L. H. BRINKMAN.

TUBE BENDING MACHINE.

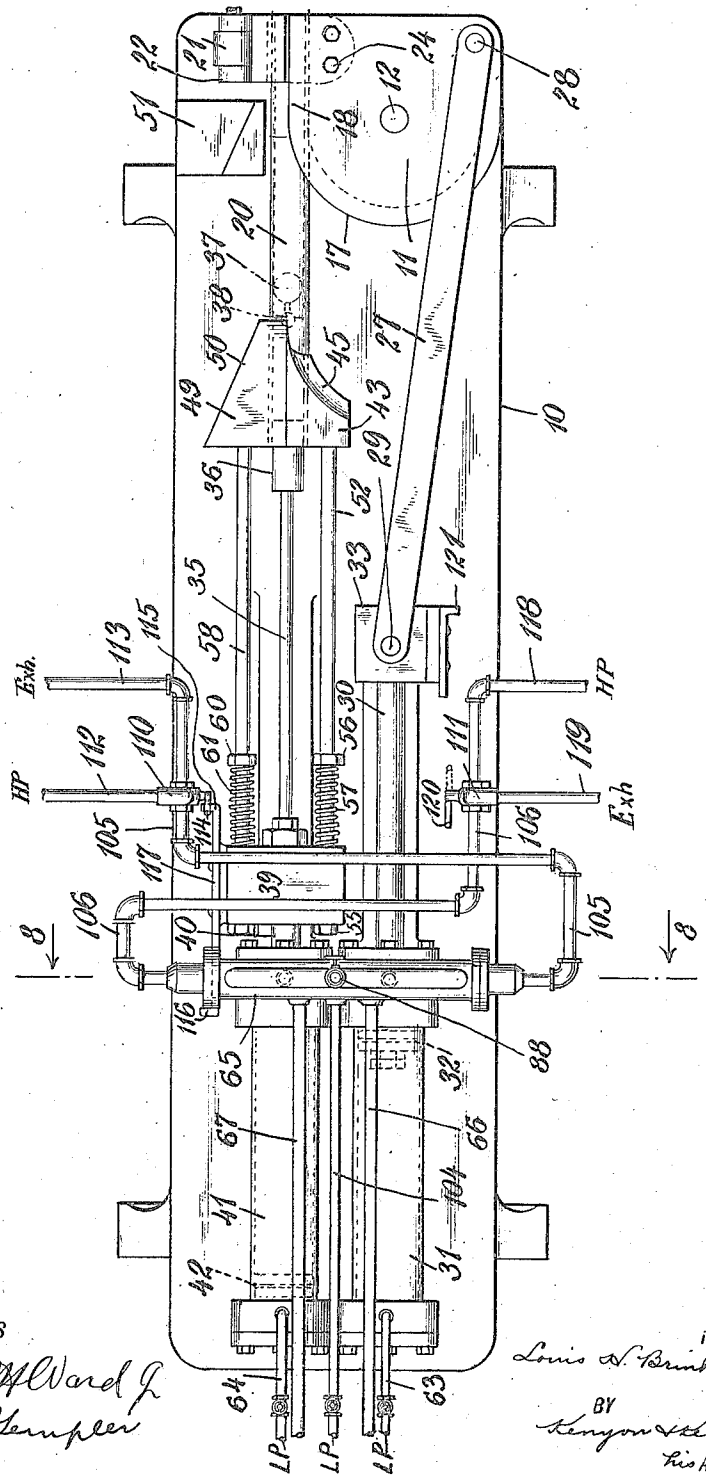
APPLICATION FILED SEPT. 12, 1912.

1,135,875.

Patented Apr. 13, 1915.

4 SHEETS—SHEET 1.

Fig. 1



WITNESSES

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4 SHEETS—SHEET 2.

Fig. 2.

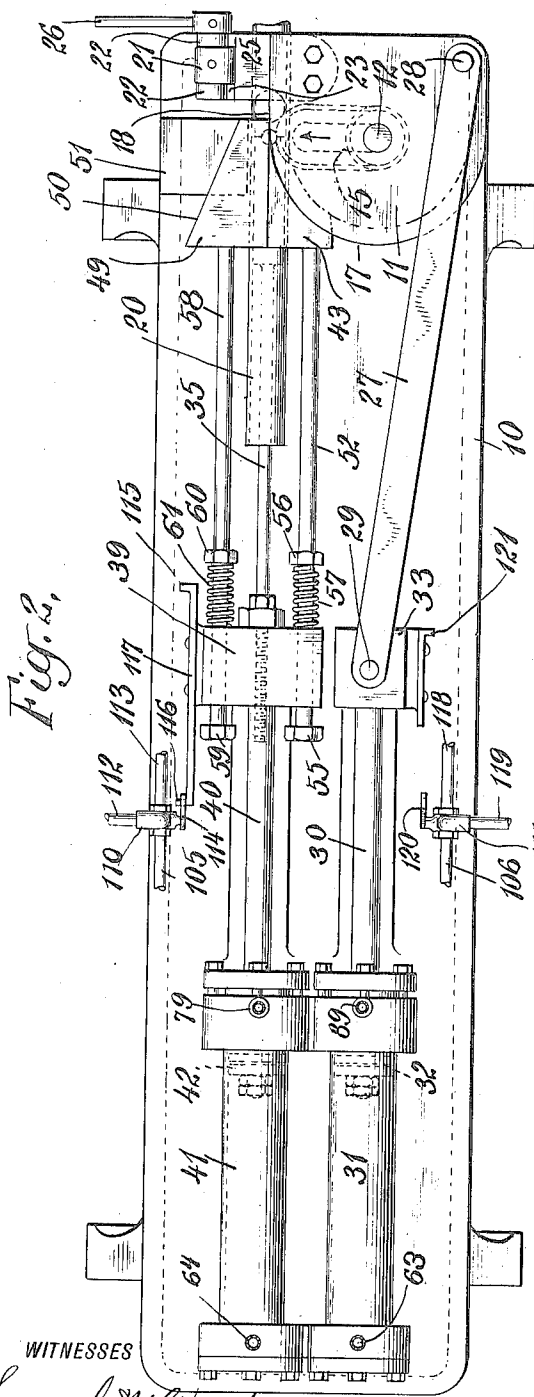
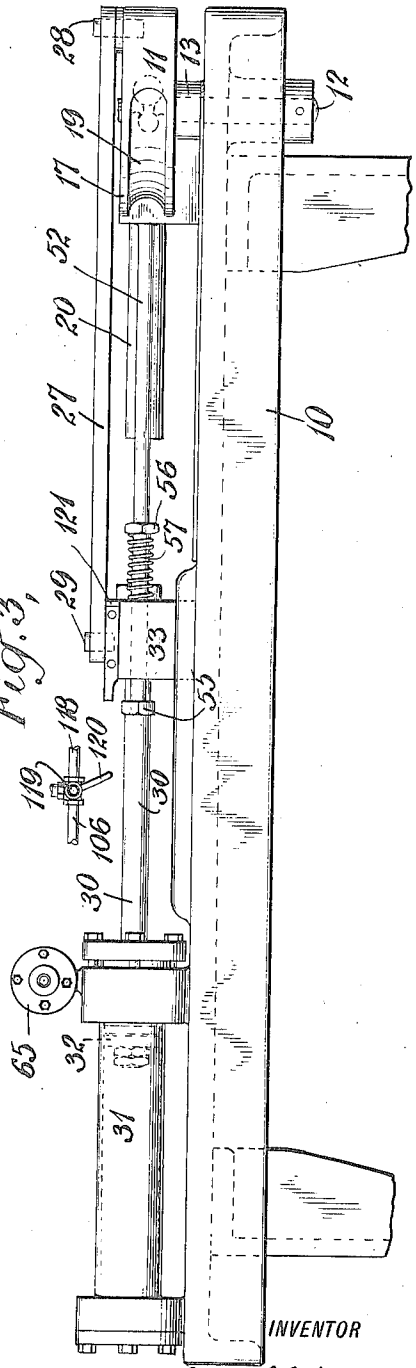


