of said table in a direction corresponding to the direction of the lapped seam of the tube, said advance movements being synchronized to occur during each closure of the jaws of the gripping and heading mechanism.

21. In a spiral pipe machine, the combination with means for shaping sheet metal into the form of a spiral pipe, of expansible inside rivet heading mechanism, complementary outside rivet heading mechanism, means for effecting the parallel travel of said rivet heading mechanisms as a whole when the same are closed upon a rivet, rivet hole punching mechanism, means for effecting the operation of the hole punching mechanism, means for effecting the operation of the rivet heading mechanism, and means whereby the rivet heading mechanism is maintained substantially stationary while the hole punching mechanism is in operation.

22. In a spiral pipe machine, the combination with wedge mechanism to grip the pipe and to head rivets inserted in the overlapping edges of the sheet metal forming the pipe, of means serving to oscillate the wedging mechanism, and means serving to reciprocate the wedging mechanism whereby the pipe may be fed for each riveting and whereby the pipe may be moved into position to receive fresh rivets to be headed by the wedging mechanism, substantially as described.

23. In a spiral pipe machine, the combination with wedge mechanism to grip the pipe and to head rivets inserted in the overlapping edges of the sheet metal forming the pipe, of means serving to oscillate the wedging mechanism, means serving to reciprocate the wedging mechanism whereby the pipe may be fed for each riveting and whereby the pipe may be moved into position to receive fresh rivets to be headed by the wedging mechanism, and toggle mechanism for operating said wedging mechanism, substantially as described.

24. In a spiral pipe machine, the combination with means for shaping a sheet metal blank into a spiral tube, of means for inserting rivets through the overlapping edges of the metal, an inside riveting head, an outside riveting head, wedge mechanism associated with each one of the heads, toggle mechanism for each wedge mechanism for actuating said wedge mechanisms to cause rivets between the heads to be headed and to grip the pipe, and means for bodily moving the heads and wedge mechanisms to carry the gripped pipe through the machine.

25. In a spiral pipe machine, the combination of means for shaping a sheet metal blank into a spirally coiled tube, riveting heads, wedges for actuating said riveting heads, toggle mechanism for actuating said wedges whereby said riveting heads are forced to head rivets inserted through the overlapping edges of the pipe, and a spiral oscillatory carrier upon which are mounted said riveting heads and the wedge and toggle mechanism for actuating the same, and means for causing a forward oscillatory movement of said carrier when the riveting heads have been forced to head the rivets, whereupon the tube is drawn through and from said shaping means.

26. In a spiral pipe machine, the combination with a former for forming a sheet metal blank into a coiled spiral tube, of gripping means, wedge mechanism for actuating the gripping means, toggle mechanism for actuating said wedge mechanism to cause actuation of the gripping means to grip the tube, and means for causing the combined oscillatory and longitudinal movement of said gripping mechanism and said wedge mechanism as a whole whereby the material of the tube is drawn spirally through the former.

27. In a spiral pipe machine, the combination with means for feeding sheet metal into the machine, of a former for shaping the same into a coiled spiral pipe, of means for punching rivet holes through the overlap-

ping edges of the material of said pipe, means for inserting rivets in said holes, wedge-actuated gripping mechanism, toggle mechanism for actuating the wedges of said wedge-actuated gripping means, whereby the pipe is gripped and the rivet headed, means for causing the combined rotary and reciprocal travel of said wedge-actuated gripping mechanism, whereby the material of the pipe is gripped and spirally drawn through the former, means for causing the relaxation of said wedge-actuated gripping mechanism, and means for returning said wedge-actuated gripping mechanism to its normal position for adding a fresh rivet.

28. In a spiral pipe machine, the combination with a former for forming sheet metal into a spiral pipe, of inside gripping and rivet heading mechanism, wedges associated therewith, means for inserting rivets through the overlapping edges of the pipe, toggle mechanism associated with said wedges, means whereby the toggle mechanism is actuated to spread the wedges to cause the actuation of the gripping and heading mechanism to head rivets and to relax said wedges to release the gripping and heading mechanism after the heading operation, and means whereby the gripping and heading mechanism may be advanced when spread to pull the pipe through the former.

