H. HIGGIN.

MACHINE FOR MAKING SHEET METAL TUBES.

APPLICATION FILED AUG. 9, 1909.

966,916.

Patented Aug. 9, 1910.

6 SHEETS—SHEET 1.

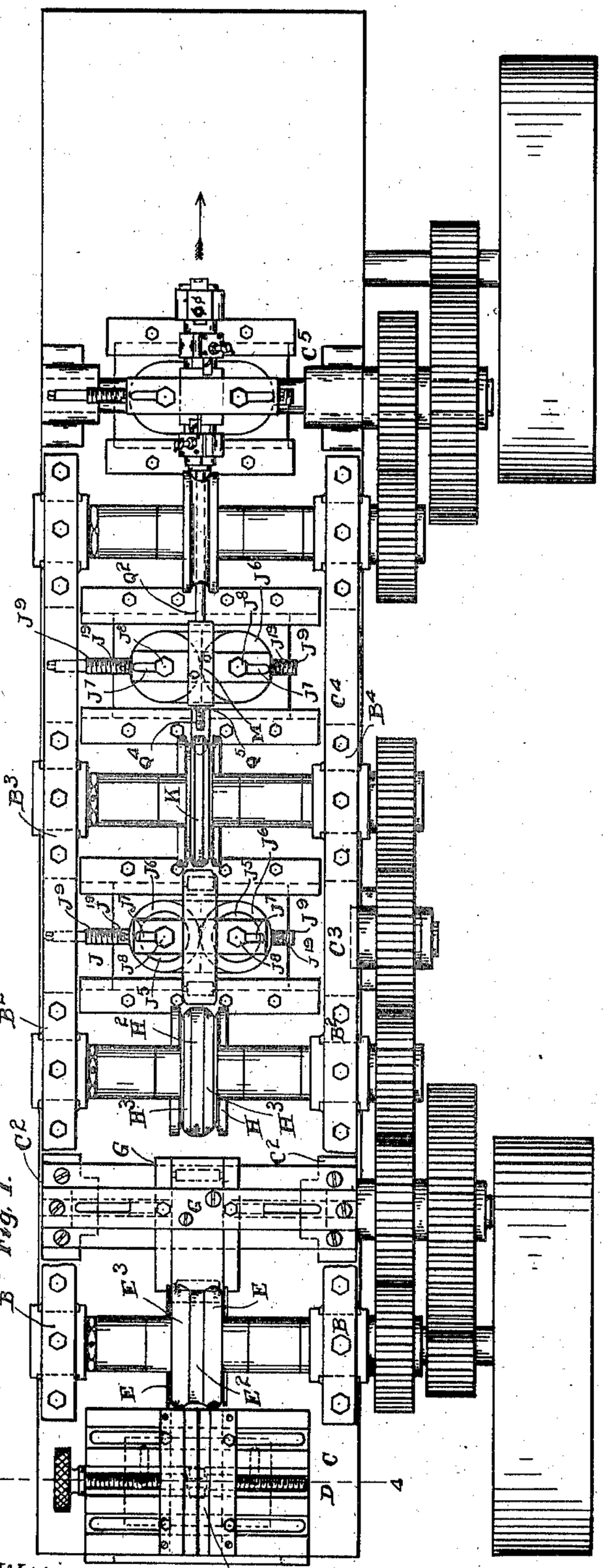

Fig. 1.

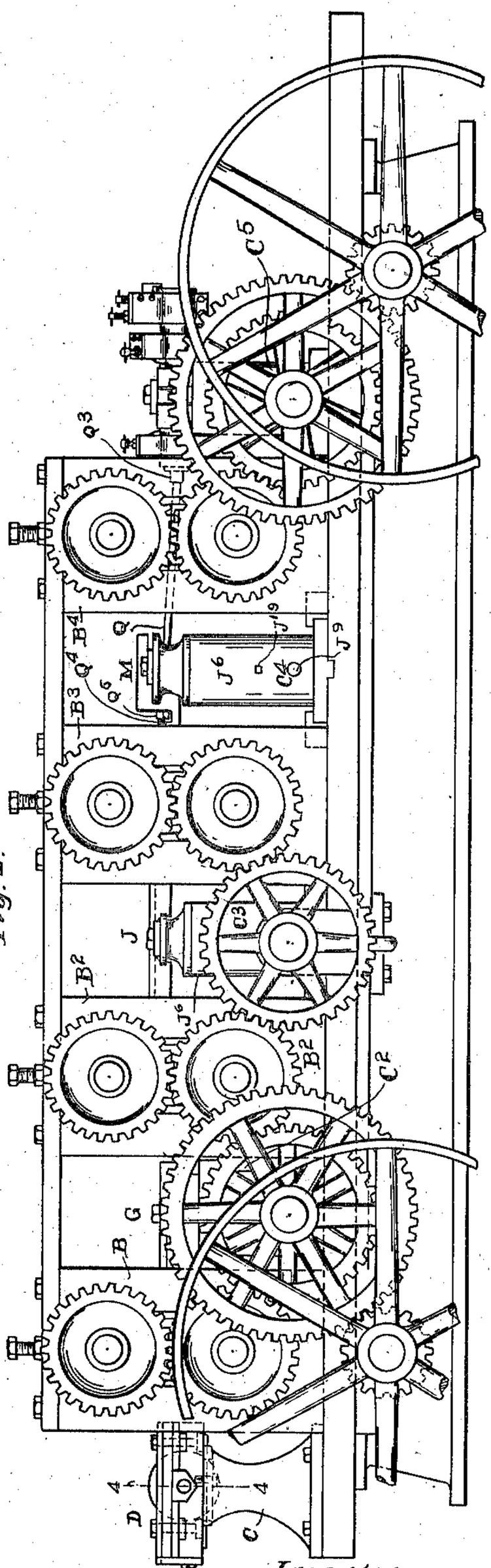

Fig. 2.

Witnesses

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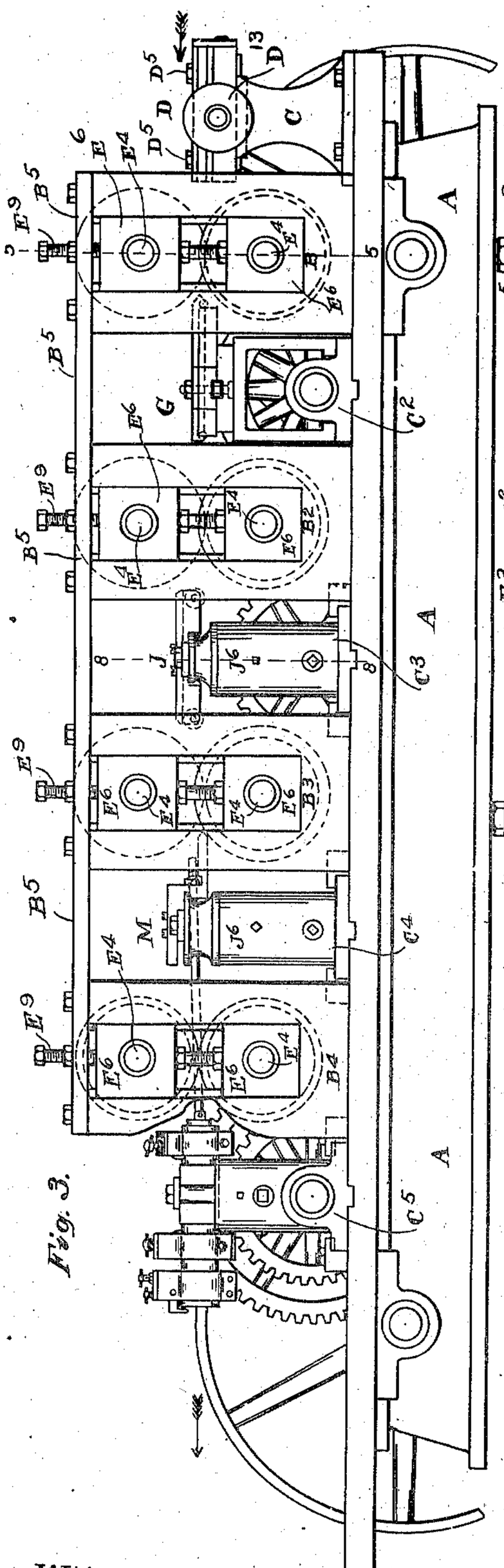

Fig. 3.

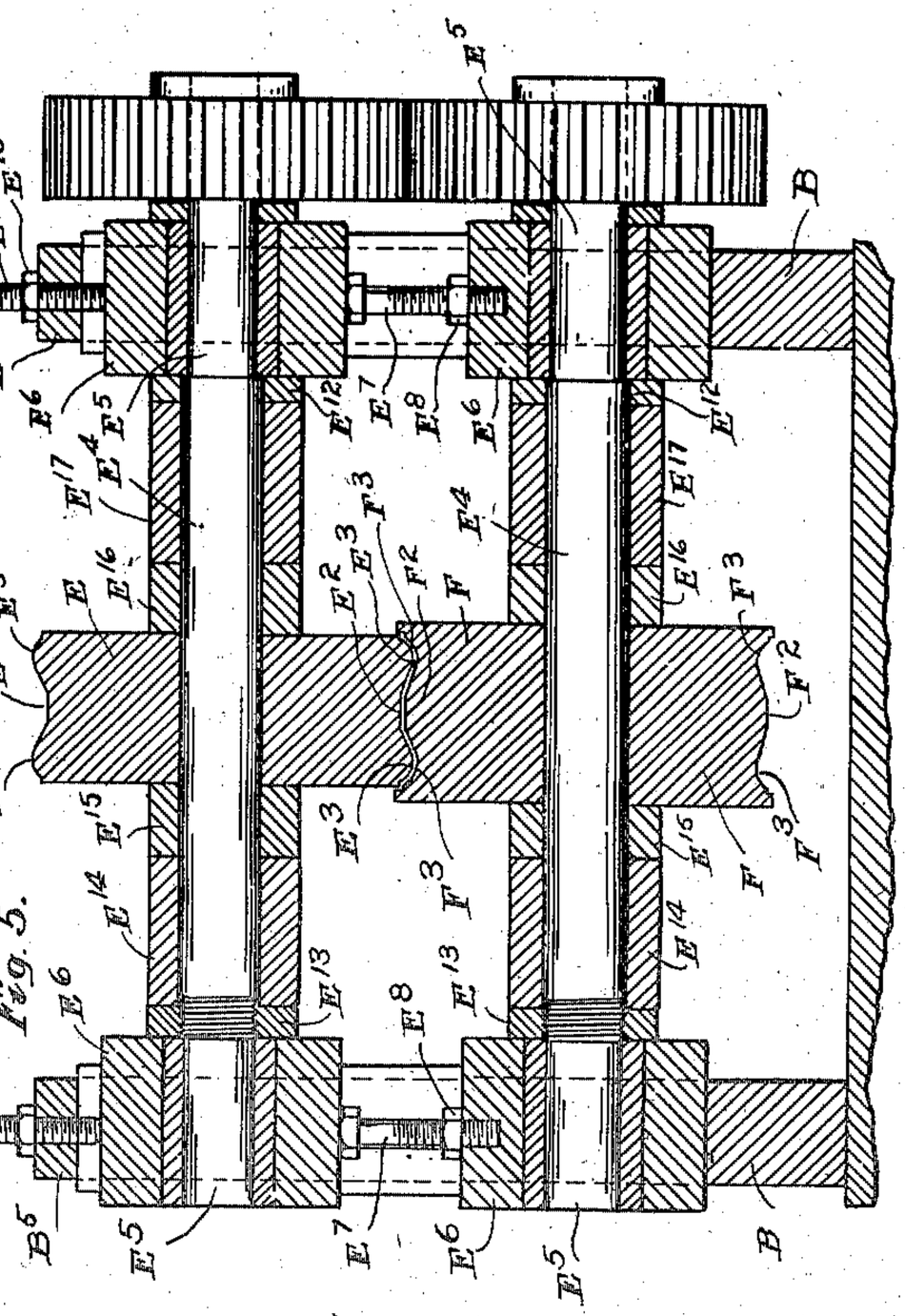

Fig. 5.

