No. 611,222. Patented Sept. 20, 1898.

E. E. RIES.

METHOD OF AND MEANS FOR MANUFACTURING METAL TUBING.

(Application filed Jan. 18, 1896.)

(No Model.) 3 Sheets—Sheet 1.

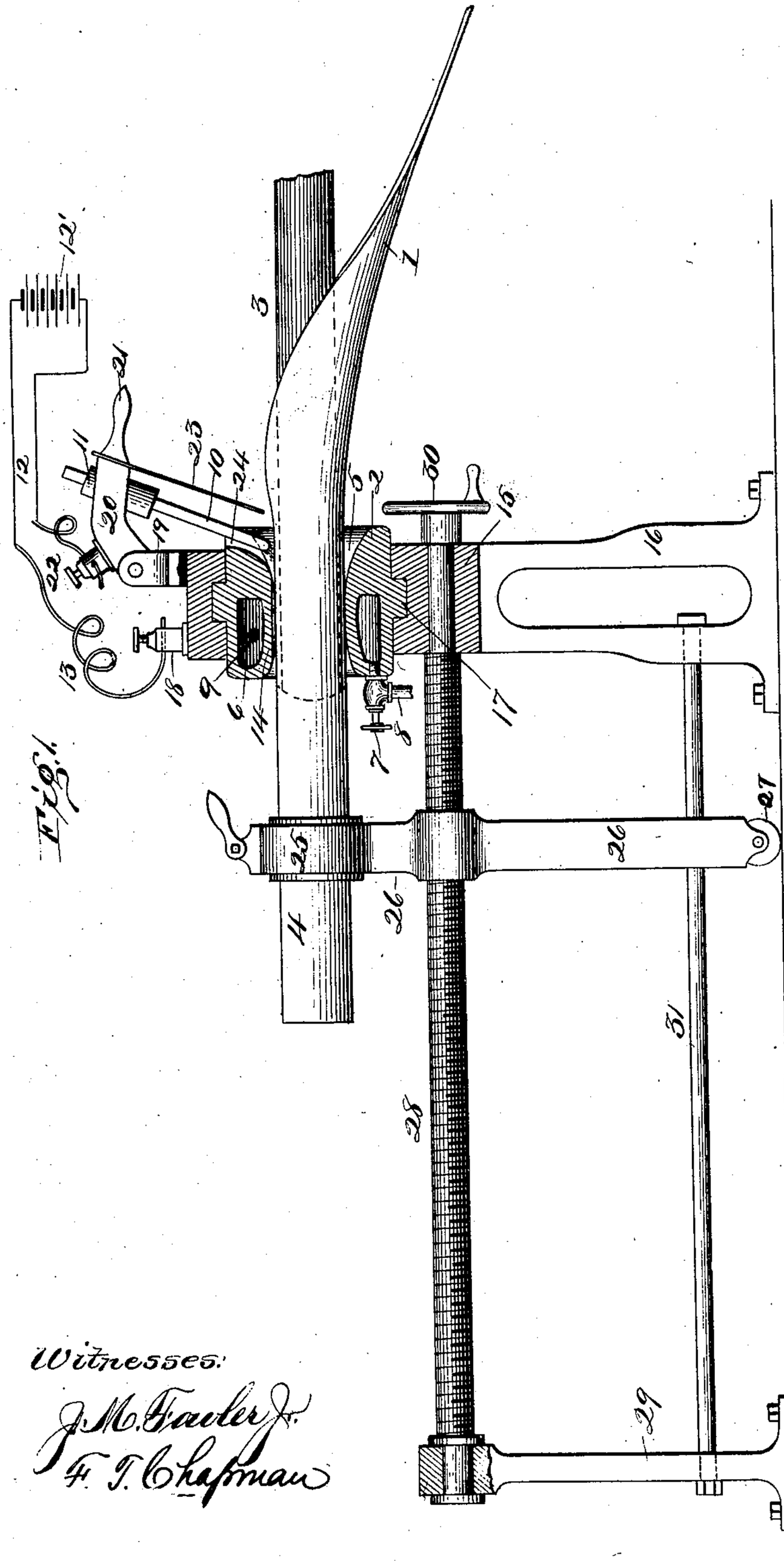

Fig. 1.

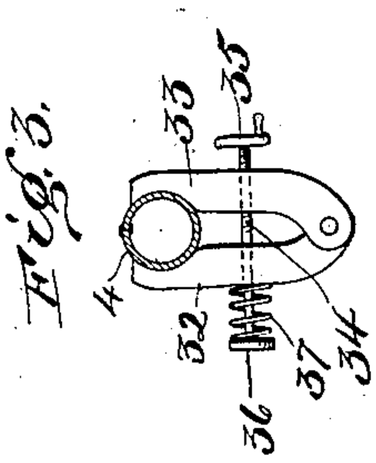

Fig. 3.

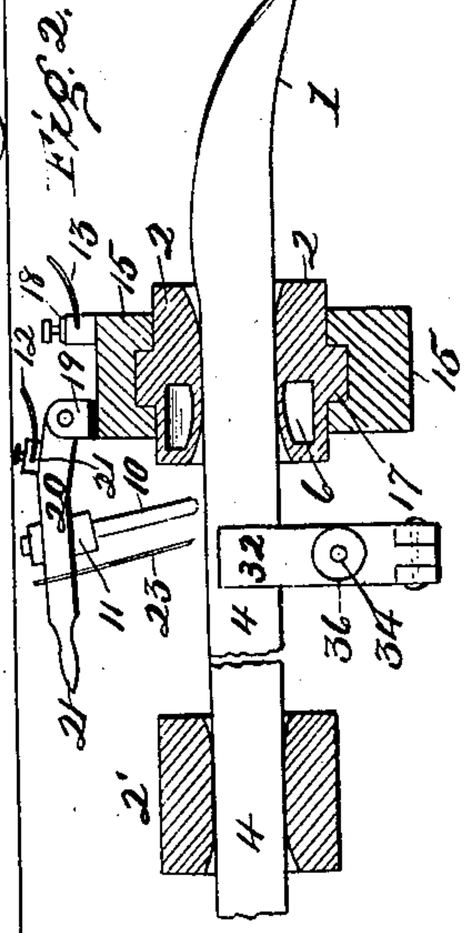

Fig. 2.