29. In a spiral pipe machine, the combination with means for shaping a sheet metal blank into a spiral pipe, of a wedge-actuated riveting device at the inside of the formed pipe, a complementary wedge-actuated riveting device at the outside of the pipe, toggle mechanism for spreading and relaxing the riveting devices to grip and release the pipe, and means for effecting the bodily oscillation and concurrent longitudinal movement of both of said riveting devices when the pipe is gripped.

30. In a spiral pipe machine, the combination with a former for forming a blank into a spirally coiled pipe, of radially movable riveting heads at the inside of the formed pipe, riveting heads at the outside of the pipe coöperating with the inside riveting heads, means for radially moving said riveting heads to cause heading of a rivet passing through the pipe walls between the heads and clamping of the pipe, and means for effecting the concurrent spiral oscillation of said riveting heads when clamping the pipe whereby the pipe is fed through the machine.

31. In a spiral pipe machine, the combination with a former for shaping a strip of metal into a spiral pipe, radially and relatively movable riveting heads, relatively stationary riveting heads coöperating with the movable heads, wedge mechanism for actuating said movable heads, toggle mechanism for actuating said wedge mechanism whereby the movable heads are moved radially to engage a rivet to head the same and simultaneously to grip the formed pipe between the heads, and means for causing the concurrent bodily oscillation in a spiral direction of said riveting heads when gripping the pipe whereby the pipe is fed through said former in a spiral direction.

32. In a spiral pipe machine, the combination with a former for shaping the same into a spiral pipe, of a radially movable inside riveting head, movable complementary outside riveting heads coöperating with the inside heads, wedge mechanism for causing the actuation of said riveting heads, toggle mechanism for actuating the wedge mechanism whereby the riveting heads are forced into engagement with rivets to head said rivets and to grip the formed pipe, and means for causing a concurrent forward spiral movement of said riveting heads when gripping the pipe whereby the pipe is fed through the machine.

33. In a spiral pipe machine, the combination with a former for shaping a sheet metal blank into a spirally coiled tube, of gripping and heading mechanism, wedge and toggle mechanism adapted to cause the alternate opening and closing of the gripping and heading mechanism, and means for causing the spiral oscillation of said gripping and heading mechanism as a whole, the advance spiral oscillatory movements being timed to correspond with the closure of the gripping and heading mechanism and the return spiral oscillatory movements being timed to occur during the open condition of said gripping and heading mechanism.

34. In a spiral pipe machine, the combination with means for forming a sheet of metal into a pipe, of means for causing an intermittent spiral advancement of the formed pipe, of a punch for punching rivet holes through the overlapping edges of the material, means for causing the actuation of said punch during the stationary condition of the pipe, a rivet feeding device for feeding rivets into the hole formed by the punch, and means for causing said punch to move vertically and diagonally after having punched a rivet hole to allow said feeding device to insert a rivet in said rivet hole.

35. In a spiral pipe machine, the combination with a former for receiving and shaping sheet material into a spirally coiled pipe with lapped edges, of means for causing the intermittent spiral advancement of the formed pipe, a punch for punching rivet holes through the overlapping edges of the material, means for actuating said punch, a rivet feeding device for feeding rivets into the holes formed by the punch, means for causing said punch to move vertically and diagonally after having punched a rivet hole to allow said feeding device to insert a rivet

into said rivet hole, and means for retaining said pipe stationary while said punching and rivet inserting operations are accomplished.

36. In a spiral pipe machine, the combination with means for feeding sheet material into the machine to form a spiral pipe, of a disk, an opening through said disk from which the pipe emerges, a vertical reciprocating punch for punching rivet holes through overlapping edges of the pipe, a rivet wire feeding device mounted upon said disk, means for rotating said disk toward the newly punched rivet hole to allow a rivet to be inserted in said rivet hole, and means for raising said punch out of the way of said feeding device, substantially as described.

37. In a spiral pipe machine, the combination with a stationary former for feeding sheet material into the machine to form spiral pipe, of a punch for punching rivet holes through the overlapping edges of the pipe, a riveting wire-feeding device for feeding wire into the holes formed by said punch, a shearing blade encircling said wire above the pipe, means for causing said pipe to rotate spirally forward, means for causing said feeding device and said blade to travel with the pipe, and means for limiting the travel of the feeding device whereby upon further travel of the blade the part of the wire in the rivet hole is severed from the wire mass, substantially as described.