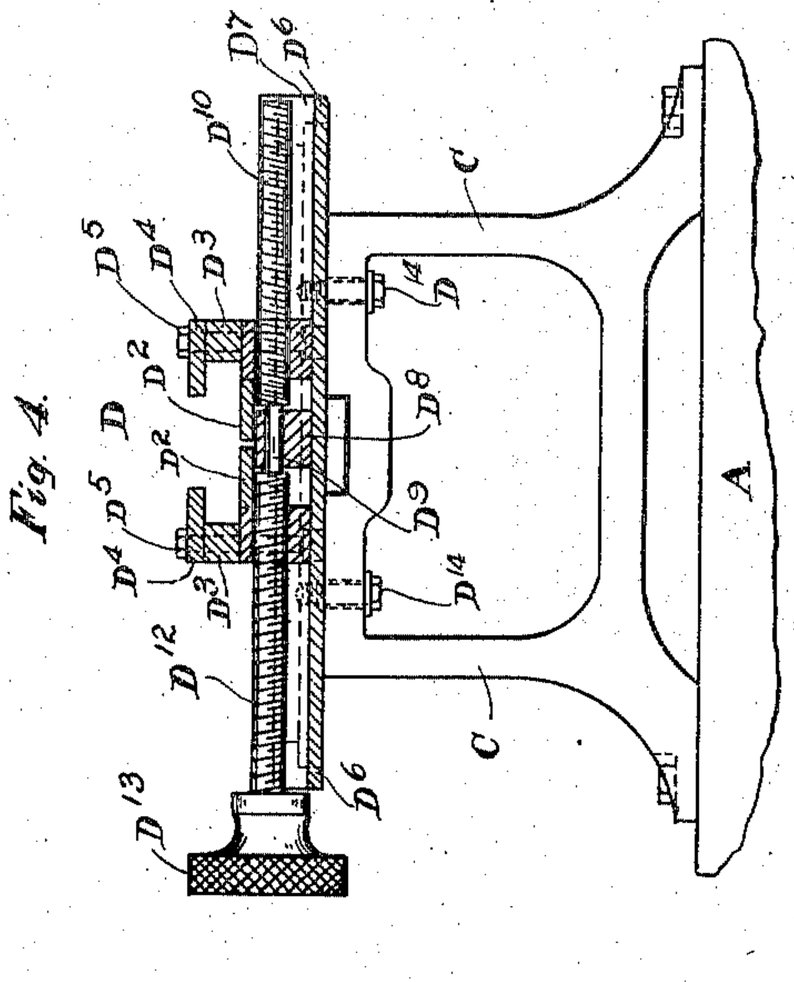

Fig. 4.

Witnesses
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Fig. 6.

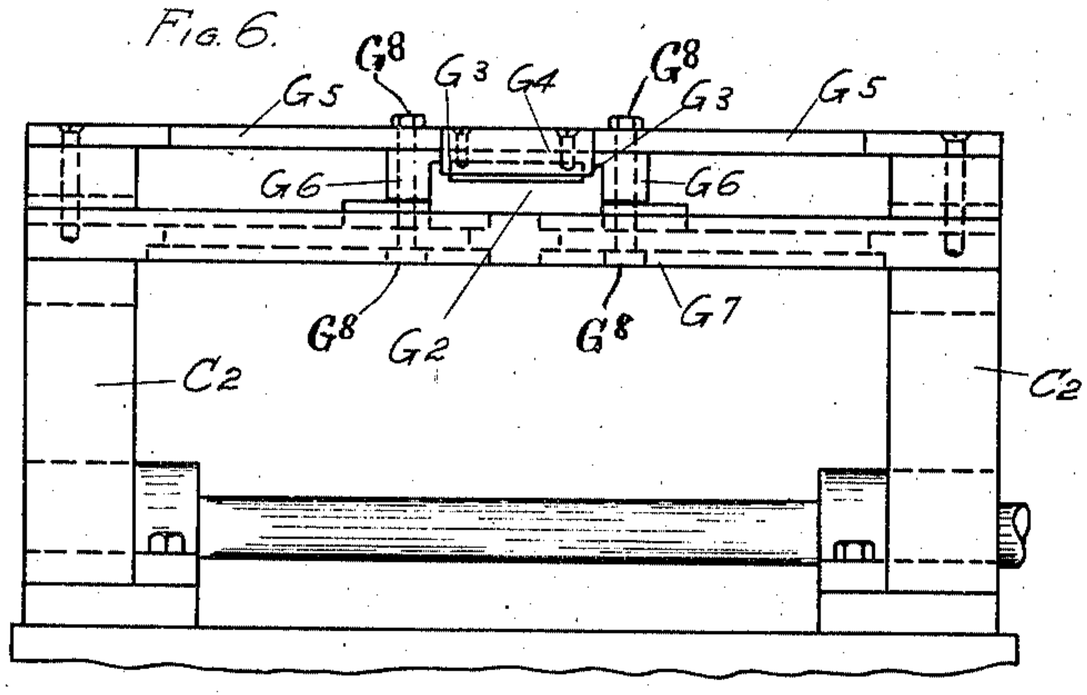

Fig. 7.

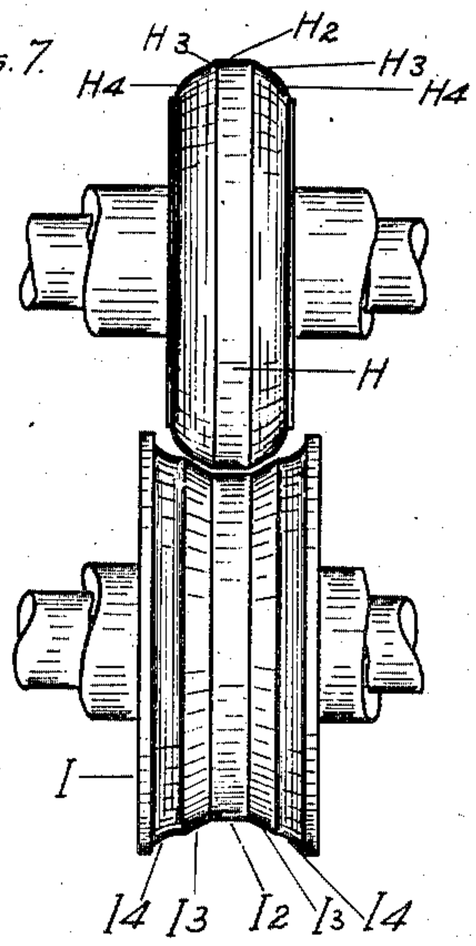

Fig. 8.

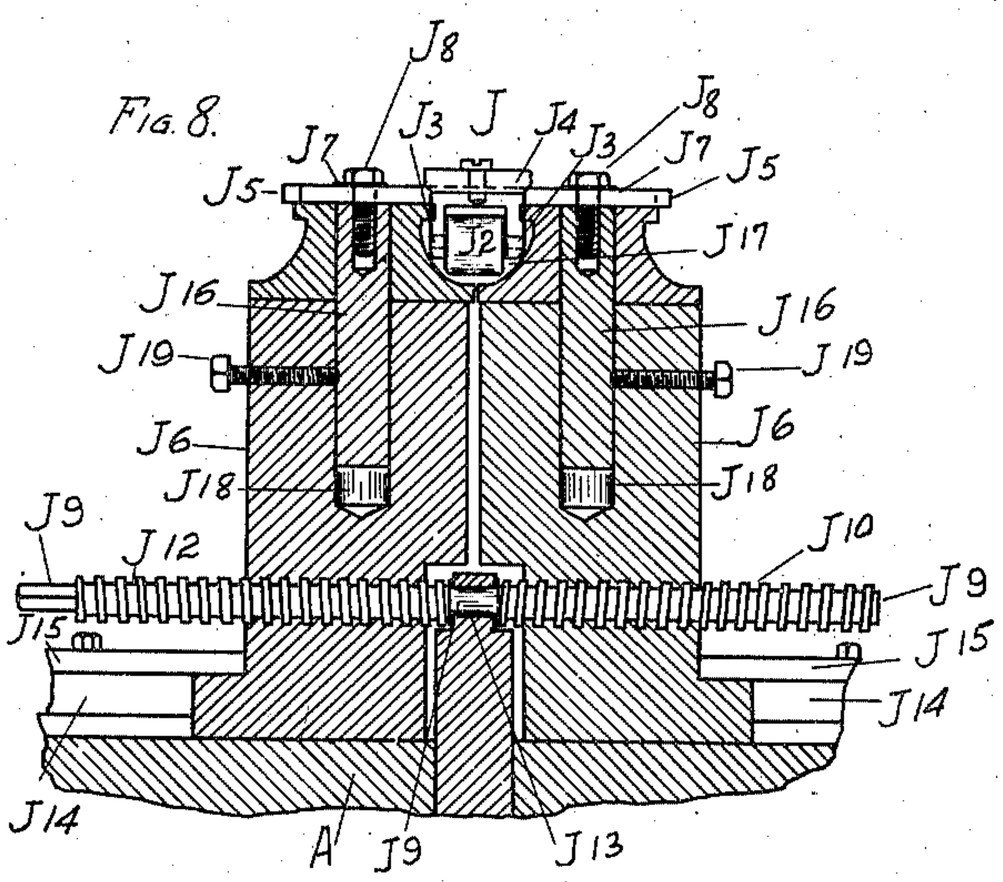

Fig. 9.

Fig. 10.

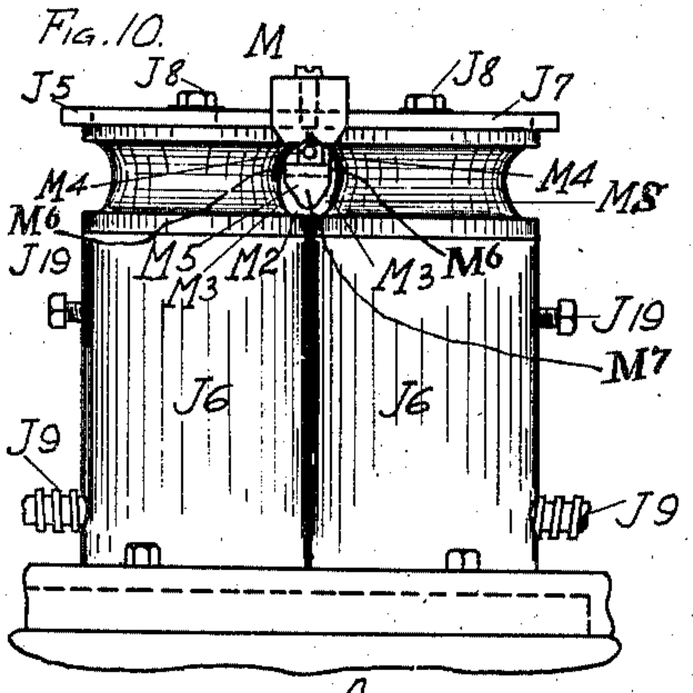

Fig. 11.