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(No Model.) 3 Sheets—Sheet 2.

Fig. 4.

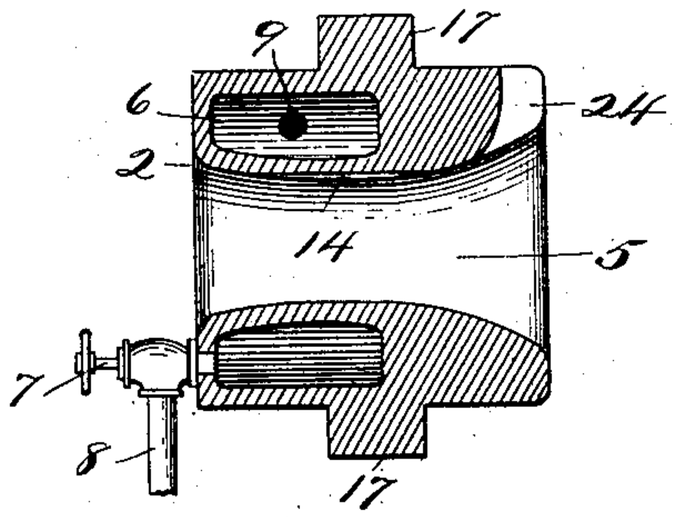


Fig. 5.

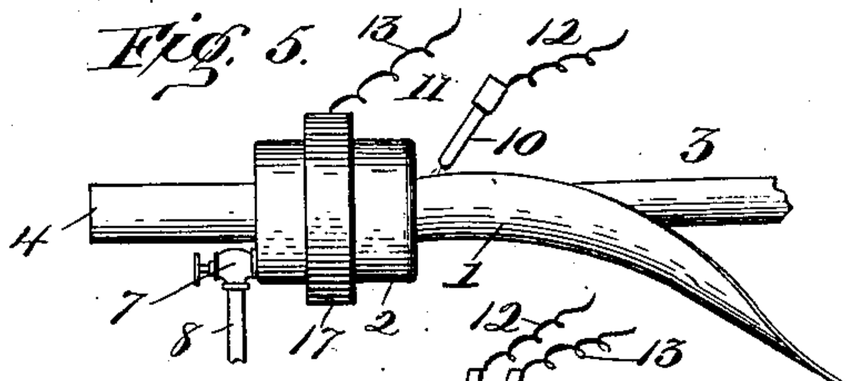


Fig. 6.

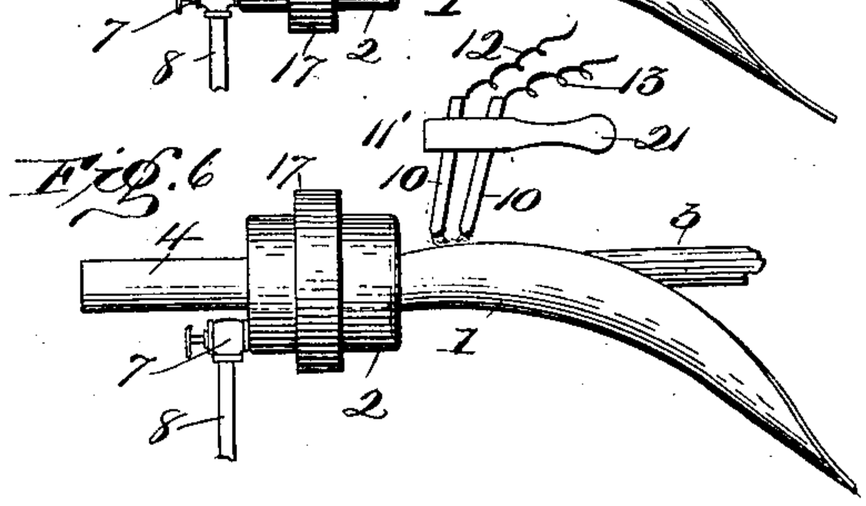


Fig. 8.

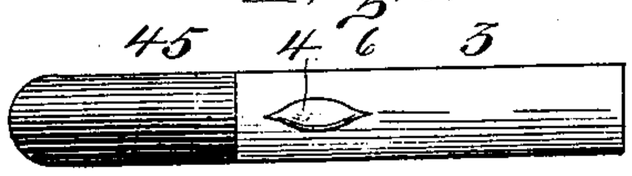


Fig. 9.

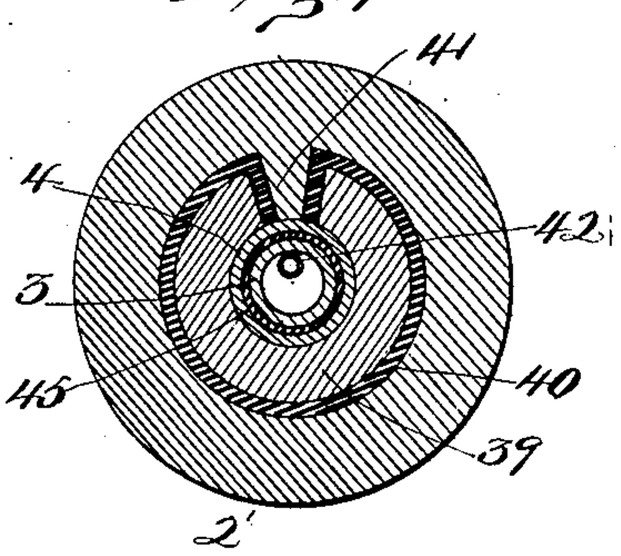


Fig. 7.