Fig. 3.



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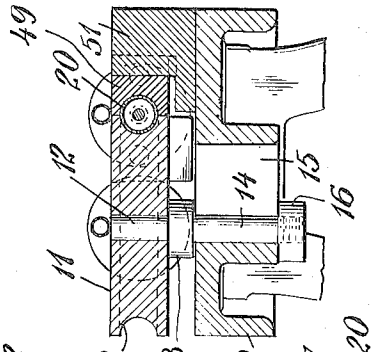


Fig. 5.

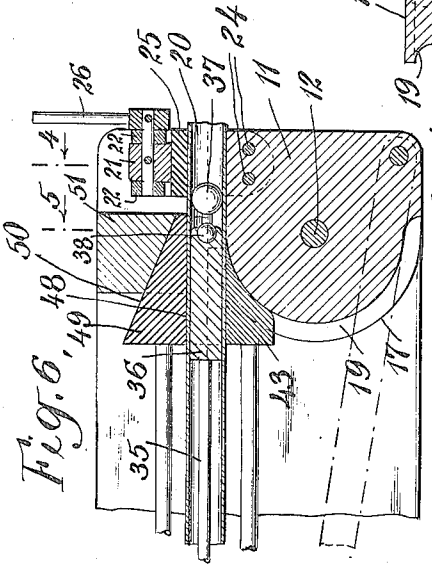


Fig. 6.

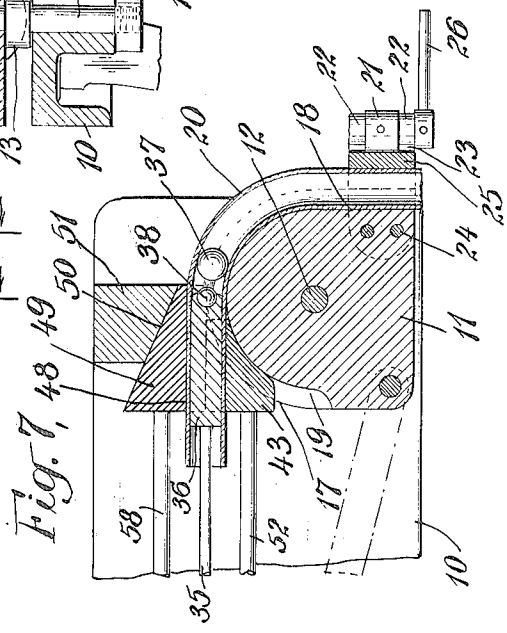


Fig. 7.

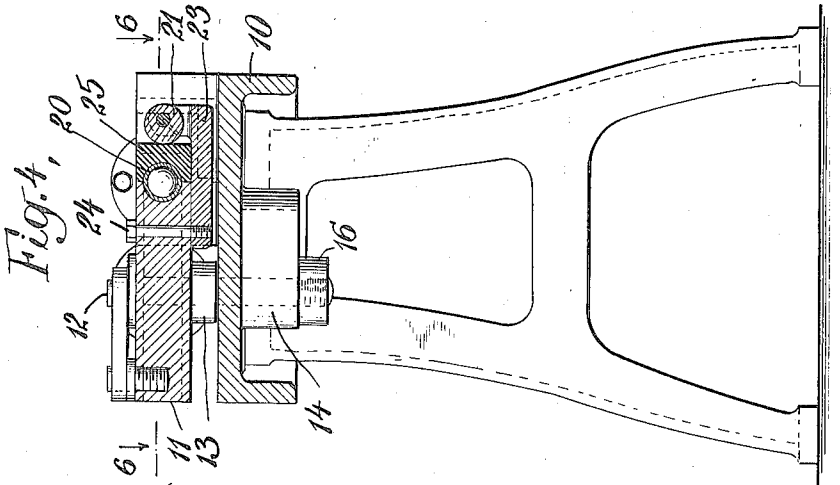


Fig. 4.

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4 SHEETS—SHEET 4.

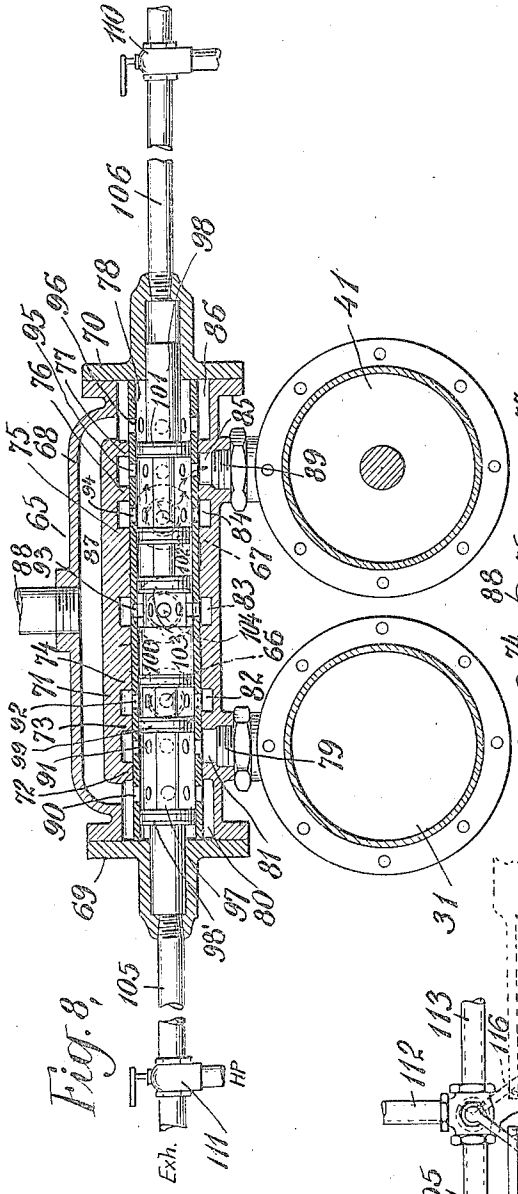


Fig. 8.