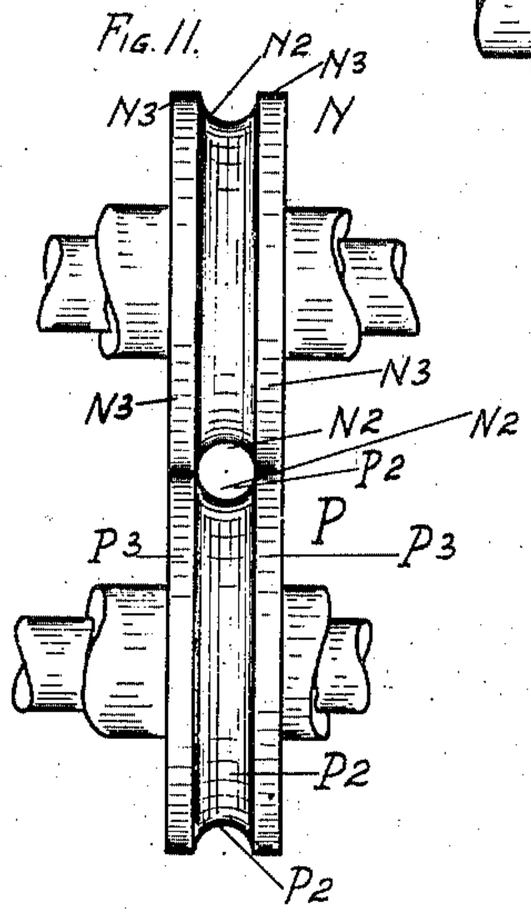

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Fig. 12.

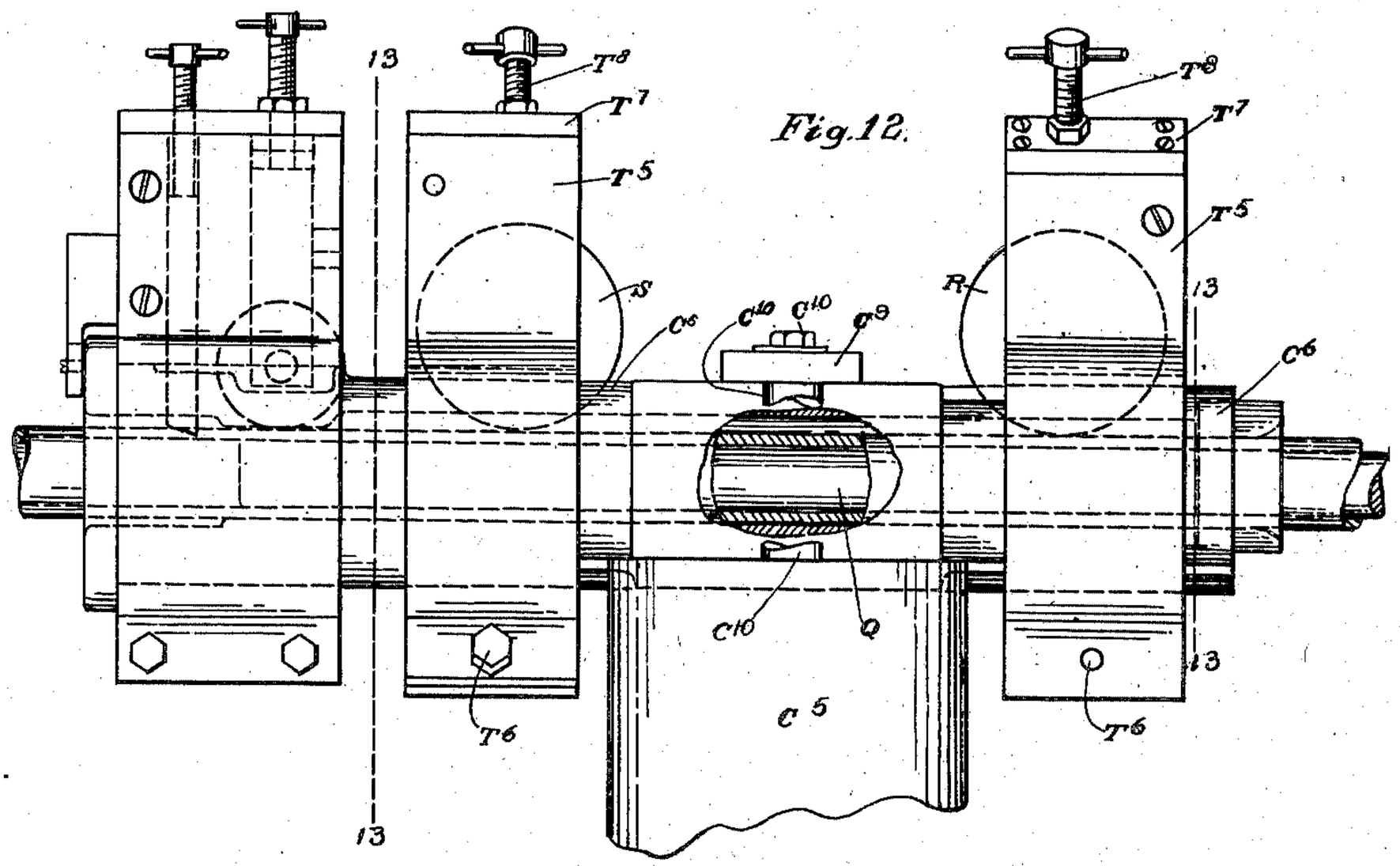

Fig 14.

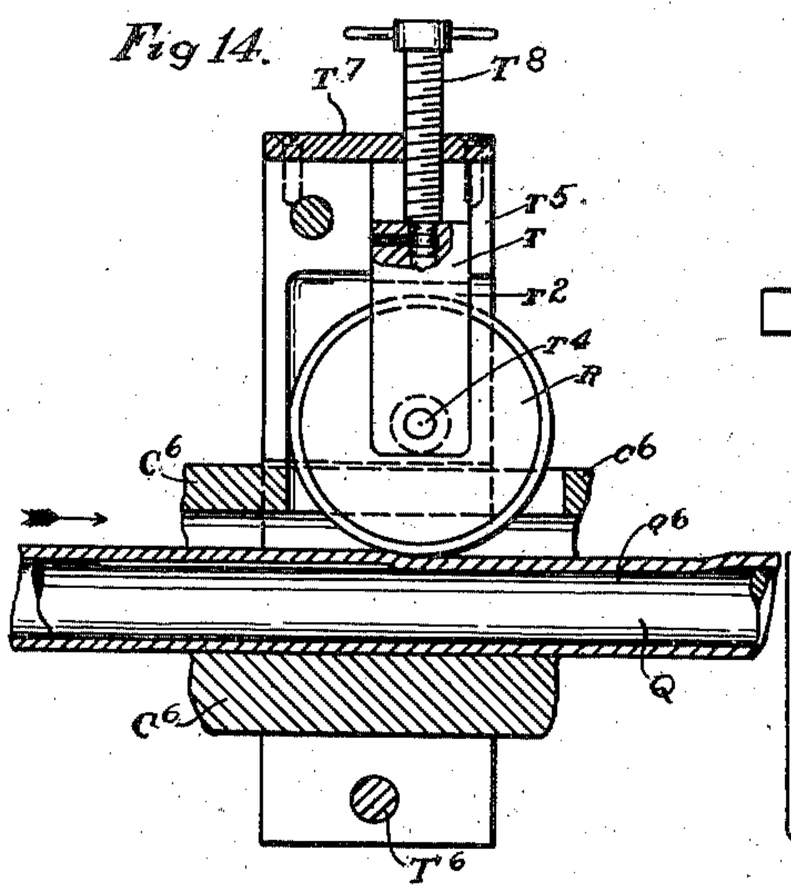

Fig 13.

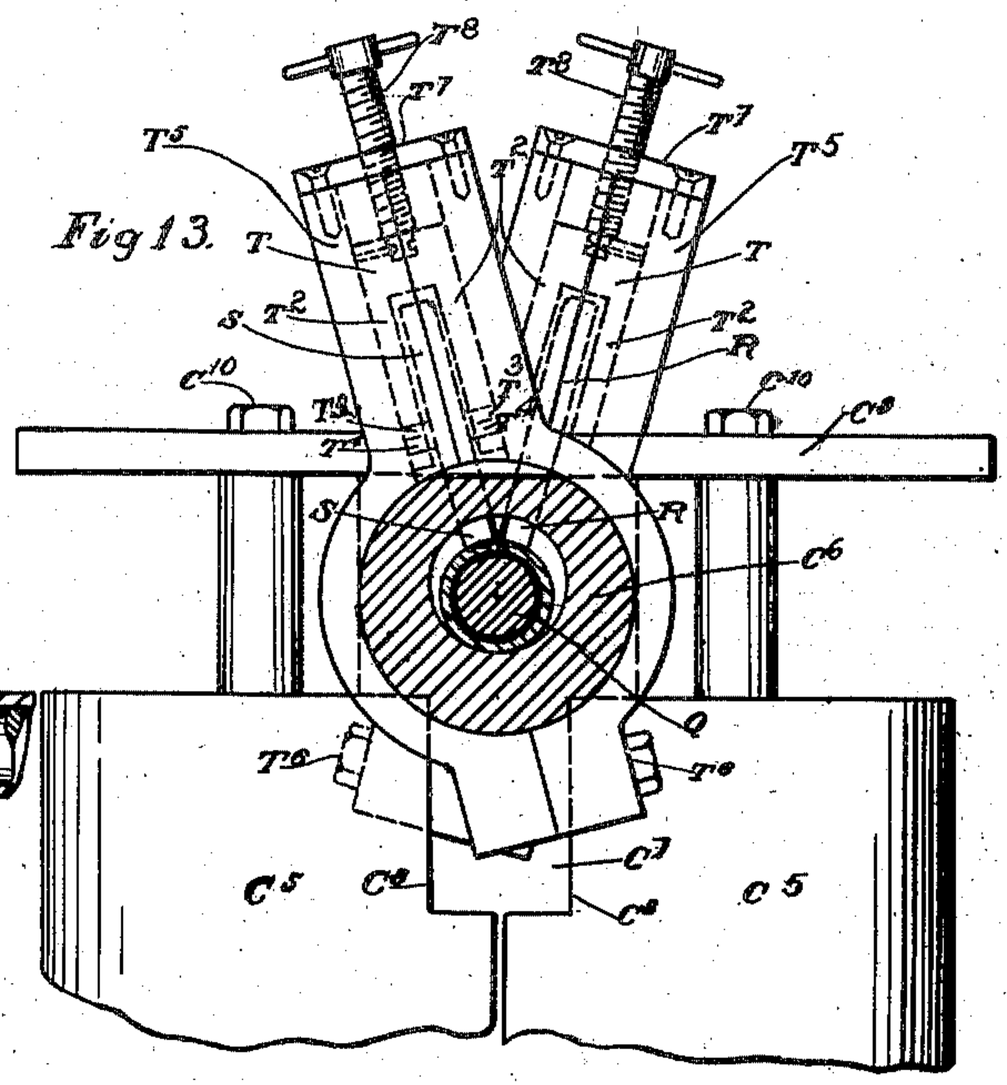

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Fig. 15.