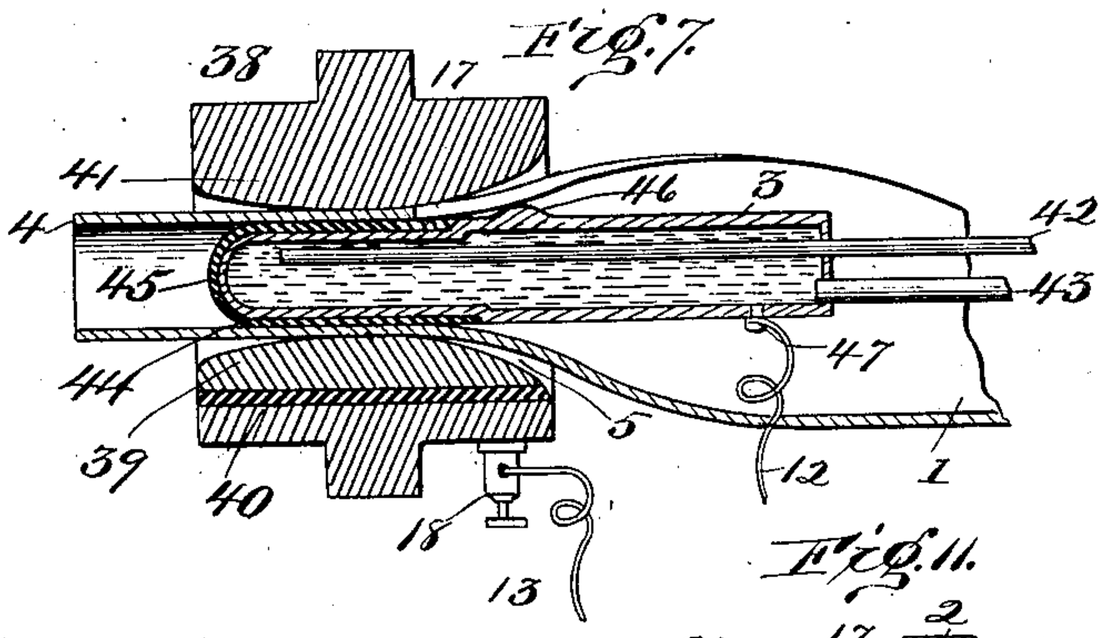


Fig. 10.

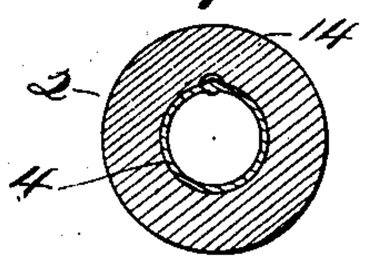
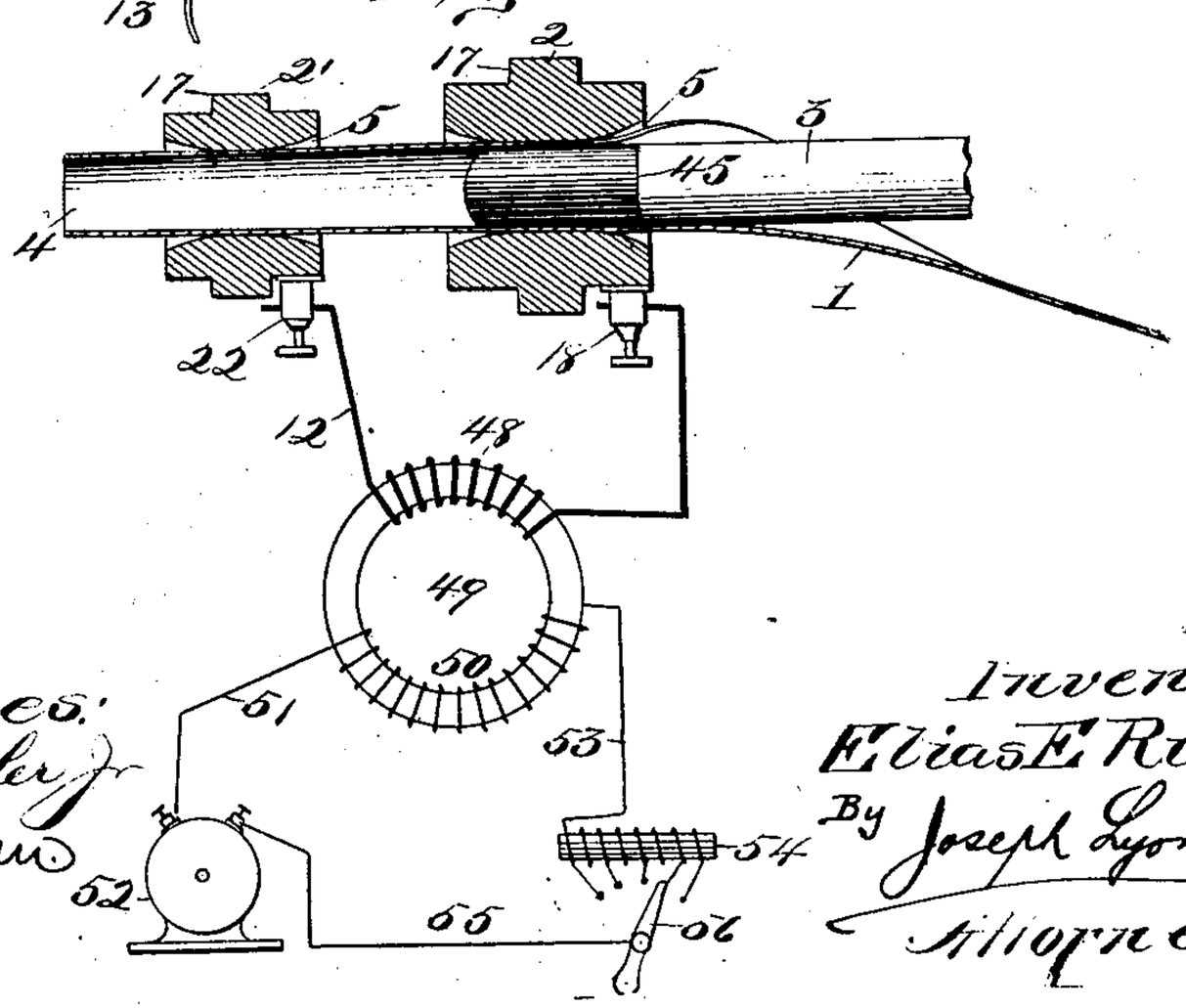


Fig. 11.