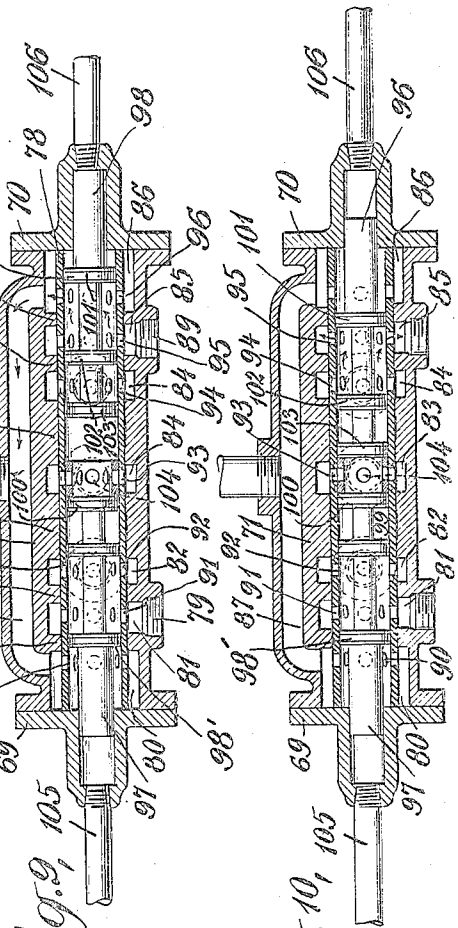


Fig. 9.

Fig. 10.

Fig. 11.

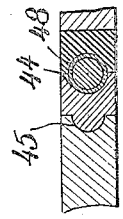


Fig. 12.

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UNITED STATES PATENT OFFICE.

LOUIS H. BRINKMAN, OF GLEN RIDGE, NEW JERSEY, ASSIGNOR TO BALTIMORE TUBE COMPANY, OF BALTIMORE, MARYLAND, A CORPORATION OF MARYLAND.

TUBE-BENDING MACHINE.

1,135,875. Specification of Letters Patent. Patented Apr. 13, 1915.

Application filed September 12, 1912. Serial No. 719,947.

To all whom it may concern:

Be it known that I, LOUIS H. BRINKMAN, a citizen of the United States, and a resident of Glen Ridge, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Tube-Bending Machines, of which the following is a specification.

My invention relates to tube bending machines, and one of the objects of the invention is to provide a durable, efficient and smoothly-operating machine for bending tubes without causing flat spots therein.

Another object of the invention is to provide a tube bending machine which is practically automatic in its cycle of operation, so that it may be readily controlled and operated with little effort or attention on the part of the attendant; and still another object of the invention is to provide a fluid pressure operated machine of the above type embodying fluid pressure operated valve mechanism controlling the fluid pressure to the machine and suitable control devices governing the same in response to movements of the parts of the machine.

The invention will be more readily understood, and further objects of the invention will more fully appear from the following description taken in connection with the accompanying drawings in which—

Figure 1 shows a top plan view of the preferred embodiment of my invention. Fig. 2 is a similar view with certain parts of the control mechanism broken away and with certain parts of the machine in different positions. Fig. 3 is a side elevation of the machine, shown in Figs. 1 and 2, with certain parts broken away. Fig. 4 is a cross-sectional view taken on the line 4—4 of Fig. 6. Fig. 5 is a cross-sectional view taken on line 5—5 of Fig. 6. Fig. 6 is a longitudinal sectional view of a part of the machine, taken on line 6—6 of Fig. 4. Fig. 7 is a similar view showing the parts in their positions after the tube has been bent. Fig. 8 is an enlarged cross-sectional view taken on line 8—8 of Fig. 1, showing the fluid pressure operated valve and control valves governing the same. Fig. 9 and 10 are similar views of the valve mechanism with the movable parts thereof in different positions; and Fig. 11 and 12 show details.

Referring to the drawings, Fig. 1 to 7, 10 is a table or platform on one end of which a former 11 is pivotally mounted on a pin 12 having a collar or annular shoulder 13 above the table 10, upon which collar the former rests, the pin having an extension 14 extending through a transverse slot 15 in the table in which slot the pin is adjustable and is securely held in its adjusted position by means of a nut 16 threaded on the lower end of the pin. This former is the part upon which the tube is to be bent, and in the present machine it has a curved edge 17 and a straight edge 18 tangent thereto; the edges being provided with a groove 19 semi-circular in cross-section, and of the proper size to fit the size of pipe 20 which the machine is intended to operate on.

In order to secure the pipe to the former some suitable means is provided, such for instance, as an eccentric 21 mounted to oscillate in bosses 22 extending upward from a horizontal bracket 23 which is secured by bolts 24 to the former, and on the upper surface of this bracket there is provided a sliding clamping-block 25 having a semi-circular groove to fit the pipe, and against which block the eccentric operates to clamp the tube when handle 26 is turned in the proper direction. It will thus be seen that when the pipe is clamped in position by turning the handle 26, the pipe and clamping mechanism will move with the former. The former is swung back and forth to bend the tube by means of a link 27 pivoted at 28 to the former and at 29 to the head of a piston rod 30 moved back and forth by means of a cylinder 31 and piston 32, the operation of which is preferably controlled as hereinafter explained.