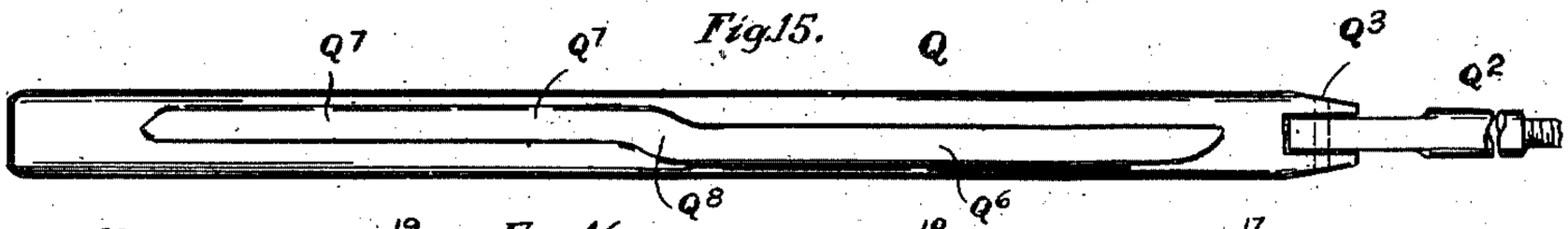


Fig. 16.

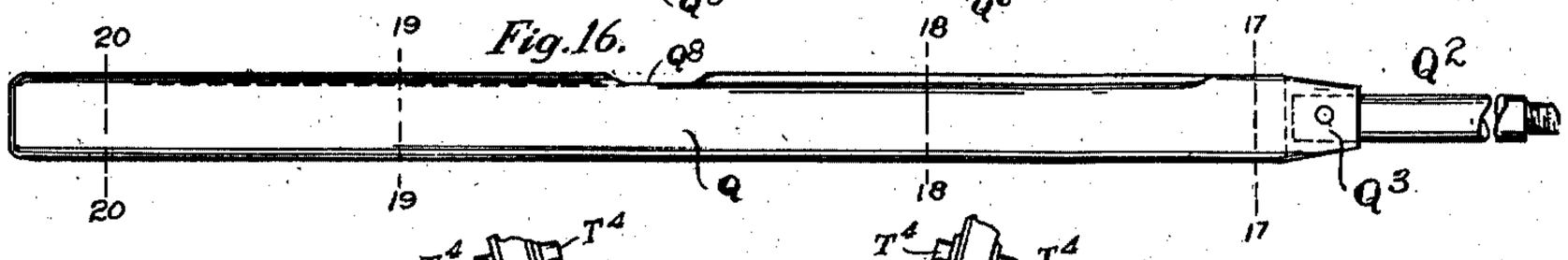
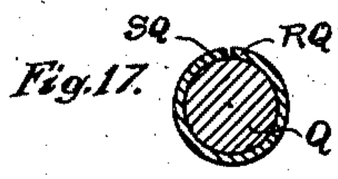


Fig. 17.



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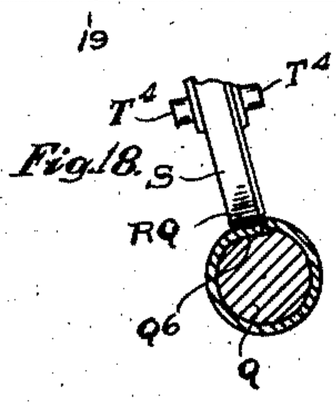


Fig. 19.

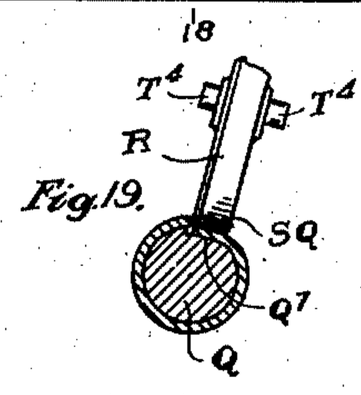
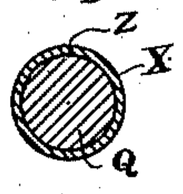


Fig. 20.



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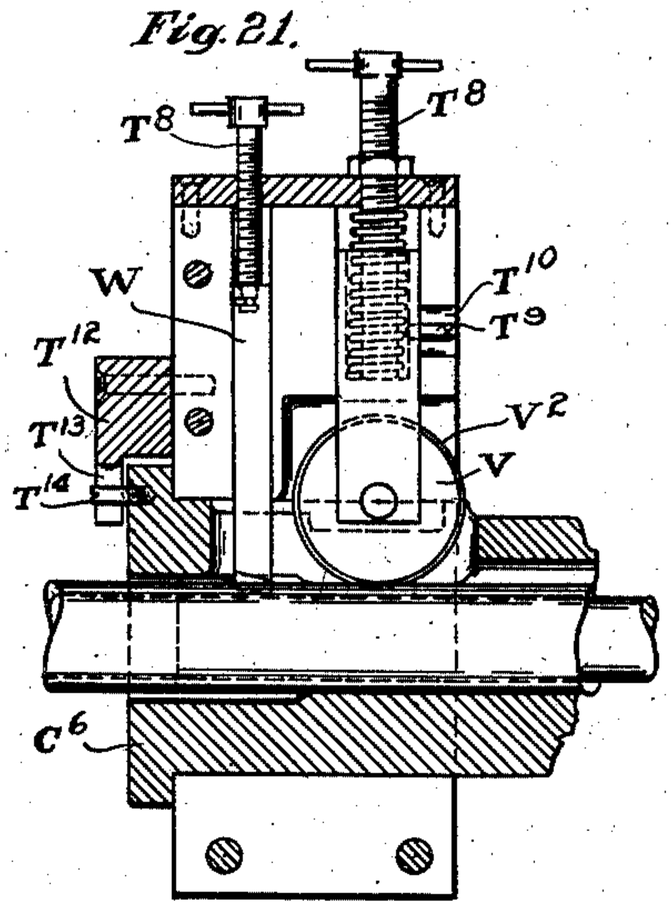


Fig. 22.

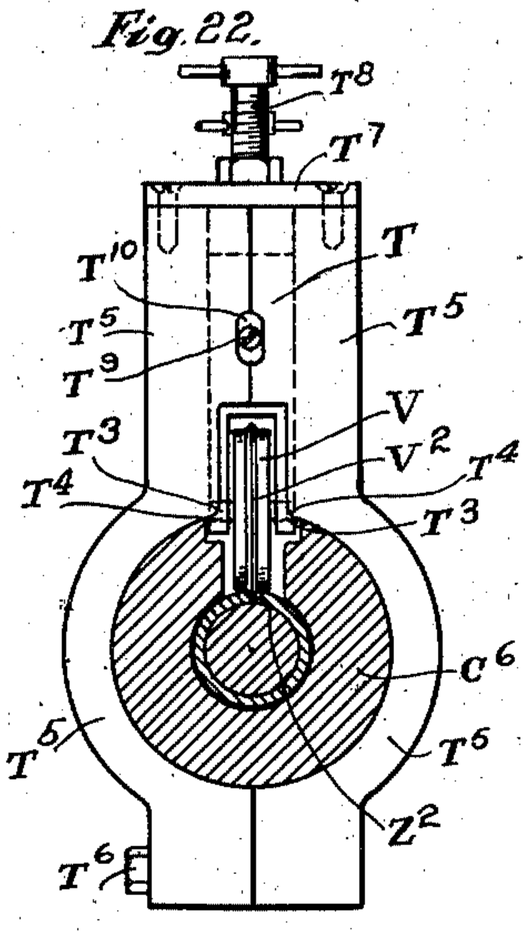
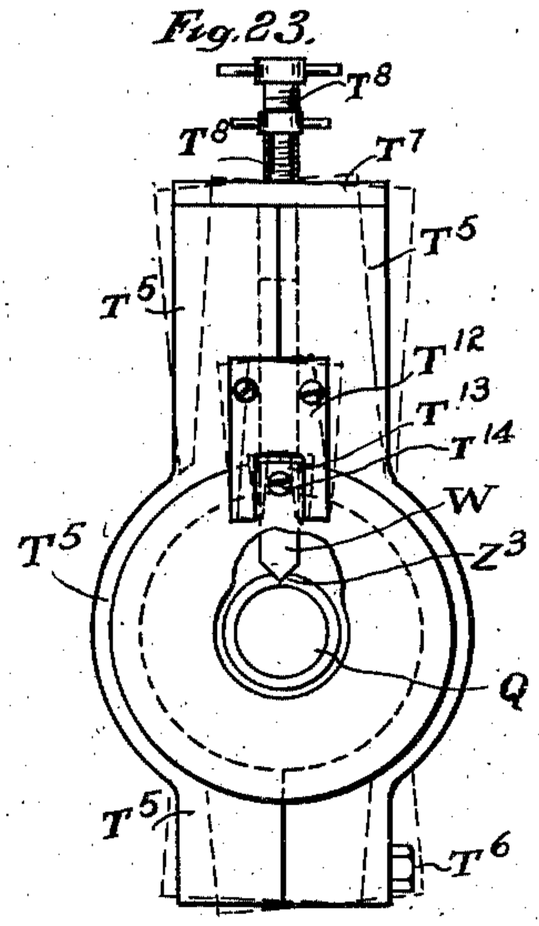


Fig. 23.



Witnesses.
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Fig. 24.

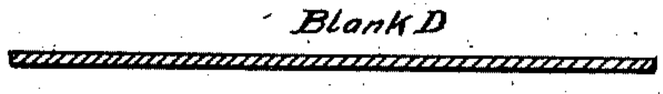


Fig. 25.

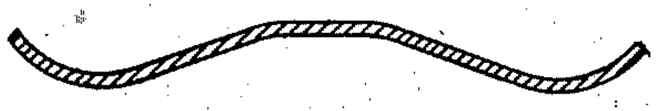


Fig. 26.

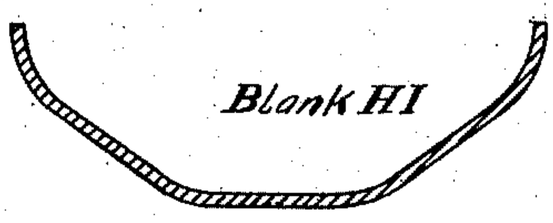


Fig. 27.

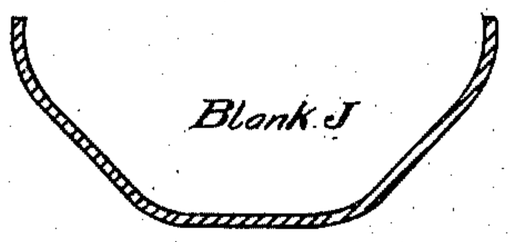
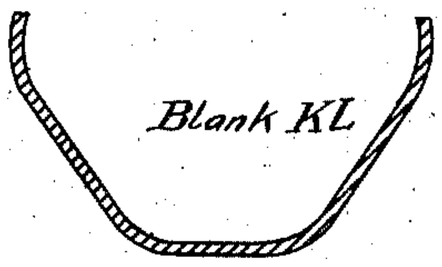


Fig. 28.