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(Application filed Jan. 18, 1896.)

(No Model.) 3 Sheets—Sheet 3.

Fig. 12.

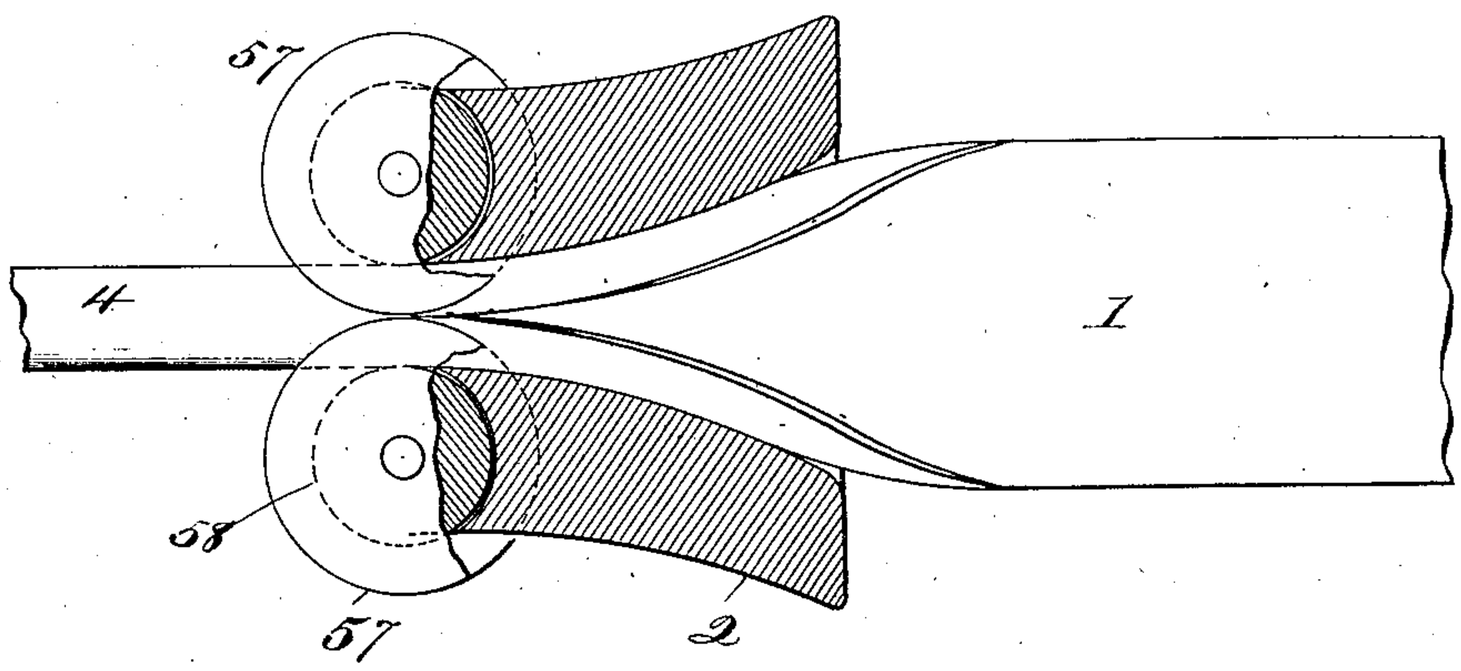


Fig. 13.

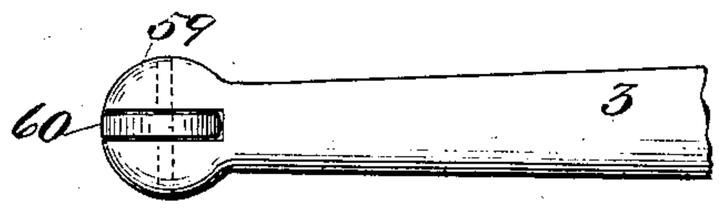
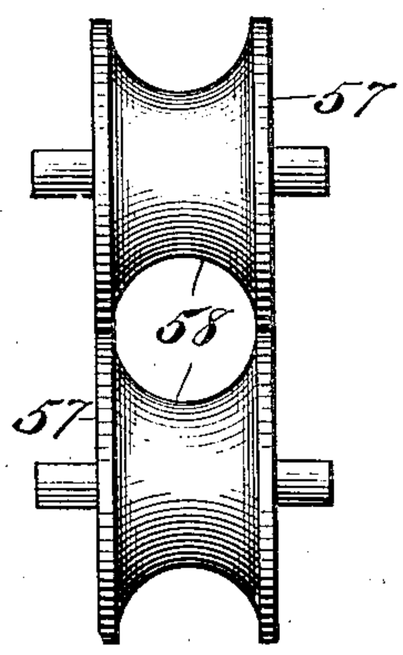


Fig. 14.



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UNITED STATES PATENT OFFICE.

ELIAS E. RIES, OF NEW YORK, N. Y.

METHOD OF AND MEANS FOR MANUFACTURING METAL TUBING.

SPECIFICATION forming part of Letters Patent No. 611,222, dated September 20, 1898.

Application filed January 18, 1896. Serial No. 576,006. (No model.)

To all whom it may concern:

Be it known that I, ELIAS E. RIES, a citizen of the United States, and a resident of New York, in the county and State of New York, have invented certain new and useful Improvements in Methods of and Means for Manufacturing Metal Tubing, of which the following is a specification.

My invention relates to improvements in the method of and means for manufacturing metal tubing from webs of metal; and its object is to produce tubing in which the meeting edges are welded together in such manner that the tubing may be redrawn cold without weakening the joint, a process only possible heretofore with ingot or weldless formed tubing.