In order to hold the tube firmly in proper alinement from lateral movement, and to prevent it from being mashed out of its proper cross-sectional shape, during the bending operation, and to avoid the formation of flat spots in the tube, the following apparatus is provided: A rod or mandrel 35, preferably having an enlarged front portion 36 of a size to fit within the tube 20, has a ball 37 mounted in its front end by a suitable loose motion connection, such for example, as by a ball-and-socket connection 38. The mandrel 35 is adapted to move back and forth in alinement with the straight edge 18 of the former when the former is in its normal position, and when the mandrel is in its forward position the ball-and-socket

connection 38 should be substantially at center line 5—5 through the pin 12 so that in bending the tube, the ball 37 can tilt or drop beyond this line which passes through the point at which the straight portion of the groove ends and the curved portion commences. The mandrel is secured at its other end to the head 39 of piston rod 40 which is adapted to be moved back and forth by means of cylinder 41 and piston 42. Between the forward end of the mandrel and the curved portion of the former a swiping block 43 is provided, the block having a groove 44 semi-circular in cross-section (Fig. 12) at one side adapted to fit the pipe 20, while the opposite face of the block 45 is made convex so as to provide a good sliding fit with the groove 19 of the former, the swiping block being tapered so as to fit in between the forward end of the mandrel and the former and extend as nearly up to the point of the ball-and-socket connection 38 as it can be safely made to do. The swiping block holds the tube and mandrel firmly from any lateral movement in the direction of the block, and prevents any flattening of the tube on the inner side of the groove when the ball 37 is withdrawn. In order to prevent any lateral movement, or side-thrust of the tube outwardly from the other side of the mandrel, I provide a wedge block 49 also having a semi-circular groove 48 in its face adjacent the mandrel, while the other face of the block 49 is made tapering and is adapted to fit against the sloping surface 50 of a suitable abutment 51 mounted on the table for the purpose of holding the wedge block from lateral movement. As will be seen from the drawings, the wedge block fits snugly in between the sloping surface of this abutment and the adjacent side of the mandrel and extends well up to the line 5—5 to firmly hold the mandrel and tube in position during the bending operation and to permit the withdrawal of the ball 37, after the tube has been bent, without damaging the shape of the pipe.

In the embodiment of the invention shown, the swiping block 43 and the wedge block 47 are operated simultaneously and from the same piston which operates the mandrel, the connection being such as to permit relative movement between the mandrel and these blocks. The swiping block is suitably secured to a rod 52 the rear end of which has a sliding fit with an opening through the piston block 39, and the rod is provided with a head or nut 55 and a second nut 56 between which last nut and the block a compression spring 57 is provided. The wedge block 49 is similarly connected to the piston block by means of a rod 58, nuts 59 and 60 and spring 61. The object of this kind of a connection is to permit the blocks to be held in position adjacent the former until after the mandrel with its ball 37 has been partly retracted or withdrawn from the tube so as to move the ball 37 beyond the curve of the tube into the straight portion thereof to avoid the formation of flat spots in the tubes, heretofore mentioned. It will be seen from this connection that when the piston block 39 is moved forward and the swiping block and mandrel reach their extreme forward position, as the movement of the piston is continued the springs 57 and 61 are compressed, while the mandrel moves farther into the tube to its operative position; hence in the backward movement of the piston to withdraw the mandrel, the piston to which the mandrel is rigidly connected, will be moved back through this distance before the block 39 engages the rear nuts 55 and 59 to move the swiping block and wedge from their position adjacent the mandrel, during which time the springs hold these blocks firmly in position.

In order to operate the machine smoothly and rapidly with little effort or attention on the part of the operator, I provide the machine with the following arrangement and construction of pipes, valve mechanism and controlling devices: The rear end of the cylinders 31, 41 are connected respectively by pipes 63, 64 to a suitable source of fluid pressure, preferably a city water supply, from which pipes fluid pressure is continuously maintained at the rear end of the cylinders during the operation of the machine, while the forward end of the cylinders are connected through suitable valve mechanism 65 respectively to pipes 66 and 67 through which pipes relatively high pressure fluid is conveyed to the forward end of the cylinders through the valve mechanism. The fluid pressure conveyed through these pipes is of sufficiently high pressure to move the pistons against the low pressure fluid continuously applied to the other end of the cylinders.

The valve mechanism 65, as shown in Fig. 1 and 8 to 10 inclusive, consists of a cylindrical shell 68 having suitable end portions 69, 70 and having an inner cylindrical frame 71 with inwardly extending annular projections or flanges 72 to 77 inclusive, which surround and fit against an inner tubular member 78, with which said flanges form chambers 80 to 86 inclusive. Between the outer shell of the valve 68 and the inner frame 71 a suitable exhaust passage-way 87 is provided to which is connected an exhaust pipe 88. The inner tubular member 78 is provided with a series of ports in the form of perforations 90 registering with one end of said passage-way 87 and with similar ports 91 to 95 registering, respectively, with the chambers 81 to 85, and with similar ports 96 registering with the other end of the passage-way 87. The high pressure fluid

pipe 66 connects with valve chamber 82 to supply high pressure fluid through ports 92, 91 and through pipe connection 79 to the forward end of the cylinder 31 when the valve is in the proper position, and high pressure pipe 67 connects with port 84 to supply fluid pressure through ports 94, 95 and connections 89 to the forward end of cylinder 41 when the valve mechanism is in the proper position, while the exhaust pipe 88 connecting with passage way 87 conveys high pressure fluid from the forward end of the cylinders through the ports 91, 90, 96 and 95 and through passage way 87.

To control the admission and exhaust of the high pressure fluid through these pipes to and from the cylinders, the inner tubular member is provided with two separately sliding rods 97 and 98, the rod 97 having three pistons or rings 98', 99 and 100 mounted thereon, while the rod 98 is provided with similar rings 101, 102 and 103. These rings fit snugly within the inner tubular member 78 so as to control the flow of fluid through its ports. The sliding rods 97 and 98 carrying these rings are normally held at their outer positions in the tube by means of relatively low pressure fluid continuously applied to the inner rings through pipe 104, valve chamber 83 and ports 93; the source of fluid pressure being preferably the same as that applied to pipes 63 and 64 for operating on the low pressure side of the cylinders. The outer ends of these sliding rods extend into the heads 69 and 70 of the valve to which are respectively connected pipes 105 and 106 for conveying relatively high pressure fluid to the other ends of the rods to force them to their inner positions against the normally applied low pressure fluid admitted through ports 93.

Fig. 8 shows the sliding rod 97 of the valve mechanism in position to exhaust high pressure fluid from the forward end of the cylinder 31 to permit the low pressure fluid at the rear of the piston 32 to move it forward to return the former to its normal position, while sliding rod 98 is shown in its position for admitting high pressure fluid from pipe 67 into the forward end of cylinder 41 to force the piston 42 backward against the low pressure fluid for withdrawing the mandrel and blocks. In other words, Fig. 8 shows these rods in their positions when the movable parts of the machine are in the positions shown in Fig. 1.