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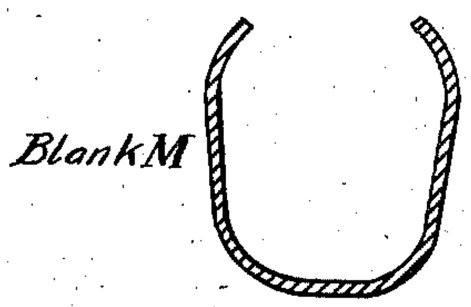


Fig. 30.

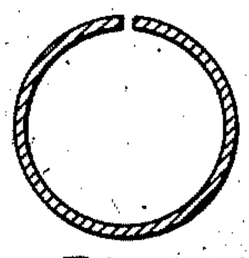


Fig. 31.

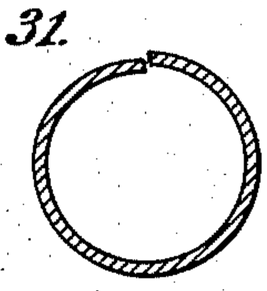


Fig. 32.

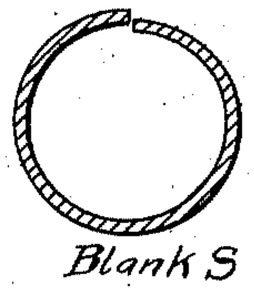


Fig. 33

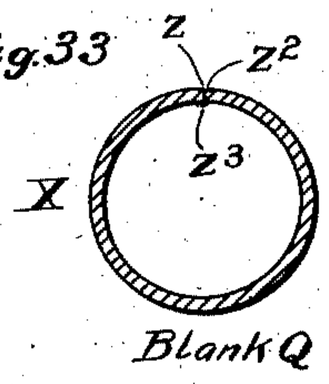


Fig. 34

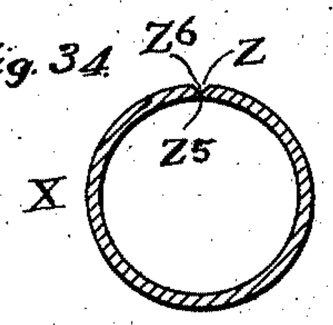
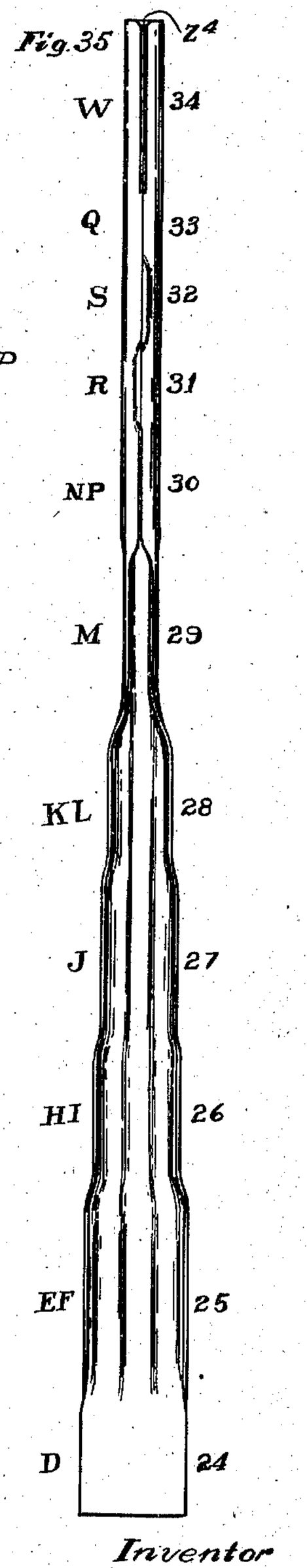


Fig. 35



Witnesses.
H. Smith.
Charles H. Spiegel.

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Henry Higgin
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Attorney

UNITED STATES PATENT OFFICE.

HENRY HIGGIN, OF NEWPORT, KENTUCKY.

MACHINE FOR MAKING SHEET-METAL TUBES.

966,916. Specification of Letters Patent. Patented Aug. 9, 1910.

Application filed August 9, 1909. Serial No. 511,944.

To all whom it may concern:

Be it known that I, HENRY HIGGIN, a citizen of the United States, and a resident of the city of Newport, in the county of Campbell and State of Kentucky, have invented certain new and useful Improvements in Machines for Making Sheet-Metal Tubes, of which the following is a specification.

The several features of my invention and the various advantages resulting from their use conjointly or otherwise will be apparent from the following description and claims.

In the accompanying drawings forming a part of this specification and in which similar letters of reference indicate corresponding parts,—Figure 1 shows a plan view of a machine embodying my invention. Fig. 2 is an elevation of that side of the machine which is nearest the spectator in Fig. 1. Fig. 3 is an elevation of that side of the machine which is farthest from the spectator in Fig. 1. Fig. 4 is a view partly in section and partly in elevation of that end portion of the machine which is at the right hand in Fig. 3. The section is a vertical one taken in the plane of the dotted line 4, 4, of Fig. 1, and includes only certain of the upper parts of said end portion. Fig. 5 is a view partly in elevation, but mostly in section of that pair of rolls which forms the initial bends in the metal sheet. The section is taken in the plane of the dotted line 5, 5, of Fig. 3. Fig. 6 is a view in elevation of the idler roll which holds the metal in position for entering between the second pair of rolls, namely those which alter a portion of the said initial bends in the said metal sheet. Fig. 7 is an elevation of the second pair of rolls, and which act upon the sheet metal having received said initial bends and change certain of these bends in the course of preparing the tubing. Fig. 8 is a sectional view taken in the plane of the dotted line 8, 8, of Fig. 3. This Fig. 8 shows the mechanism for advancing the already bent metal from the said second pair of rolls on to the third pair of rolls. Fig. 9 is an elevation of the third pair of rolls that positively act upon the bent sheet metal to impart to it more complete formation. Fig. 10 is an elevation of a device still further bending the bent metal toward the shape of a perfectly round tube. Fig. 11 is an elevation of the fourth pair of rolls for imparting a perfect tubular form, round in cross section to the bent sheet metal tube. Fig. 12 is a side elevation of the mechanism which operates upon the already formed tube, to impart to both edge portions of the tube, that is, to the opposing edge portions an elastic pressure in the direction of each other, so that each opposing edge shall press against the other, and form a perfect tube, ready for brazing. In this figure, a mid portion of the machine is broken away to disclose the sheet metal tube and its temporary combination with the core. In this figure, certain dotted lines which might have been naturally expected to be present are omitted for perspecuity. Fig. 13 is a view partly in section, but for the most part in elevation, of a part of the mechanism shown in Fig. 12. Said section is taken through Fig. 12, in the plane of the dotted line 13, 13, and shows that end of the section which faces toward the left in said Fig. 12. Fig. 14 is a view of that portion of the machine which is near the left hand end in Fig. 12. This view is partly in elevation and partly in section,—the section being a central vertical one, in the direction of the length of the machine. Fig. 15 is a view of the top of the core and of its connecting rod, the middle portion of the said rod being broken away and removed, and the front end portion of the rod being brought toward the rear for economy of space in the drawing. Fig. 16 is a side elevation of the core and rod shown in Fig. 15. Fig. 17 is a transverse section of the core taken in the plane of the dotted line 17, 17, of Fig. 16, with the tubular sheet metal blank surrounding the said core. Fig. 18 shows a transverse section of the core taken in the plane of the dotted line 18, 18 of Fig. 16, with the tubular sheet metal blank surrounding the core, and subjected to the action of one of the rolls, the latter being shown in elevation. Fig. 19 shows a transverse section of the core, taken in the plane of the dotted line 19, 19, of Fig. 16, with the tubular sheet metal blank surrounding said core, said blank being shown subjected to the action of one of the rolls, the latter being shown in elevation. Fig. 20 is a transverse section of the core, taken in the plane of the dotted lines 20, 20, of Fig. 16, with the tubular sheet metal blank surrounding it, and complete as a tube. Fig. 21 is a view partly in elevation and partly in section of the devices employed in scarfing the seam of the tube. Fig. 22 is a front elevation of the mechanism shown in Fig. 21, the arbor, the

sheet metal tube and the core being shown in section. Fig. 23 is a rear elevation of the mechanism shown in Fig. 21. Figs. 24, 25, 26, 27, 28, 29, 30, 31 and 32 are cross sections of those portions of the sheet metal tubular blank which are respectively shown at the portions marked 24, 25, 26, 27, 28, 29, 30, 31 and 32 of Fig. 35. Fig. 33 is a cross section of that portion of the said tubular blank, a completed tube, and which is shown at 33 in Fig. 35. Fig. 34 is a cross section of that portion of the tube which is shown at 34 in Fig. 35. Fig. 35 is a top view of a strip of sheet metal, viz.: the sheet metal blank, the respective portions of which have been respectively subjected to those respective portions of the machine that operate upon the said sheet metal blank. The strip which this figure represents was in the machine, and extended from one end of the machine to the other, and was lifted out of the machine after the parts of the machine were temporarily removed for this purpose.

I will now describe my invention in detail.

A indicates the basal frame, that may be made in one piece or in parts secured together.

B, B^2, B^3, B^4 indicate upright portions of the frame, one of whose offices is to support respectively certain rolls, which operate to form the sheet metal into a tube.

C, C^2, C^3, C^4, C^5 indicate other upright portions of the framework, which serve to perform other functions and offices which will be hereinafter apparent.

At the front or mouth of the machine, I preferably locate the preliminary guide. This guide D is supported upon the framework C. This guide D is composed of outer adjustable parts. A broad flat table is present, composed of two parts D^2, D^2. At the outer edge portion of each part D^2 is an upright D^3, and on the top of the latter is a piece D^4, which projects inwardly from its upright D^3 and over the part D^2 which supports its upright. The preferred means for connecting each piece D^4 and its upright D^3 to its part or semi-table D^2 are bolts D^5. Both of these semi-tables D^2 are slidable in grooves on guides D^7 in a supporting bracket or plate D^6. On this bracket plate D^6 is fixed a pillow block or large lug D^8. A shaft D^9 is rotatable in this block D^8. Outside of the block this shaft D^9 is screw-threaded, and on one side of the block D^8 the thread is a left hand screw D^{10}, and on the other side of this block D^8 the thread is a right hand screw D^{12}. The shaft has a means for rotating it, and one such means is shown in the thumb piece D^{13}. Each screw on said shaft engages a female screw in that semi-table D^2 to which it is adjacent. Thus a rotation of the said shaft D^9 in one direction approximates the compound guides, each consisting of a semi-table D^2, upright wall D^3 and the projection D^4, and a rotation of the said shaft in the opposite direction operates to separate the said compound guides. These guides can therefore be adjusted so that the space between the upright walls D^3, D^3 is substantially the same as the width of the sheet metal which is to be made into tubing, and the guides therefor can be efficient.