Prior to my invention it has been proposed to make tubing from webs of metal and weld the meeting edges together by first heating the flat web to a welding temperature in a furnace and then form the heated web into a tube, after which the meeting edges were forced together and welded. This of course necessitated the heating of the entire web to or above a welding temperature and entailed a great waste of heat, besides the constant danger of inclosing metal oxid in the joint and thereby weakening the same, also the metal cooled to some extent in passing from the furnace to the tube forming and welding apparatus, and therefore it was necessary at times to employ a gas or oil flame to maintain the metal at the meeting edges at a welding temperature. This only served to include products of combustion in the joint, thereby weakening the same. It has also been proposed to use for thin and for easily-fusible metals a flame applied to the meeting edges just prior to the welding operation as the only source of heat; but this did not avoid the weakening of the joint by the incorporation therein of the products of combustion. For these reasons welded tubing has never been able to compete with weldless tubing. By my invention, however, I have overcome the various objections to welded tubing and am able to produce welded tubing equal in every respect to weldless tubing and in some respects superior to it, besides effecting a considerable economy in its manufacture and avoiding many of the time and labor consuming operations incident to the manufacture of seamless tubing from solid ingots or disks as now practiced.

My invention consists in first forming a web into a tube without preliminary heating, except in the case of very large and thick webs, when only sufficient heat is applied to facilitate the folding of the web into a tube. The preliminary heating in such exceptional cases is always very much below a welding temperature, so that for all practical purposes the web may be said to be cold when folded into a tube, and since in the great majority of cases in the practice of my invention the web is actually cold when folded into a tube and is never highly heated preliminary to folding it into a tube, even in the exceptional cases, the web will hereinafter be referred to as being folded into a tube when cold with the understanding that the term includes the exception noted. Having folded the web into a tube when in a cold state, I heat the meeting edges only to a welding temperature, either just before or shortly after they come into contact, by means of heat generated by an electric current. The heat may be generated by springing an arc between the meeting edges and the terminal of an electric circuit, or the arc may be formed adjacent to the meeting edges between two terminals of the electric circuit, or the current may be passed directly through the formed tube, so that the higher resistance offered by the meeting edges will cause them to be heated to the desired welding temperature. As soon as the meeting edges have become sufficiently heated they are forced together and upset, thereby completing the weld.

By my process I am enabled to form and weld the tubes continuously and progressively and can regulate the heat and localize its action to a nicety. By using the electric current as a source of heat I avoid the use of a furnace and the emergency reheating by gas or oil flame with the unavoidable incorporation of the products of combustion in the joint and the consequent weakening of the same.

I am well aware that electric heating as applied to the working of metals, whether by the arc or by simply passing current through the joint, was known prior to my present invention, and I lay no claim to such matters;

but I have discovered that by utilizing the heat generated by the electric current as a step in the process of manufacturing tubing from webs of metal I not only do away with the heating-furnace and gas or oil flames heretofore deemed necessary for the formation of welded tubing, but in addition to being able to reduce the plant necessary I am enabled to produce tubing fully equal to weldless tubing, and I do this at a much less cost. In addition thereto the length of the tubing is not limited by the size of the ingot, as in weldless tubing, but may be of practically unlimited length, depending only on the length of the web, which latter may be very long. I have furthermore found that by means of the exact localization of the heat in my process I am able to produce welded tubes from flat strips or webs without the aid of any external pressure upon the heated edges other than that due to the spring-pressure imparted to the tube itself by its passage through the forming-dies, as will appear more fully hereinafter. I have also found that tubes thus produced by my process may be subjected to one or more redrawing operations without any apparent weakening of the joint or seam, and thereby be finished to size with a perfectly smooth wall, so that the seam cannot be detected and in such a manner as to present an appearance in all respects identical with that of a seamless drawn tube.

In the accompanying drawings, forming part of this specification, Figure 1 is a side elevation, partly in section, of a tube-making machine constructed in accordance with my invention and in which one mode of producing arc-welded tubes is shown. Fig. 2 is a longitudinal section, partly in elevation, of a portion of a pipe-making machine, showing a modified form of apparatus. Fig. 3 is an elevation of a clamp constituting a detail of the structure shown in Fig. 2, with the tube in place, the latter being shown in section. Fig. 4 is a longitudinal vertical section of the tube-forming die shown in Fig. 1. Fig. 5 is a side elevation of a portion of a tube-making machine, illustrating the invention. Fig. 6 is a similar view showing a modification. Fig. 7 is a longitudinal section of a portion of a tube-making machine in which the meeting edges are heated by the passage of the electric current through the metal of the tube adjacent to the edges. Fig. 8 is a plan view of the mandrel used in the machine shown in Fig. 7. Fig. 9 is a cross-section through the middle of the die of the structure shown in Fig. 7. Fig. 10 is a cross-section through a die such as shown in Fig. 1, illustrating a detail of construction. Fig. 11 is a longitudinal section of a tube-making machine, illustrating another modification of the invention and also illustrating a current-generating plant and circuit connections. Fig. 12 is a section, partly in plan, of a modified form of tube-forming die. Fig. 13 is a plan view of a modified form of mandrel, and Fig. 14 is an end view of a pair of compressing-rolls such as shown in Fig. 12 and which may replace certain of the structures shown in other of the figures.

Referring to the drawings, and more particularly to Figs. 1 and 5, there is shown a strip or web 1, which when passed through a suitable die 2 and at the same time around a cylindrical mandrel 3 is formed into a tube 4. The die 2 (see also Fig. 4) is a cylindrical casting with a central passage 5 and having, preferably, an internal chamber 6. The passage 5 is of such shape that it will cause the web 1 to roll up into a tube on the mandrel 3, as in ordinary tube-machines. The passage 5 has a flaring mouth, as shown, to facilitate the formation of the web into a tube, and it also flares slightly at the other end, as shown.