38. In a spiral pipe machine, the combination with a former for spirally feeding sheet material into the machine to form a pipe, of a disk, an opening through said disk from which the pipe emerges, punch mechanism for punching rivet holes through the overlapping edges of the pipe, a rivet wire-feeding device suspended from said disk for feeding rivet wire into the rivet holes, a shearing blade carried by the disk and encircling said rivet wire, means for gripping the pipe, means for causing rotation of said pipe and consequent travel of the feeding device and shearing blade carried by the disk, and means for limiting the travel of the feeding device whereby upon further travel of the blade the wire in the rivet hole is severed from the feed wire, substantially as described.

39. In a spiral pipe machine, the combination with means for spirally feeding sheet material into the machine to form a pipe, of a punch for punching rivet holes through the overlapping edges of the material, a rivet wire-feeding device for feeding wire into said rivet holes, a shearing blade encircling said wire above the pipe, rivet headers upon the interior of said pipe, wedges inserted between said headers, complementary headers upon the exterior of the pipe, wedges associated with said complementary headers, a toggle mechanism for simultaneously actuating said wedges whereby previously inserted rivet blanks are engaged and headed by said headers, means for causing spiral forward rotation of said heading device and the pipe when gripped thereby, means for causing said feeding device and said blade to travel with the pipe, and means for limiting the travel of the feeding device whereby upon further travel of the blade a rivet blank is severed from the wire, substantially as described.

40. In a spiral pipe machine, the combination with inside gripping and heading mechanism, complementary outside gripping and heading mechanism, jaw members for the gripping and heading mechanisms, means for moving the jaw members to cause actuation of said griping and heading mechnisms to engage and head rivets, means serving to impart a concurrent rotatory movement to said gripping and heading mechanisms after heading of the rivets, and means for then causing movement of the jaw members to their normal relative position to cause the gripping and heading mechanisms to release the rivets.

41. In a spiral pipe machine, the combination with inside gripping and heading mechanism, complementary outside gripping and heading mechanisms, jaw members for the gripping and heading mechanisms, means serving to cause relative longitudinal movements of the jaw members of the gripping and heading mechanisms to cause said mechanisms to engage and to head rivets, means serving to impart a concurrent reciprocal movement to said gripping and heading mechanisms after heading of the rivets, and means for causing relative movement of the jaw members to their normal position to cause the mechanisms to release the rivets.

42. In a spiral pipe machine, the combination with inside gripping and heading mechanism, of complementary outside gripping and heading mechanism, means serving to successively open and close the jaws of said gripping and heading mechanisms, and means serving to impart a combined rotary and longitudinal reciprocal movement to said gripping and heading mechanisms concurrently, the combined movements being timed so as to intervene between the open and closed position of the jaws.

43. In a spiral pipe machine, the combination with inside gripping and heading mechanism, of complementary outside gripping and heading mechanism, power driven toggle mechanism and wedge mechanism serving to cause movements of jaw members of said gripping and heading mechanisms to head rivets and to grip the pipe, crank and link mechanism serving to impart a

concurrent oscillatory motion to said gripping and heading mechanisms when gripping the pipe, and means for actuating the wedge and toggle mechanism to restore the jaw members to their normal relative position.

44. In a spiral pipe machine, the combination with inside gripping and heading mechanism, of complementary outside gripping and heading mechanism, power driven toggle mechanism and wedge mechanism serving to cause spreading of the jaws of said gripping and heading mechanisms and closure thereof, said jaws when spread heading a rivet and gripping the pipe, and crank and link mechanism serving to impart a concurrent oscillatory motion to said gripping and heading mechanisms when gripping the pipe.

45. In a spiral pipe machine, the combination with inside gripping and heading mechanism, of complementary outside gripping and heading mechanism, power driven toggle mechanism and wedge mechanism serving to cause spreading apart of the jaws of one of said gripping and heading mechanisms and closure thereof, said jaws when spread heading the rivet and thereby gripping the pipe, crank and link mechanism serving to impart a concurrent rotary movement to said gripping and heading mechanisms when gripping the pipe, and cam mechanism actuated upon each of said rotary movements to cause also longitudinal movement of said gripping and heading mechanisms.