Fig. 9 shows sliding rod 97 in its position for admitting high pressure fluid from pipe 66 to the forward end of cylinder 31 to swing the former to bend the tube, while rod 98 is shown in its position for exhausting high pressure fluid from the forward end of cylinder 41 to move the mandrel forward. In other words, the sliding rods of the valve mechanism are shown in their positions when the mandrel, swiping block and wedge are in their forward positions, with the former being swung to bend the tube.

Fig. 10 shows the sliding rods in their inner positions at which high pressure is being admitted to the forward end of each of the cylinders 31 and 41. In other words, the rods are shown in their positions at which the former is being held in its operative position after bending the tube, with the mandrel, swiping block and wedge being retracted therefrom.

As far as certain features of my invention are concerned, any suitable means may be provided for controlling the valve mechanism 65, but in the embodiment of the invention shown, the high pressure fluid to the valve mechanism is controlled by means of what may be termed master control devices in the form of valves 110 and 111 connected respectively to pipes 105 and 106. These valves are two-way valves, the valve 110 having a port connected to pipe 105, a port connected to pipe 112 leading to a suitable source of high pressure fluid, and a port connected to an exhaust pipe 113. The valve is operated by a suitable lever 114 which, in the embodiment of the invention shown, extends down into a position to be engaged by suitable projections 115 and 116 extending laterally from a bar 117 secured to the sliding piston block 39. Valve 111 is similarly connected with pipe 106 and with pipe 118 leading to a suitable source of high pressure, and to an exhaust pipe 119; and this valve is provided with an operating lever 120 extending down into the path of movement of a lateral projection 121 secured to the sliding piston block, the object being to actuate these control valves in response to movements of the former and mandrel in such manner as to make the machine automatic in its cycle of movements after the operator has thrown the lever of control valve 111 in position to start the mandrel forward.

The operation of the embodiment of the invention above described is as follows:— With the movable parts of the machine in the positions shown in Fig. 1, the pipe 20 is threaded over the mandrel and securely clamped to the former 11. Low pressure fluid is now applied to the rear ends of the cylinders and through pipe 104, to the inner ends of the sliding rods of the valve mechanism 65, and with the lever of the control valve 110, in the position shown in Fig. 1, to exhaust the high pressure fluid through pipe 105, and with the lever of valve 111, in the position shown in full lines in Fig. 1, to admit high pressure through pipe 106, the sliding rods of valve 65 will be as shown in Fig. 8, in which position the forward end of cylinder 31 is connected to the exhaust pipe so that the low pressure

at the rear of the piston 32 holds the former in the position shown in Fig. 1; while high pressure fluid is admitted to the forward end of cylinder 41 to hold the piston 42 operating the mandrel in its rearmost position against the low pressure fluid to hold the mandrel, swiping block and wedge retracted. Under this condition, to start the machine, the operator throws lever 120 of control valve 111 to the dotted line position shown in Fig. 1, whereupon the high pressure fluid in pipe 106 leading to the valve mechanism is exhausted through pipe 119 permitting the relatively low pressure fluid at the inner end of sliding rod 98 to move the rod outward into the position shown in Fig. 9, at which point high pressure fluid from pipe 67 is cut off and the pressure in the end of cylinder 41 is allowed to exhaust through connection 89, ports 95 and 96 to pipe 88, whereupon the low pressure fluid at the rear end of piston 42 will move the piston, swiping block and mandrel into their forward positions adjacent the former, relative movement being provided between the mandrel on the one hand, and the swiping block and wedge on the other, as heretofore described.

When the piston is moved to its forward position projection 116 engages valve lever 114 to throw it in position to admit high pressure fluid from pipe 112 through pipe 105 to the valve mechanism 65; whereupon sliding rod 97 is moved against the low pressure fluid to its inner position shown in Fig. 9, at which position high pressure fluid is admitted from pipe 66 through ports 92, 91 and connection 79 to the forward end of cylinder 31 to move piston 32 backward against the low pressure fluid, swinging the former to bend the tube; the former, mandrel, swiping block and wedge now being in the position shown in Fig. 7, and the valve mechanism being in the position shown in Fig. 9. As the piston 32 reaches its rearmost position, when swinging the former to bend the tube, projection 121 on sliding block 33, engages lever 120 of valve 111 to throw it in position to admit high pressure from pipe 119 through pipe 106 to the outer end of sliding rod 98 to move it against the low pressure fluid into its position shown in Fig. 10, whereupon high pressure fluid is again admitted from pipe 67 to the forward end of cylinder 41 to move piston 42 backward to retract the mandrel, swiping block and wedge; the swiping block and wedge remaining in position adjacent the former until the mandrel has been partly retracted, as heretofore explained, as a result of the sliding connections and springs. When the piston 42 has reached its rear position, the projection 115 engages lever 114 of valve 110 to swing it back into its normal position to connect pipe 105 with exhaust pipe 113 so as to permit the sliding rod 97 of valve mechanism 65 to assume its normal position, shown in Fig. 8, at which position high pressure fluid is exhausted from the forward end of cylinder 31, and the low pressure fluid at the rear of the cylinder will again move the piston forward to return the former to its normal position, shown in Fig. 1. This completes the cycle of movements and the machine is now in position to have the bent tube unclamped and a second tube clamped to the former. It will thus be seen that the operator has only to throw the lever of control valve 111, whereupon the entire cycle of movements of the machine is automatic, and yet the machine is under the complete control of the operator.

While I have described my invention with particularity in connection with the preferred and most complete embodiment thereof, it will be obvious to those skilled in the art that various modifications as to the arrangement and construction of parts, and additions and substitutions of various parts may be made, without departing from the scope and spirit of my invention.

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

1. In a tube bending machine, the combination of a former on which the tube is to be bent, a mandrel for the tube, a swiping block and a wedge one on either side of the mandrel adapted to be moved adjacent the former, means for producing relative angular movement between the mandrel, swiping block and wedge on the one hand, and the former on the other hand, to bend the tube, and means for partly withdrawing the mandrel from the tube while the swiping block and wedge remain in position adjacent the former.

2. In a tube bending machine, the combination of a former on which the tube is to be bent, a mandrel for the tube adapted to be moved into position adjacent the former, a swiping block and wedge one on either side of the mandrel adapted to be moved into position adjacent the former, means for swinging the former to draw the tube over the mandrel, and means for partly withdrawing the mandrel from the tube while the swiping block and wedge remain in position adjacent the former.

3. In a tube bending machine, the combination of a pivoted former on which the tube is to be bent, a mandrel for the tube adapted to be moved into position adjacent the former and having a ball loosely connected to the end thereof, a swiping block adapted to fit in between the front end of the former and the mandrel, a wedge on the other side of the mandrel, and means for holding the block and wedge in position until the mandrel has been withdrawn from the former far enough to draw the ball past

the bend of the tube when bent so as to prevent the bend of the tube being flattened in withdrawing the ball.