The chamber 6 is provided with an inlet connected through a valve 7 to a pipe 8, and it also has an outlet-opening 9, which, it will be understood, is connected to a suitable pipe. (Not shown.) The chamber 6 is provided for the introduction into the die of a cooling fluid, for, as will presently be seen, the die is subjected in some of the processes about to be described to a sufficient degree of heating to make the use of some cooling agent advisable. As the web passes to the die and is shaped thereby from a flat condition into a tube the edges approach each other until when the mouth of the die is reached they are in close relation, but still out of contact, and when the point of least diameter of the die is reached they are pressed thereby into firm contact. Just before the two edges are brought into contact in the arrangement of apparatus now under consideration I heat them until they are raised to a welding temperature, and before these edges can cool they are forced together by the die and are welded. It will of course be understood that the width of the web and the smallest diameter of the die are so proportioned that the heated edges of the web will be upset into each other until the metal of the two edges coalesce and thereby forms the weld in the now well-known manner. In order to progressively heat the edges of the web preparatory to welding them, I utilize the heating effect of the electric current, and for this purpose in the apparatus now under consideration I use a carbon or other conducting pencil 10, mounted in a suitable holder 11 and connected by a conductor 12 to a suitable source 12′ of current-supply, which may be a secondary battery, a straight-current dynamo, or any other suitable current source. The die 2 is also connected by a conductor 13 with the source of current-supply. When the leading end of the web has been introduced into the die far enough to bring the two edges close together and just before they are forced into contact, the carbon pencil 10 is adjusted, so as to be in contact with these two edges. A circuit will thus be established from the source 12′ of current-supply by the conductor 13 through the

die 2 to the two edges of the web, from thence to the carbon pencil 10, and by the conductor 12 back to the source 12′ of current-supply. Now by moving the carbon pencil 10 a short distance away from the juxtaposed edges of the web an arc will be established, which will play between the carbon pencil and the said edges. As is well known, the temperature of the arc is very high, and consequently the two edges of the web are quickly brought to the welding temperature, and as the web passes into the die to the point of least diameter these edges are forced together and welded, as before stated. As the web passes into the die the heated edges are prevented from collapsing by the mandrel 3, which is of the same diameter as the internal diameter of the tube when formed and is in this instance made of refractory material.

In order to prevent the heated and therefore softened metal of the tube from being dragged and torn during the passage through the die, I may cut away or groove the die, as shown at 14 in Figs. 1, 4, and 10, so that the heated edges before welding and the beaded seam or joint after welding do not come into such contact with the die as to be damaged. With the means of quickly heating the edges of the web to the welding temperature afforded by the electric arc, the manufacture of tubing from a web with the seam welded may be quickly and progressively accomplished.

In Fig. 1 I have shown a complete tube-making machine embodying my invention, but with the mandrel-support and web-holding reel or support omitted.

The die 2 is mounted in a suitable seat formed in a head 15 on the upper end of a standard 16. The die may either be tapered on its outer surface and removably held in a correspondingly-tapered seat in the head 15 or it may be permanently held in its seat by means of an annular rib 17 on the die entering a corresponding groove in the head 15. Secured to this head 15 is a binding-post 18, receiving the conductor 13, and rising but insulated from the head 15 there is a short standard 19, to which is pivoted one end of a lever 20, terminating in a handle 21. The lever 20 carries a binding-post 22, receiving the conductor 12, and also carries the carbon-holder 11, with its carbon pencil 10. By means of this lever 20 the carbon pencil 10 can be readily manipulated by an attendant in the manner before stated to produce the arc. On account of the heat and brilliancy of the arc a shield 23, of transparent refractory material, such as mica, and tinted a suitable color, say blue, is fastened to the lever 20 between the carbon-holder 11 and the handle 21 in order to protect the attendant. The upper wall of the mouth of the die is cut away, as shown at 24, (see Figs. 1 and 4,) to permit the carbon pencil 10 to be brought as close to the point where the two edges of the web are forced into contact as possible. The web is drawn through the die by means of mechanism which I will now describe with reference to Fig. 1.

A clamp 25, shaped to grasp the completed tube after it has left the die, is formed upon the upper end of a carrier 26, which latter has at its lower end a roller 27, resting upon the floor or on a base-plate to which the standard 16 may be secured. Below the clamp this carrier is traversed by a screw-threaded rod or feed-screw 28, supported at one end by the head 15, through which it is passed and in which it is journaled, as shown, and at the other end by a journal-bearing, as shown, in the upper end of a post 29, secured to the floor or base-plate on which the machine rests. It will be understood that where the feed-screw 28 passes through the carrier 26 the latter is screw-threaded, so that when the feed-screw is turned in its bearings the carrier will be moved from or toward the standard 16, as the case may be. In order to rotate the feed-screw 28, it is extended beyond the head 15 and is there provided with a hand-wheel 30, within reach of the attendant operating the machine, or, as is evident, this feed-screw may be rotated by power. The lower end of the carrier 26 is guided by a rod 31, passing through the carrier and supported at the ends in the standard 16 and post 29, respectively. By turning the hand-wheel 30 with the proper speed after the clamp 25 has been secured to the tubing that has been formed by the die the web will be drawn through the die at a steady rate and with comparative rapidity. At the same time the arc is established and the meeting edges of the web are progressively welded together at the same steady and rapid rate. It will be evident that instead of using a revolving feed-screw mechanism for moving the clamp 25 I may use hydraulic power or any other well-known or desirable form of drawn-bench mechanism for imparting the desired uniform speed to the clamp or carrier. When the carrier has reached the limit of its travel, the electric circuit is interrupted to break the arc, and the clamp 25 is loosened. The carrier is then returned to its first position and the tube again clamped, after which the arc is again established and the manufacture of the tubing progresses as before. It will thus be seen that the length of the tubing thus manufactured is only limited by the length of the web. The die is of course subjected to heat radiated from the arc and to heating by contact with the heated metal of the web. It would therefore in a short time become unduly heated were it not for the fact that provision is made for the cooling of the same. This I do by means of a cooling agent introduced into the chamber 6, as before described. Instead of heating the edges of the web at the mouth of the die it may be rolled up into the form of a tube and the seam heated and welded after its passage through the die. This method is preferred by me, particularly in the case of tubes formed from the thinner gages of metal. Means for this purpose are shown in Figs. 2