The supporting bracket plate D^6 is suitably secured to the frame C^2, C^2. In the present instance, the screws D^{14}, D^{14} constitute such means.

Next at the rear of the guide D are the forming roll E and the forming roll F. These rolls are supported by the upright frame pieces B. The middle portion E^2 of the periphery of the roll E is concave, and the outer or edge portions E^3, E^3 are convex. The middle portion F^2 of the periphery of the opposing roll F is convex, and the outer portions F^3 are respectively concave. The blank of flat sheet metal enters the machine through the guide D and is passed between these rolls E and F. These rolls form the said blank into the shape shown in Fig. 25.

At this point in the specification, I will describe the preferred mode of erecting, supporting and adjusting the rolls E and F. Each roll is fixed on a shaft E^4. The journals E^5, E^5 of each shaft E^4 are respectively located in the bearings E^6, E^6, which bearings are respectively supported in the said side frames B. Each of the bearings E^6, E^6 slides in its supporting frame. Each upper bearing E^6 is made vertically adjustable by means of a screw E^7 screwed into the lower bearing, this screw E^7 and the nut E^8 being located between the upper and lower bearings, and also by the supplemental screw E^9 screwed through the upper portion of frame B and bearing against the upper bearing E^6, and provided with a set nut E^{10}. Each shaft E^4 has a shoulder E^{12} next one bearing to prevent said shaft slipping through said bearing, and next to the opposite bearing carries a washer E^{13} screwed onto the shaft E^4 and is in fact an adjustable shoulder. This latter prevents the shaft from slipping through the adjacent bearing. A series of sleeves E^{14}, E^{15}, E^{16} and E^{17} on each shaft serve to keep the upper roll E in alinement with the lower roll F.

It is to be understood that the preferred mode of erecting, supporting and adjusting the succeeding pairs of rolls, to wit: the rolls H and I of frame B^2; the rolls K and L of frame B^3 and the rolls N and P of frame B^4, is exactly like that just described in relation to the rolls E and F. The bar B^5 connecting the upper ends of each of the parts of each frame B, B^2, B^3 and B^4 is preferably a continuous one and extends over all of said frames.

Next behind the initial rolls E and F is the device G for guiding the sheet metal blank thus formed forward to the succeeding pair of rolls H, I. This feeding device G consists of a roller G^2 journaled respectively at G^3, G^3, in the flanged ends of a hanger or support G^4, attached to a supporting cross beam G^5 in turn supported at each end by the frame C^2, C^2 aforementioned. Upright walls G^6, G^6 are present sliding each in a groove in a basal cross piece G^7,—the latter at each end fixed to its adjacent frame upright C^2. The upper end portion of each wall is slidable in a groove in the cross-beam G^5. Set bolts G^8, one for each wall G^6, are present. By screwing down the nut of the set bolt G^8, it will tighten against the beam G^5 and set the wall G^6 of which it forms a part. The width of the space between the walls G^6, G^6 can thus be regulated to suit the width of the partially bent metal blank, and is an efficient guide. The partially bent sheet metal blank now enters between the second pair of forming rolls H and I. These rolls are duly supported in the upright frames B^2, B^2, one at each side of these rolls. The middle portion H^2 of the roll H is flat and projects beyond the outer or side portions of the periphery. These side portions are of two shapes. That part H^3 nearest the middle part H^2 inclines slowly away from the middle part and then joins the outer part H^4 which rapidly convexly curves over toward the extended axis of this roll and to the adjacent side of this roll. The periphery of the roll I is in general concave. The middle portion I^2 is flat and the part I^3 adjacent on each side inclines upward and outward. The outer part I^4 next to each side of the roll does preferably not come close to the part H^4 of the roll H as does the part I^2, and the parts I^3 to their opposing faces H^2 and H^3 of the roll H, but extend in a concave curve somewhat flat and terminating at the side of the roll I at a distance from the roll H and in a plane quite beyond the plane of the side of the roll H. The roll I is as shown thicker than the roll H. As the partially bent blank passes through this roll it is bent into the shape shown in Fig. 26.

From the rolls H and I, the bent metal blank passes to the metal tube forming device and guide J. This consists of a roller J^2, journaled in bearings J^3, J^3, hung on a support J^4, connected to plate J^5, supported on two standards J^6, J^6. The plate J^5 is provided on each side of the support J^4 with a slot J^7. The screws J^8 which connect the plate J^5 to the standards J^6, J^6, through the intermediate means of the vertical bars J^{16} extend respectively through the said slots J^7, J^7, and are screwed into their respective standards J^6. In furtherance of this provision for moving the standards J^6, J^6 nearer together or farther apart, a screw threaded bar J^9 is present, whose right hand screw J^{10} and left hand screw J^{12} respectively engage the respective female screws in the respective standards. This bar J^9 is itself prevented from sliding by being journaled at its midlength in a bearing J^{13}, whose shoulders abut against the adjacent ends of the screws, and which bearing is fixed to the stationary basal frame A. The base of each standard J^6 is enlarged into a foot or flange. The standards set in a grooved guide J^{14}, and this foot of the standard extends at the front and rear under an adjacent flange J^{15} of the guide J^{14}. By duly rotating the screw bar J^9, the standards can be separated or approximated at will. In this way the width of the space J^{17} at the roller J^2 can be regulated to suit the width of the bent metal blank; and the operation of guiding this blank can be made very efficient.

In order to always keep the roller J^2 at a proper altitude relatively to the bottom of the space J^{17}, that the imparting of a special shape to the partially bent sheet metal blank may be satisfactorily done, a provision for the vertical adjustment of the roller J^2 through the preferred means is as follows: The plate J^5 is directly supported on the upright bars or pillars J^{16}, each of which is slidable in that recess J^{18} in its standard J^6 which holds it (said bar J^{16}). Each plate J^5 is held to the bars J^{16} by the adjacent one of the screws J^8. A set screw J^{19} screwed into the pillar abuts against the said vertical bar J^{16}. The bars J^{16}, J^{16} are raised or lowered carrying with them the plate J^5 and the roller J^2. When the desired position of the roller J^2 in the space J^{17} has been secured, each set screw J^{19} is tightened and the parts are thus fixed in the proper working position. By this tube forming device J, the tube blank formed as shown in Fig. 26, is now so bent that it takes the shape shown in Fig. 27.

From device J, the bent metal blank passes to the rolls K, L. The upper roll K has the middle portion K^2 of its periphery flat. Those parts K^3, K^3 of the periphery which are adjacent to the middle portion K^2, are each quite sharply inclined away from said portion K^3 toward and to their respective sides of the roll K. This roll K is on each side provided with an annular shoulder K^4, concentric with the roll, and forming a supplemental part of this roll K. Opposed to this roll K is the roll L. The peripheral portion of this roll L is, in a general sense, concave. The middle portion L^2 of the periphery is flat. Those portions L^3, L^3 of the periphery which are adjacent to the said portion L^2 are rapidly inclined outwardly, and at their outer edges terminate in the concavely curved outwardly extending portions L^4, L^4. The annular shoulders K^4 of the roll K are respectively oppo-

site the concave portions L^4, L^4 of the periphery of the roll L. As the sheet metal blank is passed between these rolls K and L, it is caused to assume the shape shown in Fig. 28. From these rolls K and L, the sheet metal blank thus bent, passes to the sheet metal bending device M. In this construction, the space MS through which the tube passes is flat on the bottom M^2, and the sides M^3, M^3 of this space extend up and a little outward, and are slightly concave. Each side at its upper portion M^4 curves somewhat inwardly as shown. A central forming device M^5 extends down into this space and above has sides M^6, M^6, substantially flat and vertical, and below terminates in an extension M^7 having the shape, in cross section, of a truncated cone, inverted sides and the truncated cone being slightly rounded.

A provision for adjusting each side M^4, M^3 of the space M^2, so as to render the space wider or narrower is present. A provision for adjusting the central device M^5 higher up or lower down relatively to the bottom of the space M^2 is present. The preferred description of such provisions for said lateral and said vertical adjustment are respectively the same as those for the lateral and vertical adjustment of the roller J^2 of the sheet forming device J, and reference is hereby made to those means heretofore fully specified. As the bent sheet metal blank passes through this device M, the shape imparted to it is shown at Fig. 29.

From the device M, the bent sheet metal blank passes between the rolls N, P. The middle portion N^2 of the periphery of the roll N is concave, and in section is the half of a circle. This annular semi-circular, in cross section, groove N^2 is bounded by edges N^3, N^3, sufficiently wide to impart strength to the outer edges of this annular groove N^2. The lower roll P has an annular groove P^2, which is the exact duplicate of the groove N^2. The lower roll P has edges P^3, P^3, which are duplicates of the edges N^3, N^3 aforementioned. The opening between the rolls is circular. When the bent sheet metal tube is passed between these rolls N and P, it will be formed into a circular tube. But the junction of the meeting edges of this tube is not a perfect one. The junction is not absolutely close. For the purposes of forming a perfect tube, as well as for enabling the tube to be brazed, the seam formed by the meeting edges of the tube should be nothing more than a fine line. I have devised a mechanism and a mode whereby this seam can be made thus fine, and whereby the meeting edges of the tube shall not only actually meet, but shall elastically press against each other with an emphatic and forcible pressure. I will now describe this feature of my invention. I provide a metal core Q, and connect it to a rod Q^2 by a hinge connection Q^3. This rod I fasten to a stationary part of the machine, and also locate it so that as the sheet metal tube is formed, the tube shall close around it and inclose it, and as the tube is moved forward it shall move on over the core and receive the latter within it. By these means, the core is retained at a given place in the machine, and cannot be carried thence by the tube which surrounds it. I connect this core to the rod by a hinge Q^3, so as to allow the core to the better accommodate itself to that part of the tube in which it is, and so as to prevent it binding upon the sides of the tube, and by intense friction interfere with the desired onward movement of the tube, and with certain operations to which the tube is subjected at the place where the core is and while the core is within it. The preferred place where I fasten the rod Q^2 in the machine is at the sheet metal bending device M aforementioned, and the preferred mode wherein I secure the rod Q^2 there is as follows: I form an opening through the upper portion of the working part of this device M from front to rear. Through this opening I insert the rod Q^2. The free end of this rod has a screw thread Q^4 and on this end I screw the nut Q^5. The rod Q^2 extends thence between the rolls N and P, and thence on to where it is hinged at Q^3 to the core Q.