4. In a tube bending machine, the combination of a pivoted former with means for securing a tube thereto, a mandrel for the tube adapted to be moved into position adjacent the former and having a ball loosely connected to the end thereof, a swiping block adapted to fit in between the front end of the former and the mandrel, a wedge on the other side of the mandrel, a support against which the wedge is adapted to be moved to hold the wedge from lateral movement away from the mandrel, and means for holding the block and wedge in position until the mandrel has been withdrawn far enough to draw the ball past the bend in the tube when bent so as to prevent the bend of the tube being flattened in withdrawing the ball.

5. In a tube bending machine, the combination of a mandrel for a tube, a former on which the tube is to be bent, a swiping block adapted to fit between the mandrel and the former, a wedge on the other side of the mandrel, means for producing relative movement between the former on one hand and the block, wedge and mandrel on the other, in the general direction of the mandrel, and means for producing relative angular movement between the block, wedge and mandrel on the one hand, and the former on the other, to bend the tube.

6. In a tube bending machine, the combination of a mandrel for a tube, a former on which the tube is to be bent, a swiping block adapted to fit between the mandrel and the former, a wedge on the other side of the mandrel, means for moving the block and wedge back and forth along the general direction of the mandrel, and means for swinging the former to bend the tube.

7. In a tube bending machine, the combination of a pivoted former, said former having a groove along its edge comprising a curved portion and a straight portion tangent to the curved portion, a mandrel for the tube movable back and forth in register with the straight portion of the groove when the former is in its normal position, a swiping block movable back and forth along the general direction of the mandrel and adapted to fit in between the mandrel and the curved portion of the groove in the former and having a groove for the tube in alinement with the straight portion of the groove of the former, a wedge also movable along the general direction of the mandrel and also having a groove for the tube, said wedge being adapted to fit on the other side of the mandrel from the swiping block, means for holding the swiping block, wedge and mandrel in position, and means for swinging the former to bend the tube.

8. In a tube bending machine, the combination of a pivoted former, said former having a groove along its edge comprising a curved portion and a straight portion tangent to the curved portion, a mandrel for the tube movable back and forth in register with the straight portion of the groove when the former is in its normal position, a movable swiping block adapted to fit in between the mandrel and the curved portion of the groove of the former and having a groove for the tube in alinement with the straight portion of the groove of the former, a movable wedge also having a groove for the tube and adapted to fit on the other side of the mandrel from the swiping block, means for moving the mandrel, swiping block and wedge toward and away from the former, said means including means for permitting relative movement between the mandrel on the one hand and the block and wedge on the other when adjacent the former.

9. In a tube bending machine, the combination of a pivoted former, said former having a groove along its edge comprising a curved portion and a straight portion tangent to the curved portion, a mandrel for the tube movable back and forth in register with the straight portion of the groove when the former is in its normal position, a movable swiping block adapted to fit in between the mandrel and the curved portion of the groove of the former and having a groove for the tube in alinement with the straight portion of the groove of the former, a movable wedge also having a groove for the tube and adapted to fit on the other side of the mandrel from the swiping block, means for moving the mandrel, swiping block and wedge toward and away from the former, said means including means for permitting relative movement between the mandrel on the one hand and the swiping block and wedge on the other when adjacent the former, means for adjusting the former toward and from the line of movement of the mandrel, a guide against which the wedge is adapted to fit to hold it against lateral movement, means for swinging the former to bend the tube, and means for securing the tube to the former.

10. In a tube bending machine, the combination of a former on which the tube is to be bent, a mandrel for the tube adapted to be moved into position adjacent the former, a swiping block and wedge one on either side of the mandrel adapted to be moved into position adjacent the former, means including a cylinder and a fluid pressure operated piston for swinging the former to bend the tube thereon, and means including a cylinder and fluid pressure operated piston for moving the swiping block and wedge into position adjacent the former.

11. In a tube bending machine, the combination of a former on which the tube is to be bent, a mandrel for the tube adapted to be moved into position adjacent the former, a swiping block on one side of the mandrel adapted to be moved into position adjacent the former, means for swinging the former to bend the tube thereon, means for moving the mandrel into and out of position adjacent the former, and means operatively connecting said last means and said swiping block to move the swiping block from its position adjacent the former after the mandrel has been partly withdrawn.

12. In a tube bending machine, the combination of a former on which the tube is to be bent, a mandrel for the tube adapted to be moved into position adjacent the former, a swiping block and wedge one on either side of the mandrel adapted to be moved into position adjacent the former, means for swinging the former to bend the tube thereon, means for moving the mandrel into and out of position adjacent the former, and means operatively connecting said last means and said swiping block and wedge to move the swiping block and wedge from their position adjacent the former after the mandrel has been partly withdrawn.

13. In a tube bending machine, the combination of a former on which the tube is to be bent, a mandrel for the tube adapted to be moved into position adjacent the former, a swiping block and wedge one on either side of the mandrel adapted to be moved into position adjacent the former, means for swinging the former to bend the tube thereon, and means for holding the swiping block and wedge in position adjacent the former until the mandrel is partly withdrawn.

14. In a tube bending machine, the combination of a former on which the tube is to be bent, a mandrel for the tube adapted to be moved into position adjacent the former, a swiping block and wedge one on either side of the mandrel adapted to be moved into position adjacent the former, means for swinging the former to bend the tube thereon, and means with which the mandrel, swiping block and wedge are connected for moving them into position adjacent the former.

15. In a tube bending machine, the combination of a former on which the tube is to be bent, a mandrel for the tube adapted to be moved into position adjacent the former, a swiping block and wedge one on either side of the mandrel adapted to be moved into position adjacent the former, means including a cylinder and a fluid pressure operative piston for swinging the former to bend the tube thereon, and means including a cylinder and fluid pressure operative piston with which the mandrel, swiping block and wedge are connected for moving them into and out of position adjacent the former, said last means including means for holding the swiping block and wedge into position adjacent the former until the mandrel is partly withdrawn.

16. In a tube bending machine, the combination of a former on which the tube is to be bent, a mandrel for the tube adapted to be moved into position adjacent the former, a swiping block and wedge one on either side of the mandrel adapted to be moved into position adjacent the former, means for swinging the former to bend the tube thereon, means for moving the mandrel into and out of position adjacent the former, and means operatively related to said means and said swiping block and wedge so as to move the swiping block and wedge into position adjacent the former in advance of the mandrel and to withdraw them after the mandrel has been partly withdrawn.