and 3. The die 2 and head 15 are practically the same as shown in Fig. 1. The lever 20 is mounted at the rear of the head 15 instead of at the front, so that the arc is established between the carbon pencil 10 and the edges of the seam in the tube after the latter has left the die. In order to force the heated edges of the tube together and thus complete the weld, I sometimes provide a clamp, which may be termed a "welding-clamp," composed of two jaws 32 33, hinged together at one end and shaped to grasp the tube at the other end. These jaws are adjusted to grasp the tube with any desired pressure by means of a rod 34, terminating at one end in a hand-wheel 35 and at the other in a head 36. A portion of the rod is threaded and passes through a nut formed in the jaw 33, while the smooth portion of the rod passes freely through the jaw 32. A spring 37 is placed on the rod 34 between the head 36 and jaw 32. By this means the jaws are made to grasp the tube with a pressure tending to force the two edges together and will automatically effect the welding of these edges when they are heated. The welding or pressure clamp just described is employed by me in cases where the tubes to be formed are made of comparatively soft or ductile metal, such as brass or copper, or of highly-annealed iron or steel, in which the degree of hardening produced by the passage of the web through the forming-die is insufficient to produce a spring-pressure between the meeting edges of the tube under formation. When my process is applied to the manufacture of thin-walled smooth steel tubing, however, such as I propose to use for bicycle-frames, interior electric-wire conduits, &c., to which my improved process is especially applicable with great economy and other advantages over existing methods, I prefer to so proportion the die 2 and the mandrel 3 as to form the tube with the edges pressed together with considerable force at and beyond the point where it emerges from the die, this pressure being sufficient to cause the edges of the tube to be welded together when suitably heated—as, for instance, in the manner described with reference to Fig. 2—that is to say, the seam is heated after the web has passed through the die. In such cases the tube undergoes a slight drawing operation and receives a certain spring tension (due to its crowding between the forming mandrel and die) sufficient to produce the requisite welding pressure, so that the welding-clamp may be dispensed with. I may replace the welding-clamp shown in Figs. 2 and 3 by a die 2′, (shown in Fig. 2,) which die will be placed as close to the carbon pencil 10 as possible and will be of such diameter as to slightly reduce the tube formed by the die 2, in order to effect the welding and finishing of the joint.

My invention is not limited to the use of an arc established between a carbon pencil and the two edges to be welded, as shown in Figs. 1, 2, and 5, for these edges may be heated by an arc formed between two adjacent carbon pencils. Such an arrangement is shown in Fig. 6, where the arc is established between two carbon pencils 10 10, both mounted in a common holder 11′, which may be carried by or form part of the lever 20. It will be understood that suitable means for adjusting the carbon pencils 10 10 relative to each other will be provided, but such means form no part of the present invention and are omitted from the drawings.

My invention may also be practiced by heating the edges to be welded by the heating effect of a suitable electric current passed directly through them when they are arranged to bridge the terminals of the electric circuit. One means for this purpose is shown in Figs. 7, 8, and 9. The die 2 is in this structure composed of an outer shell 38 and an inner shell 39, the two shells being separated by interposed refractory insulating material 40. The shell 38 is formed with an inwardly-projecting rib 41, extending through but insulating from the shell 39, as shown in Fig. 9. This rib 41 may be shorter than the shell, or, as indicated in Fig. 7, it may be as long as the shell. The inner end of the rib 41 conforms to or may project slightly beyond the inner face of the shell 39, and it is so located that as the web passes through the die the inner end of the said rib makes contact with the two edges to be welded, the binding-post 18 receiving the conductor 13, secured to the outer shell 38. Consequently the current can pass from this shell to the web only through the rib 41. The other terminal of the electric circuit is formed by the mandrel 3, which in this instance is of material made hollow and is provided with inlet and escape pipes 42 43 for the circulation in the mandrel of a cooling fluid. Where the mandrel is touched by the web as the latter is curled up into the form of a tube, it is reduced in diameter, as shown at 44, and covered with a jacket 45 of refractory insulating material the thickness of which is such that the normal diameter of the mandrel is restored. On the top of the mandrel, at a point just back of the insulating-jacket 45 and close to where the two edges to be welded come into contact with the rib 41, there is a projection or boss 46, so formed as to make contact with both of the edges to be welded as they enter the mouth of the die. The mandrel 3 being connected, as at 47, with the conductor 12, the circuit is established between the rib 41 and mandrel by way of that portion of the metal of the web which lies between the said rib 41 and boss 46, and the current being suited for the purpose the metal immediately adjacent to these two edges and included between these two contacts will be quickly raised to a welding temperature. In this structure, as well as in the structures shown in the previous figures, the web after being heated is further reduced in diameter, so that

the heated edges are forced together and welded.

In Fig. 11 I have shown another means whereby the heating of the web by the passage therethrough of the electric current may be effected. In this case, the same as in the structure shown in Fig. 2, I use a forming-die 2 and a reducing-die 2'. The forming-die 2 is of such diameter as to bring the meeting edges of the web firmly together, while the die 2' is so proportioned as to still further, though slightly, reduce the diameter of the tube formed by the die 2. The binding-post 18 is on the die 2 and receives the conductor 13, and the binding-post 22 is on the die 2' and receives the conductor 12. The mandrel 3 is covered with insulating material, as in Figs. 7, 8, and 9, where it enters the die 2. The circuit between the two dies is completed by the intervening length of tubing, and this is quickly heated by the current. Experience has shown that under such circumstances when the meeting edges are raised to the welding temperature the rest of the tube is considerably cooler, and will therefore resist the strain as the tube passes through the die 2'. These edges will be forced together and welded. The dies 2 and 2' may of course be constructed like that shown in Figs. 7 and 9.

In Fig. 11 I have also shown a well-known means for generating currents of the requisite heating effect adapted to the method of tube manufacture set forth with reference to Figs. 7 and 11. The two conductors 12 13 are connected, respectively, to the terminals of the thick-wire coil 48 of a converter 49. The thin-wire coil 50 of this converter is connected on one side by a conductor 51 to one terminal of an alternating-current generator 52 and on the other side by a conductor 53 to a reaction-coil 54. The other terminal of the generator 52 is connected by a conductor 55 to a switch 56, capable of including more or less of the reaction-coil in the circuit for regulating the current-supply. The generator 52 may be located at a distant station, in which case the conductors 51 and 55 would represent the mains, and it would then supply currents of comparatively high tension. With such a generator I obtain the low-tension currents best adapted for welding in the manner set forth with reference to Figs. 7 and 11 by means of the converter 49, designed for this purpose. It will be understood, of course, that the generator 52 may be so constructed as to supply directly the low-tension currents adapted to the practice of my invention as set forth with reference to Figs. 7 and 11. It will also be understood that in the practice of my invention, whether I use the heat of the electric arc or heat the web directly, I am in no wise limited to any specific source of current-supply, since I may use any source of current adapted to the purpose of my invention.