The core Q is combined with mechanism as follows: A cylindrical hollow arbor C^6 is supported upon the upright frames C^5. The preferred mode of securing it in place consists, as shown, in setting an extension C^7 of this arbor down into recesses C^8, C^8 of these frames C^5. Above, a broad plate C^9 binds this hollow arbor down in place in these recesses, and bolts C^{10}, C^{10}, extending down from this plate C^9 and screwed into the respective frame pieces C^5, C^5, hold this plate C^9 firmly in position. On this arbor C^6 are mounted two rolls respectively marked R and S. It is to be noted here that the rolls R and S respectively extend through respective openings in the arbor C^6 and come into close juxtaposition to the core Q. The mechanism for supporting these rolls R and S is substantially the same, and is as follows: Each housing consists of a slide T, provided with arms T^2, T^2. Each of these arms carries a journal bearing T^3. Between these arms the roll is located and its journals T^4, T^4, each enters the adjacent bearing T^3. This slide T is slidable in an embracing frame T^5. The lower portion of this frame T^5 embraces the arbor C^6 and is firmly secured thereto, by means of the screw T^6, which forcibly brings together the opposite portions of the frame T^5 and clamps them upon the arbor C^6. The upper halves of the frame T^5 are secured together by a cross bar T^7 bolted thereto. Through this cross bar T^7 is

screwed the adjusting rod T^8 whose lower end is secured in the upper end of the slide T, so that it can rotate in said slide T but cannot slip out of the latter. The roll carried in the slide T can be advanced toward the center of the arbor C^6 or retracted therefrom by properly rotating the adjusting rod T^8. The rolls R and S are separate from each other and the just described mechanism for supporting and adjusting the one roll is separate from that for supporting and adjusting the other roll. It will be observed that the roll R is inclined in one direction relatively to the vertical, and that the roll S is inclined in another direction relatively to the vertical, each roll making substantially the same angle on opposite sides of a vertical plane. The core Q extends through this arbor C^6. At one side of a vertical plane through the length of the core Q, the latter on its upper portion is provided with a depression Q^6, and farther along, at the other side of the said vertical plane, the said core on its upper portion is provided with a depression Q^7. These depressions Q^6 and Q^7 are shaped substantially as shown, and are preferably connected at Q^8. That portion of the core Q which has the depression Q^6 is so located in the arbor C^6 with relation to the roll R, that the latter will be opposite the mid-length portion of the depression Q^6 of the core. The roll S is also so located that it will be opposite the mid-length portion of the depression Q^7 of the core Q. Each of the rolls R and S comes so close to the roll that only a substance of the thickness of the sheet metal of the tube can come between the roll and the bottom of that depression in the core Q that is beneath the said roll. The mode in which these features of my invention operate is as follows: The bent sheet metal blank coming from the rolls K and L, passes through the tube forming device M and on to the rolls N and P. The top of the bent blank is yet open and the rod Q^2 connected to the core Q is received into the interior space within the said blank. The said blank travels through the rolls N and P, and is there bent into a circular tube which encircles the rod Q^2. As this now tubular blank is advanced it receives the core Q and moves on over this and comes to the depression Q^6 of the core. It will be remembered that the edges of this tubular blank do not fully meet, or if meeting do not press against one another with any such pressure as is desirable to have them do, in order to have them make a perfect and durable union, when afterward brazed together. The condition and form of this tubular blank is illustrated in Fig. 17. When this tubular blank comes to this depression, that edge portion RQ of the said blank is over the depression Q^6. As the said blank advances, the roll R engages this edge RQ of the said blank and bends it down into the said depression Q^6. As the said blank continues to advance, the edge RQ acted upon by the roll R will rise, but having been bent inwardly, as described, its tendency to spring outwardly and away from the opposite edge SQ, has been destroyed, and an elastic tendency to spring forward against the edge portion SQ when in true tubular position has been created in it. As the said blank continues to advance, this edge RQ is moved up out of the depression Q^6 and onto the true cylindrical surface of the core Q, and the edge portion SQ is brought over the depression Q^7 of the core Q, and as the said blank continues to move forward the said edge SQ is brought under the roll S, and this roll S acts upon this edge SQ and bends it down into the said depression Q^7. As the said blank continues to advance, the edge portion SQ acted upon by the roll S will rise, but having been bent inwardly, as described, its tendency to spring outwardly and away from the opposite edge RQ has been destroyed and an elastic tendency to spring forward against the edge portion RQ already acted upon by roll R, has been created in it. As the said tubular blank continues to advance, the edge portion SQ is moved out of this depression Q^7 and is brought upon the true cylindrical surface of the core Q. The edge portions RQ and SQ are now close against each other at their meeting edges, and there is not only no space between such edges, but the said edges are pressing against each other, with elastic force. The tube is now successfully manufactured, and is a complete tube and will bear the ordinary manipulations incident to the turning of it down, the polishing of it, and other manipulations of manufacture. Its form in cross section is indicated in Figs. 20 and 33, the tube there being marked X.

It should be here noted that leaving the edges of the sheet metal blank flat, square and not chamfered, before the sheet metal blank passes between the rolls N and P, enables the edge portions of the tubular blank to resist pressure and the better enables the metal to flow out, that is, to conform to the walls of the said rolls N and P.

The screws T^8, T^8 enable the roll R or S, as the case may be, to be advanced or retracted relatively to the bottom of the depression it is opposite, and to be adjusted not only to take up wear, but to be adjusted to act upon a thicker or thinner sheet metal according to the thickness of the metal employed in the manufacture of the blank.

In the finer grades of sheet metal tubing, it is desirable to braze the meeting edges of the tube, for among other reasons, so that neither of the said edges can be, by local pressure, bent down and out of the true circular form of the cylindrical tube, and so

that at the junction of these edges the tube shall be substantially as strong as at other portions of it.

The sheet metal blank fed to the machine is a strip usually cut from a broad sheet of metal, and on each edge there is usually found a slight bur. This bur is located on one side of each edge, and usually on the same side. Also on that side of the edge opposite where the bur is located, the metal is slightly diminished. In feeding the strip of metal to the tube forming machine, the strip is laid down so that the sides of the edges which carry the burs are undermost. As the tube is formed, the burs are turned in making a very slight extension Z^3 on the inside of the tube at the seam, and a very slight depression Z^2 on the outside of the tube at the seam, see Fig. 33.

I have devised a valuable and most efficient means for preparing the meeting edges of the tube X for the reception of the brazing compound. These means are as follows: After the tube has been completed, it is advanced to a roll V having a thin peripheral edge V^2, adapted to enter the slight shallow groove Z^2 at the meeting edges of the tube X. This roll V is supported upon mechanism that allows it to alter its position so that the central radial plane of the roll will always be coincident with the plane passing through the axis of the tube X. While the peripheral edge V^2 is in the said groove Z^2 in the outer part of the seam Z of the tube, it is desirable that a core or true cylindrical bar be present beneath where the said edge V^2 of the roll V is, in order to properly support the tube.

Before introducing the sheet metal blank into the machine, it is desirable to cut off the corners diagonally. Then when the tube is formed, there will be at its forward end a V-shaped recess Z^4, see the upper end of the tube in Fig. 35. Obviously when the sharp bead V^2 of the roll V meets this recess Z^4, the latter will guide the said bead V^2 to and into the said hollow groove Z^2 of the seam Z. Once in the said groove, the bead V^2 will follow it until the entire metal blank has been formed into a tube and has passed out from the machine. Connected to this roll V and at the rear of it, is a scarfing tool W, whose knife enters the groove Z^2 of the seam Z. The core Q extends under this scarfing tool W to give a support to the tube where this tool bears against it.

The frame that holds the roll V and the frame that holds the cutting (scarfing) knife are rigidly connected together, so that the oscillation of the guide roll V as it finds the groove Z^2 of the seam Z and follows the same is communicated to the scarfing tool W. Therefore the scarfing tool W is always in alinement with the guide V, and will always work accurately, and scarf both edges of the groove Z^2 of the seam Z alike. This result of this scarfing is shown in Figs. 23 and 34. By this operation, the edges of the seam are each scarfed so that a V-shaped groove is present in the outer part of the seam and such a V-shaped groove I indicate by the character Z^6. But the edges of the seam Z are not scarfed for their entire depth, but the inner portion of each edge at Z^5, see Fig. 34, is left flat as in the original edge of the metal blank, and these edges here coming together make a close joint and support each other. Into this groove the brazing compound is introduced and the brazing operation is duly finished.

The preferred means for carrying the roll V, V^2 is similar to those employed to carry the rolls R and S respectively. There is present a two part clamp frame T^5, T^5, located on an arbor such as C^6, and in the present illustrative instance, the arbor C^6 is continued from the frames of the rolls R and S on through this clamp frame of the roll V, V^2. The clamp frame is secured to the arbor by the screw T^6, but the frictional pressure is not so great as to prevent the clamp frame from being rotatable on the arbor C^6.

The upper ends of the frame T^5, T^5 are secured together by the bar T^7, bolted thereto. Within the frame is a slide T, slidable in the frame T^5, T^5, and whose arms T^2, T^2, respectively have the journal bearings T^3, T^3, which latter respectively engage the journals T^4, T^4 of the roll V, V^2. An adjusting screw T^8 is present, connected to the slide T, as it is in the device shown in Fig. 14, and serves to elevate and depress the roll V, V^2 the desired distance. A set screw T^9 in a slot T^{10}, limits the vertical movement of the slide T.

As to the preferred mechanism for carrying the scarfing tool W, this tool W is mounted in the frame T^5, T^7, with nut T^6, which carries the guide roll V, V^2, but this scarfing tool W is provided with its own slide holder T and adjusting screw T^8. A projection T^{12} fixed to the frame T^5, T^5, is provided with a recess T^{13}, and within this recess is a screw stud T^{14}, fixed to the stationary arbor C^6. The oscillation of the frame T^5, T^5, T^7 is limited by the width of the recess T^{13} in which the screw stud T^{14} moves.

There are obviously great advantages in imparting the elastic spring to the edge portions of the tube so that they will meet squarely and press hard against one another. There is also obviously a marked advantage in scarfing the edges of the seam Z after the edges have received such an elastic pressure toward each other and in alinement with each other. Where the edges of the sheet metal blank are scarfed while yet in its condition of a flat metal sheet, the diffi-

culty of making these edges properly meet is practically insurmountable. So also any imparting to the edge portions the desired elastic pressure toward each other and in direct alinement is practically prevented.

The manner in which my machine operates as an entirety is as follows: The flat sheet metal blank is first introduced into the guide D, and the form of this blank shown in cross section and marked Blank D is not changed in passing through this guide D. The said metal blank next passes the rolls E and F and receives the shape in cross section shown in the blank marked Blank EF, Fig. 25. The said blank thus formed passes without change through guide G. It then passes between the rolls H and I, and receives the shape shown in cross section shown in the Blank HI of Fig. 26. It then passes through the forming guide J, and acquires the shape in cross section shown by the blank marked Blank J, Fig. 27. It then passes through the forming rolls K, L, and receives the shape shown in cross section in the blank marked Blank KL, Fig. 28. It next passes through the forming guide M, and receives the shape shown in cross section in the blank marked Blank M, Fig. 29. It next passes through the rolls N, P, and it is formed into the tubular shape shown in cross section by the blank marked Blank NP, Fig. 30. This tubular blank is now subjected to the action of roll R, and while under said roll acquires the shape shown in cross section by the Blank R, of Fig. 31, but this edge portion of the tube which is depressed is moved outwardly by the core and is received upon the cylindrical surface of the latter. This tubular blank is now subjected to the action of the roll S, and while under said roll is bent to the shape shown in cross section, as shown by the Blank S, of Fig. 32. This tubular blank is now subjected to the action of the core Q, and the cylindrical portion of the core succeeding the said depressions Q^6 and Q^7 receives the tube and brings the two edges of the tube opposite one another, and causes the blank to assume the shape shown in cross section, as shown by the blank marked Blank Q, which latter is a perfect tube, with the edges of the seam Z, Fig. 33, in contact and exerting a pressure toward each other. This blank is now subjected to the action of the scarfing knife W, guided by the roll V, V^2, in the slight shallow depression Z^2 in the upper part of the seam Z, and the outer portions of the edges of the blank at the seam are scarfed, leaving a V-shaped groove Z^6 at the outer part of the seam of the tube X, the inner part of the seam of the said tube X being the close seam Z heretofore mentioned, Fig. 34. This blank thus made I have marked Blank W, and it is shown in Fig. 34.