17. In a tube bending machine, the combination of a former on which the tube is to be bent, a mandrel for the tube adapted to be moved into position adjacent the former, a swiping block and wedge one on either side of the mandrel adapted to be moved into position adjacent the former, means including a cylinder and fluid pressure operative piston for swinging the former to bend the tube thereon, means including a cylinder and fluid pressure operative piston for moving the mandrel into and out of position adjacent the former, and means connecting said last means and said swiping block for moving the swiping block from its position adjacent the former after the mandrel has been partly withdrawn.

18. In a tube bending machine, the combination of a former on which the tube is to be bent, a mandrel for the tube adapted to be moved into position adjacent the former, a swiping block and wedge one on either side of the mandrel adapted to be moved into position adjacent the former, means including a cylinder and fluid pressure operative piston for swinging the former to bend the tube thereon, and means including a cylinder and fluid pressure operative piston for moving the mandrel and swiping block into position adjacent the former, said last means including means for holding the swiping block into position adjacent the former until the mandrel is partly withdrawn.

19. In a tube bending machine, the combination of a former on which the tube is to be bent, a mandrel for the tube adapted to be moved into position adjacent the former, a swiping block and wedge one on either side of the mandrel adapted to be moved into position adjacent the former, means for swinging the former to bend the tube thereon, means including a rod for moving the mandrel into and out of position adjacent

the former, rods for operating the swiping block and wedge, said last rods having a sliding connection with the mandrel rod, and means operatively related with the three rods for holding the sliding block and wedge in position adjacent the former until the mandrel is partly withdrawn.

20. In a tube bending machine, the combination of a former, a mandrel for the tube, means including a cylinder and fluid pressure operated piston for swinging the former to draw the tube over the mandrel and bend it, means including a cylinder and fluid pressure operated piston for moving the mandrel into and out of position adjacent the former, fluid pressure conveying pipes leading to said cylinders, valve mechanism connected with said pipes, and means controlling said valve mechanism for admitting and exhausting fluid through said pipes to swing the former to bend the tube and then retract the mandrel from the tube.

21. In a tube bending machine, the combination of a former, a mandrel for the tube, means including a cylinder and fluid pressure operated piston for swinging the former to draw the tube over the mandrel and bend it, means including a cylinder and fluid pressure operated piston for moving the mandrel into and out of position adjacent the former, fluid pressure conveying pipes leading to said cylinders, fluid pressure operated valve mechanism connected with said pipes, for admitting and exhausting fluid therethrough and pipes for conveying fluid pressure to said valve mechanism for operating the same to swing the former to bend the tube and then retract the mandrel from the tube.

22. In a tube bending machine, the combination of a former, a mandrel for the tube, means including a cylinder and fluid pressure operated piston for swinging the former to draw the tube over the mandrel and bend it, means including a cylinder and fluid pressure operated piston for moving the mandrel into and out of position adjacent the former, fluid pressure conveying pipes leading to said cylinders, fluid pressure operated valve mechanism connected with said pipes, and means including fluid pressure conveying pipes connected with said valve mechanism and valves connected therewith for controlling the valve mechanism to operate the mandrel and former.

23. In a tube bending machine, the combination of a former, a mandrel for the tube, means including a cylinder and fluid pressure operated piston for swinging the former to draw the tube over the mandrel and bend it, means including a cylinder and fluid pressure operated piston for moving the mandrel into and out of position adjacent the former, fluid pressure conveying pipes leading to said cylinders, valve mechanism connected with said pipes, means controlling said valve mechanism for admitting and exhausting fluid through said pipes to operate the mandrel and former, and means operatively relating said valve mechanism and pistons through which means the valve mechanism is controlled to operate in response to movements of the pistons.

24. In a tube bending machine, the combination of a former, a mandrel for the tube, means including a cylinder and fluid pressure operated piston for swinging the former to draw the tube over the mandrel and bend it, means including a cylinder and fluid pressure operated piston for moving the mandrel into and out of position adjacent the former, fluid pressure conveying pipes leading to said cylinders, fluid pressure operated valve mechanism connected with said pipes for admitting and exhausting fluid pressure through said pipes to operate the mandrel and former, fluid pressure conveying pipes connected with said valve mechanism, master control valves connected with said pipes and means operatively relating said master control valves and pistons for causing the actuation of the fluid pressure operated valve mechanism in response to movements of the pistons.

25. In a tube bending machine, the combination of a former, a mandrel for the tube, means including a cylinder and fluid pressure operated piston for swinging the former to draw the tube over the mandrel and bend it, means including a cylinder and fluid pressure operated piston for moving the mandrel into and out of position adjacent the former, fluid pressure conveying pipes leading to said cylinders, valve mechanism connected with said pipes for admitting and exhausting fluid pressure through said pipes, control devices operatively connected with said valve mechanism for controlling the valve mechanism to operate the mandrel and former, and parts connected with the pistons and movable therewith to engage the control devices to operate them when the pistons are moved.

26. In a tube bending machine, the combination of a former, a mandrel for the tube, means including a cylinder and fluid pressure operated piston for swinging the former to draw the tube over the mandrel and bend it, means including a cylinder and fluid pressure operated piston for moving the mandrel into and out of position adjacent the former, fluid pressure conveying pipes leading to said cylinders, motive power operated valve mechanism connected with said pipes for controlling the movements of the mandrel and former, valve control devices operatively connected with said valve mechanism for controlling the application of power thereto, means operatively relating one of said devices with the piston operat-

ing the mandrel to admit power to the valve mechanism, when the mandrel has been moved forward, for moving said mechanism into position to admit fluid to the former operating piston for swinging the former, and means operatively relating the other control device to the piston of the former to admit fluid pressure to the valve mechanism when the former has been swung, for moving said valve mechanism into position to admit fluid pressure to the mandrel operating piston for retracting the mandrel.

27. In a tube bending machine, the combination of a former, a mandrel for the tube, means including a cylinder and fluid pressure operated piston for swinging the former to draw the tube over the mandrel and bend it, means including a cylinder and fluid pressure operated piston for moving the mandrel into and out of position adjacent the former, fluid pressure conveying pipes leading to said cylinders, valve mechanism connected with said pipes, means controlling said valve mechanism for admitting and exhausting fluid through said pipes to operate the mandrel and former, said valve mechanism being normally moved to its position for exhausting fluid pressure through the pipes from one end of the cylinders and pistons operating the former and mandrel, and means controlling said valve mechanism for admitting fluid pressure to said ends of the cylinders to swing the former and retract the mandrel.