46. In a spiral pipe machine, the combination with inside gripping and heading mechanism, of complementary outside gripping and heading mechanism, power driven toggle mechanism and wedge mechanism serving to cause spreading apart of jaw members of said gripping and heading mechanisms and closure thereof, crank and link mechanism serving to impart a concurrent rotary movement to said gripping and heading mechanisms, and cam mechanism actuated upon each of said rotary movements to cause also longitudinal movement of said gripping and heading mechanisms.

47. In a spiral pipe machine, the combination with a frame, of a carrier, means for causing a spiral oscillation of said carrier, and gripping and rivet heading mechanism mounted upon said carrier to grip the pipe and to head rivets during such oscillation.

48. In a spiral pipe machine, the combination with a machine frame, of a carrier, means for causing a spiral oscillation of said carrier, gripping and heading mechanism mounted upon said carrier, and wedge and toggle mechanism mounted upon said carrier and adapted to cause the actuation of said gripping and heading mechanism to head rivets and to grip the pipe during such oscillation.

49. In a spiral pipe machine, the combination with a machine frame, of a carrier, means for causing a spiral oscillatory movement of said carrier, gripping and rivet heading mechanism mounted upon said carrier to head rivets and to grip the pipe during such oscillation, and rivet hole punching mechanism mounted upon said machine frame and independent of the motion of said carrier.

50. In a spiral pipe machine, the combination with a machine frame, of a carrier, means for causing a spiral oscillatory movement of said carrier in a direction corresponding with the direction of the seam of the pipe to be formed, gripping and heading mechanism mounted upon said carrier, to head rivets and to grip the pipe during such oscillation, wedge and toggle mechanism for actuating said gripping and rivet heading mechanism, and rivet hole punching mechanism mounted upon said frame and independent of the motion of said carrier.

51. In a spiral pipe machine, the combination with a stationary machine frame, of a carrier rotatably mounted in said frame, mechanism serving to impart to said carrier a combined oscillatory and reciprocal motion, gripping and heading mechanism mounted on said carrier, means for actuating said gripping and heading mechanism in synchronism with the movements of said carrier to head rivets and to grip the pipe, a punch for punching rivet holes mounted directly on said machine frame, and means for actuating said punch in synchronism with the movements of said carrier.

52. In a pipe machine, the combination with means for forming a strip of metal into a pipe, of a bodily traveling riveting and gripping device adapted to rotate and advance said pipe when moved in one direction, and means for automatically releasing said device at the end of its stroke and when moved in the opposite direction, thereby allowing said pipe to retain the position to which it has been thus rotated and advanced.

53. In a pipe machine, the combination of a bodily reciprocating device having inside and complementary outside riveting means, the pipe being gripped during riveting and carried with said device when the device is moved in one direction, and means for releasing said riveting means, thereby allowing said pipe to retain its position when said device reaches the end of its stroke and is moved in the opposite direction.

54. In a pipe machine, the combination with means for forming sheet metal into a pipe, of riveting mechanism, means for causing the mechanism to head the rivets

and to simultaneously grip the pipe, and means for effecting bodily travel of the riveting means with the pipe gripped thereby.

55. In a pipe machine, the combination of a stationary former, a frame reciprocable with reference to the former, gripping jaws bodily carried by said frame for gripping the material of which the pipe is to be formed, means for punching rivet holes through the material, means for feeding rivets between the gripping jaws before said jaws are actuated to grip the material whereby said material is riveted together during the gripping operation to form a pipe, means for causing a forward movement of the frame while said material is gripped by the jaws, whereby the material is drawn through the former to form additional pipe, means for releasing the jaws from the gripping position at the end of the forward movement, and means for returning the frame to its initial position.

56. In a pipe machine, the combination of a former, combined feeding and riveting clamps, means for feeding rivets to the clamps whereby the material for the pipe is riveted when gripped by the clamps, and means for bodily moving the clamps to cause the material to be carried thereby through the former to bring a new section of pipe into the riveting field.

In witness whereof, I hereunto subscribe my name this fourth day of June A. D., 1902.

JAMES HALL TAYLOR.

Witnesses:

HARVEY L. HANSON,

JOHN STAHR.