By the conformation shown in Fig. 25, the midlength portion is not materially bent and the metal there is yet soft. Under the action of the rolls N, P, this Blank M is shaped into Fig. 30, Blank NP. In this operation, the upper end portions of the blank, Fig. 30, contain a space of larger radius than that of the completed tube, and being the weaker parts because not braced at all against side pressure come together first. The soft midlength assists in enabling the circular shape (in cross section) to be readily attained.

The soft metal at the midlength or bottom of the blank first conforms to the action of the rolls and becomes circular and then forms the brace so to speak, whereby the sides of the blank are forced and bent into conformation with the sides of the operating space of these rolls N and P.

The metal blank shown in Fig. 35 is to be run entirely through the machine before the parts of it assume the completed condition of the part shown at W, Fig. 34.

It will be understood without further remark, that metal strips of a length much greater than that of the machine can be manufactured into tubing by being run into and through the machine.

It will be obvious from the above description that my invention is capable of considerable modification without material departure from the principles and spirit of the same, and for this reason I do not wish to be understood as limiting myself to the precise form and arrangement of the device herein set forth in carrying out my invention in practice.

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

1. In a tube making machine, the combination with means for bending a sheet metal blank into a tubular shape, of a core provided with a depression into which one edge portion of the tube is pressed, and provided with a succeeding depression into which the other edge of the tube is pressed, and a roll for bending the first named edge portion into the first depression, and a roll for next bending the opposite edge portion of the said tubular blank into the second depression, the core being cylindrical at the farther end of the depressions to elevate the edge portions after being depressed.

2. In a tube making machine, the combination of a pair of rolls adapted to bend the metal blank into a tubular shape, a core and a guiding rod thereto, the guide extended between the said rolls, and being adapted to be embraced within the tubular blank and the core being adapted to be within the said tubular blank, the core being provided with a depression into which one edge portion of the tubular blank is pressed, and provided with a succeeding depression into which the opposite edge portion of the tube is pressed,

and a roll for bending the first named edge portion into the first depression, and a roll for bending the second named edge portion into the second depression, the core being cylindrical at the farther end of the depressions to elevate the edge portions after being depressed.

3. In a tube making machine, the combination of a pair of rolls adapted to bend the blank into a tubular shape, a core and a rod coupled thereto, the rod being connected to the machine in advance of the rolls, and extending rearward between said rolls, and a core provided with two depressions, one after the other, a roll being opposite each of said depressions, the rod and core being adapted to be received and to be within the tubular blank as it comes from said first named pair of rolls, and the roll, opposite its said depression of the core, adapted to press an edge portion of the blank therein, and the roll opposite the other said depression of the core adapted to press the opposite edge portion of the blank therein.

4. In a tube making machine, the combination of a pair of rolls adapted to bend the blank into a tubular shape, a device preceding this pair of rolls and adapted to partially shape the said blank, a core provided with two depressions, the one succeeding the other, and a roll opposite each depression, the one of these last named rolls adapted to press one edge portion of the tubular blank into one of these depressions and the other of these rolls adapted to press the opposite edge portion of the blank into the other of these depressions, the core and its said rolls, coming after the first named pair of rolls, and a rod hinged to the forward end of this core and extending forward between the said first named pair of rolls and connected to said tube shaping device preceding said first named pair of rolls.

5. In a tube shaping machine, mechanism for shaping the sheet metal blank into a tube, and a device for scarfing the edges of the seam of the tube and consisting of a roll and a scarfing tool, the roll provided with a peripheral sharp bead adapted to enter the outer portion of the seam, a support for the roll adapted to allow the roll to change its position so that the plane of the roll shall pass through the axis of the tube, the scarfing tool being connected to the frame of the said roll, and altering its position as the roll does, relatively to the seam of the tube to be scarfed.

6. In a tube shaping machine, mechanism adapted to shape a sheet metal blank into a tube, and a device for scarfing the said tube consisting of a carriage and a roll provided with a sharp peripheral bead adapted to enter and follow the seam of the tube, and a scarfing knife located after the roll and with connection therefor with the carriage of the roll, said connections adapted to compel the said scarfing knife to change its position with the said roll, and thus follow in the said seam, and scarf its edges.

7. In a tube shaping machine, mechanism adapted to shape a sheet metal blank into a tube, and a device for scarfing the said tube, consisting of a roll provided with a sharp peripheral bead adapted to enter and follow the outer portion of the seam of the tube, and a scarfing knife, and a carriage for the roll with means to allow the roll to shift transversely to enter and to follow the said seam, and the said scarfing knife connected to the said carriage and adapted to follow in the seam and to scarf the outer edges thereof.

8. In a tube shaping machine, mechanism adapted to shape a sheet metal blank into a tube, a device for scarfing the said tube consisting of a carriage, a roll provided with a sharp peripheral bead adapted to enter and follow the seam of the tube and means to allow the roll to shift transversely, and a scarfing knife located after the roll and with connection therefor with the carriage of the roll, said connections adapted to compel the said scarfing knife to change its position with the said roll, and thus follow in the said seam, and scarf the edges.

9. In a tube making machine, a device for partially forming the blank, comprising a form having a space provided with a flat bottom, sides first inclined outward and then proceeding in an almost vertical direction in lines slightly curved, and a roll centrally located above the said flat bottom, and whose periphery is somewhat wider than said flat bottom, and means for adjusting the width of said space, and means for adjusting the height of the said roll relatively to the bottom of the form.

10. In a tube making machine, a device for partially forming the said sheet metal blank into a tubular form and consisting of two upright parts respectively located in slides, and a right and left hand screw secured to a stationary part of the machine, the right and left hand screws respectively engaging the respective upright parts, and adapted to approximate and separate said upright parts, each of these upright parts provided with one duplicate half of the space, whose boundary surface participates in the formation of the sheet metal blank, each of these upright parts having a recess, and a vertical rod sliding therein and a set screw for regulating the elevation of the said vertical rod, a device in the said space for assisting in the conformation of the said metal blank, a support for said device, this support being connected to the said vertical rods, and thus providing means for elevating and lowering the said forming device located in the said space.

11. In a tube making machine, a device for partially forming the blank, comprising a form having a space whose bottom is narrow from right to left, and whose sides incline upward and slightly outward for two thirds of their extent, and for the remaining third extending more rapidly inward and being for the whole of their extent curved, and a central device located in such space having straight sides as far apart as the bottom of the said space is wide, and having below an inverted truncated cone whose lower end is rounded.

12. In a tube making machine, a device for partially forming the blank, comprising a form having a space whose bottom is narrow from right to left, and whose sides incline upward and slightly outward for two thirds of their extent and for the remaining third extend more rapidly inward and being for the whole of their extent curved, and a central device located in such space having straight sides as far apart as the bottom of the said space is wide, and having below an inverted truncated cone whose lower end is rounded, means for adjusting the width of the said space and means for adjusting the height of the said central device, substantially as and for the purposes specified.

13. In a tube forming machine, a core adapted to take over it the tubularly formed blank, the core having two depressions succeeding one another, and two rolls respectively opposite such depressions, a hollow arbor, having a central passage through it, and in which passage the said core is located, and through which passage the said tubular blank embracing the core can pass, the arbor having spaces through which the said rolls respectively extend to the core, each roll provided with a carriage independent of the other carriage, each carriage having a two part frame surrounding the arbor and secured together at the arbor by a screw, the two part frame secured together at its upper end, a slide within said frame slidable therein, and carrying the roll duly journaled therein, an adjusting screw engaging the said frame and connected to the said slide, the mechanism thus permitting of the plane of the roll being shifted so that its plane shall change its angle relatively to the horizontal, and also permitting of the advance and retraction of the roll to and from the core.

14. In a tube forming machine, a core adapted to take over it the tubularly formed blank, the core having two depressions succeeding one another, and two rolls respectively opposite such depressions, a hollow arbor, having a central passage through it, and in which passage the said core is located, and through which passage the said tubular blank embracing the core can pass, the arbor having spaces through which the said rolls respectively extend to the core, each roll provided with a carriage independent of the other carriage, and means for changing the angle at which the plane of the roll meets the core, and means for adjusting the roll nearer to and farther from the said core.

15. In a tube forming mechanism, the roll having a sharp bead adapted to enter the outer portion of the seam of the tube, a scarfing tool for cutting the edges of the outer portion of said seam, the said roll and scarfing tool being connected, so as to oscillate around a common support, means for advancing and retracting the roll and means for advancing and retracting the said scarfing tool.

16. In a tube forming mechanism, the roll having a sharp bead adapted to enter the outer portion of the seam of the tube, a scarfing tool for cutting the edges of the outer portion of said seam, an arbor having a passage way through it, a core or anvil present therein, the passageway adapted to receive the said tube passing on around the said core, the arbor having openings through which the roll and scarfing tool extend into said passageway, a two part frame adapted to embrace the arbor, and fastened thereto, but capable of rotating thereon, the scarfing tool and the roll being connected to this frame, a slide in the latter carrying the roll and a screw for advancing and retracting the roll to and from the tube, a slide in the frame carrying the scarfing tool, and a screw for advancing and retracting the scarfing tool to and from the tube.

17. In a tube forming mechanism, rolls for forming the blank into a tubular form, a core and rod coupled together, the rod fastened in advance of said rolls, and passing between them, the rod and core adapted to be received within the tube as the sheet metal is folded around them while being formed into a tube, an arbor having a central passageway in which is said core and which is adapted to receive the said tube as it is passed on over the core, the core having two depressions succeeding one another, two rolls mounted to extend through said arbor and respectively opposite said depressions, a roll provided with a sharp V-shaped bead, and a scarfing knife located after the roll, this roll and said knife extending through said arbor and near to said core, and a carriage for said roll and knife adapted to turn upon the said arbor.

18. In a tube finishing machine, the combination of a guide roll whose narrow sharp peripheral bead fits into the seam of the tube, the carriage of the roll adapted to alter its inclination to permit the roll to follow in said seam, and a scarfing knife, attached to said carriage, and following said roll and adapted to scarf the edge of said seam, to the desired depth.

19. In a tube forming machine, means for

feeding a transversely bent tubular blank, a mandrel having longitudinal non-alining depressions corresponding with the adjacent edges of the blank and means for flexing the edges into said depressions, for the purpose set forth.

20. In a tube forming machine, means for feeding a transversely bent tubular blank, a mandrel having longitudinal non-alining depressions in sequence and corresponding with the adjacent edges of the blank and means for flexing the edges into said depressions, for the purpose set forth.

21. In a tube forming machine, means for feeding a transversely bent tubular blank, a mandrel having longitudinal non-alining depressions corresponding with the adjacent edges of the blank and means for flexing the edges into said depressions, with means for restoring the edges to normal position, for the purpose set forth.

22. In a tube forming machine, means for feeding a transversely bent tubular blank, a mandrel having longitudinal non-alining depressions in sequence and corresponding with the adjacent edges of the blank and means for flexing the edges into said depressions, with means for restoring the edges to normal position, for the purpose set forth.

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Attest:
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