28. In a tube bending machine, the combination of a former, a mandrel for the tube, means including a cylinder and fluid pressure operated piston for swinging the former to draw the tube over the mandrel and bend it, means including a cylinder and fluid pressure operated piston for moving the mandrel into and out of position adjacent the former, fluid pressure conveying pipes leading to said cylinders, valve mechanism having ports connected with said pipes and having a plurality of movable parts controlling the admission and exhaustion of fluid therethrough, means conveying fluid pressure to said valve mechanism to continuously exert pressure against said movable parts thereof to move them in positions to exhaust fluid pressure through the pipes from one end of the cylinders, and means controlling said movable parts to move them into positions for admitting fluid pressure to said ends of the cylinders to swing the former and retract the mandrel.

29. In a tube bending machine, the combination of a former, a mandrel for the tube, means including a cylinder and fluid pressure operated piston for swinging the former to draw the tube over the mandrel and bend it, means including a cylinder and fluid pressure operated piston for moving the mandrel into and out of position adjacent the former, fluid pressure conveying pipes leading to said cylinders, valve mechanism having ports connected with said pipes and having a plurality of movable parts controlling the admission and exhaustion of fluid therethrough, means conveying fluid pressure to said valve mechanism to continuously exert pressure against said movable parts thereof to move them in positions to exhaust fluid pressure through the pipes from one end of the cylinders, means including pipes with control valves therein for applying relatively high pressure fluid to the movable parts of the said valve mechanism for admitting fluid pressure to said ends of the cylinders to swing the former and retract the mandrel.

30. In a tube bending machine, the combination of a former, a mandrel for the tube, means including a cylinder and fluid pressure operated piston for swinging the former to draw the tube over the mandrel and bend it, means including a cylinder and fluid pressure operated piston for moving the mandrel into and out of position adjacent the former, fluid pressure conveying pipes leading to said cylinders, valve mechanism having ports connected with said pipes and having a plurality of movable parts controlling the admission and exhaustion of fluid therethrough, means conveying fluid pressure to said valve mechanism to continuously exert pressure against said movable parts thereof to move them in positions to exhaust fluid pressure through the pipes from one end of the cylinders, means including pipes with control valves therein for applying relatively high pressure fluid to the movable parts of the said valve mechanism for admitting fluid pressure to said ends of the cylinders to swing the former and retract the mandrel, means operatively relating one of said control valves with the mandrel to control said valve by movements of the mandrel, and means operatively relating the other control valve with the former to control said last valve by movements of the former.

31. In a tube bending machine, the combination of a former, a mandrel for the tube, means including a cylinder and fluid pressure operated piston for swinging the former to draw the tube over the mandrel and bend it, means including a cylinder and fluid pressure operated piston for moving the mandrel into and out of position adjacent the former, pipes for conveying fluid pressure to one end of the cylinders, pipes for conveying relatively high pressure fluid to the other end of the cylinders, valve mechanism connected with said last pipes, and means controlling said valve mechanism to admit high pressure fluid to the cylinders for moving the pistons against the low pressure fluid and for exhausting said high pressure fluid

from the cylinders to permit the return of the pistons by the low pressure fluid.

32. In a tube bending machine, the combination of a former, a mandrel for the tube, means including a cylinder and fluid pressure operated piston for swinging the former to draw the tube over the mandrel and bend it, means including a cylinder and fluid pressure operated piston for moving the mandrel into and out of position adjacent the former, pipes for conveying fluid pressure to one end of the cylinders continuously during the operation of the machine to move the mandrel and former, pipes for conveying relatively high pressure fluid to the other end of the cylinders for moving the mandrel and former against the relatively low pressure fluid, valve mechanism controlling said last pipes, said valve mechanism being normally moved to its position to exhaust the high pressure fluid from said cylinders, to permit the low pressure fluid to move the pistons, and means controlling said valve mechanism to admit said high pressure fluid to the cylinders to move the pistons against the low pressure fluid.

33. In a tube bending machine, the combination of a former, a mandrel for the tube, means including a cylinder and fluid pressure operated piston for swinging the former to draw the tube over the mandrel and bend it, means including a cylinder and fluid pressure operated piston for moving the mandrel into and out of position adjacent the former, pipes for conveying fluid pressure to one end of the cylinders continuously during the operation of the machine to move the mandrel and former, pipes for conveying relatively high pressure fluid to the other end of the cylinders for moving the mandrel and former against the relatively low pressure fluid, valve mechanism having ports connected to said last pipes and having two movable parts controlling said ports, means for continuously applying power to said parts during the operation of the machine to move them in positions for exhausting the high pressure fluid from the cylinders to permit the pistons to be moved by the low pressure fluid, and means for applying power to said movable parts to move them into positions for admitting the relatively high pressure fluid to the cylinders to move the piston against the low pressure fluid.

34. In a tube bending machine, the combination of a former, a mandrel for the tube, means including a cylinder and fluid pressure operated piston for swinging the former to draw the tube over the mandrel and bend it, means including a cylinder and fluid pressure operated piston for moving the mandrel into and out of position adjacent the former, pipes for conveying fluid pressure to one end of the cylinders continuously during the operation of the machine to move the mandrel and former, pipes for conveying relatively high pressure fluid to the other end of the cylinders for moving the mandrel and former against the relatively low pressure fluid, valve mechanism having ports connected to said last pipes and having two movable parts controlling said ports, means for continuously applying power to said parts during the operation of the machine to move them in positions for exhausting the high pressure fluid from the cylinders to permit the pistons to be moved by the low pressure fluid, means operatively relating said movable parts of the valve mechanism with the mandrel and former to cause said parts to be moved in response to movements of the mandrel and former.

35. In a tube bending machine, the combination of a former, a mandrel for the tube, means including a cylinder and fluid pressure operated piston for swinging the former to draw the tube over the mandrel and bend it, means including a cylinder and fluid pressure operated piston for moving the mandrel into and out of position adjacent the former, pipes for conveying fluid pressure to one end of the cylinders continuously during the operation of the machine, pipes for conveying relatively high pressure fluid to the opposite end of the cylinders, valve mechanism having ports connected with said last pipes and having a plurality of movable parts controlling the admission and exhaust of fluid therethrough, means conveying fluid pressure to said valve mechanism to continuously exert pressure against said movable parts thereof to move them in positions to exhaust high pressure fluid through the pipes from one end of the cylinders to permit the pistons to be moved by the low pressure fluid, and means including pipes with control valves therein for applying relatively high pressure fluid to the movable parts in said valve mechanism to move them in positions to admit the high pressure fluid to the cylinders to move the pistons against the low pressure fluid to swing the former and retract the mandrel.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

LOUIS H. BRINKMAN.

Witnesses:

SAMUEL M. WARD, JR.,

EDWIN SEGER.