In Figs. 12 and 14 I have shown a die in which the web is bent into the form of a tube partly by the body of the die and partly by forming-rolls between which the web, already partly completed by the body of the die, is drawn to force the edges constituting the seam into contact. In this instance the meeting edges of the web are heated just in advance of the rolls, so that the said edges are welded together on passing between these rolls. In the structure shown in these Figs. 12 and 14 the die 2 has a flaring mouth and contracted throat, as in the other figures of the drawings. At the rear end of the die there are journaled two rollers 57 57, each with a semicircular groove 58 in its periphery. These rollers are so arranged that the tube formed by the die will pass between them and be somewhat reduced in size thereby. In this structure the meeting edges of the web are heated by an electric arc, as in Fig. 1, just before the rollers 57 are reached. The slight reduction of the diameter of the tube due to the rollers 57 is sufficient to cause the welding of the heated edges of the tube. It will be understood, of course, that I may use reducing-rollers in place of the die for forming the web into a tube, or I may replace the welding-clamp (shown in Figs. 2 and 3) or the die 2' (shown in Figs. 2 and 11) with rollers having the same function.

In those structures embodying my invention wherein the meeting edges of the web are heated before they are brought into contact I may form the mandrel, as shown in Fig. 13, so as to prevent the heated and softened metal from being dragged and torn by contact therewith. For this purpose I form the mandrel with a globular head 59, in which is journaled a roller 60, with its periphery flush with the surface of the head 59. This roller 60 is arranged to rotate in the direction of the line of travel of the web and in contact with the meeting edges of the said web, so that these edges when heated are not dragged or torn on passing over the mandrel.

Having now fully described my invention, I claim and desire to secure by Letters Patent—

1. The method of manufacturing tubing from webs of metal, which consists in progressively folding the web into a tube, with the meeting edges in abutment and sprung together by the resiliency of the metal of the web, and progressively heating the contacting edges to a welding temperature, whereby the said edges are upset and welded by the spring of the tube, substantially as described.

2. The method of manufacturing tubing from webs of metal, which consists in progressively folding the web into a tube with the meeting edges pressed together by the resiliency of the metal of the tube, and progressively heating the meeting edges to a welding temperature by an arc established between the said meeting edges and a terminal of an electric circuit, whereby the resiliency of the tube is utilized to complete the weld, substantially as described.

3. In an apparatus for making tubes from

webs of metal, the combination of a stationary mandrel, a tube forming and closing die surrounding the head of the same, a traveling clamp for the tube, and means substantially as described for electrically heating the tube along the line of the seam formed by the passage of the web between the mandrel and die, to a welding temperature, substantially as described.

4. In an apparatus for making tubes from traveling webs of metal, the combination of a stationary mandrel, a tube forming and closing die, a source of electric current having one of its terminals electrically connected with the tube-forming die, an electrode connected with the opposite terminal of said source and adapted to be brought into contact with the edges or seam of the traveling web or tube at or near the closing-die, and means substantially as described for imparting motion to the said web or tube while the same is being traversed by the current, substantially as and for the purpose described.

5. In an apparatus for making tubes from traveling webs of metal, the combination of a tube-forming die constituting one terminal of a source of electric heating-current, an electrode constituting the opposite terminal of said source and adapted to be brought into operative contact with the tube at a short distance from the forming-die, and a traveling clamp or clutch for moving the tube and thereby causing successive portions of the same to be traversed by the heating-current, substantially as described.

6. In an apparatus for making tubes from webs of metal, the combination, with the stationary tube-forming die, of an adjustable electrode-holder mounted upon the framework of said apparatus near said die, but insulated therefrom, and having one or more electrodes in connection with a suitable source of heating-current, said holder being adapted to be moved so as to bring its electrode or electrodes into and out of operative connection or proximity with the tube formed by said apparatus, substantially as described.

7. The method of manufacturing tubing from webs of metal, which consists in shaping or forming the web into a tube with the meeting edges abutting, condensing the metal of said tube concurrently with such shaping or forming process so as to produce in the same a spring-pressure tending to force the abutting edges firmly together, and in heating the abutting edges while under such pressure to a temperature suitable for welding or otherwise uniting the same, substantially as described.

8. The method of manufacturing tubing from webs of metal, which consists in shaping the web into approximately tubular form while the same is cold or practically cold, drawing or compressing the metal of said tube so as to impart thereto a spring-pressure tending to force together the opposing or abutting edges of the same, heating the said edges to a welding or brazing temperature without destroying the tension or appreciably drawing the temper of the main body of said tube, and in completing the welding or union of the said edges while so heated by virtue of the spring pressure or tension imparted to the walls of said tube during the drawing or compressing operation, substantially as described.

9. The method of manufacturing tubes from webs of metal which consists in progressively folding the web into a tube, with the meeting-edges in abutment and sprung together by the resiliency of the metal of the web, progressively heating the contacting edges to a welding temperature, whereby said edges are upset and welded by the spring of the tube, and redrawing the said welded tube for finishing, substantially as described.

10. An apparatus for manufacturing tubes from webs of metal comprising the combination of a forming-die arranged to fold the web into a tube so as to spring the edges in abutment by the resiliency of the metal of the tube and a heating device for heating the contacting edges to a welding temperature whereby the said edges are upset and welded by the spring of the tube, substantially as described.

11. An apparatus for manufacturing tubes from webs of metal comprising the combination of a forming-die arranged to fold the web into a tube so as to spring the edges in abutment by the resiliency of the metal of the tube and an electric heating device for heating the contacting edges to a welding temperature whereby the said edges are upset and welded by the spring of the tubes, substantially as described.

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

ELIAS E. RIES.

Witnesses:
FELIX R. SULLIVAN,
G. DAVIS NEAVITT.