No. 828,732. PATENTED AUG. 14, 1906.

F. G. FRANKENBERG.

MACHINE FOR BENDING AND COILING METAL RIBBONS.

APPLICATION FILED OCT. 20, 1905.

4 SHEETS—SHEET 1.

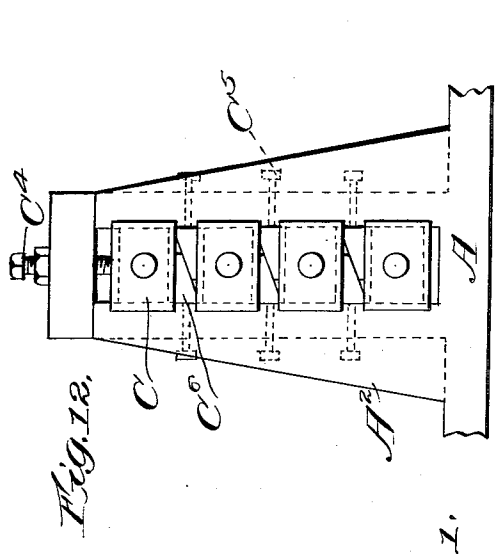

Fig. 12.

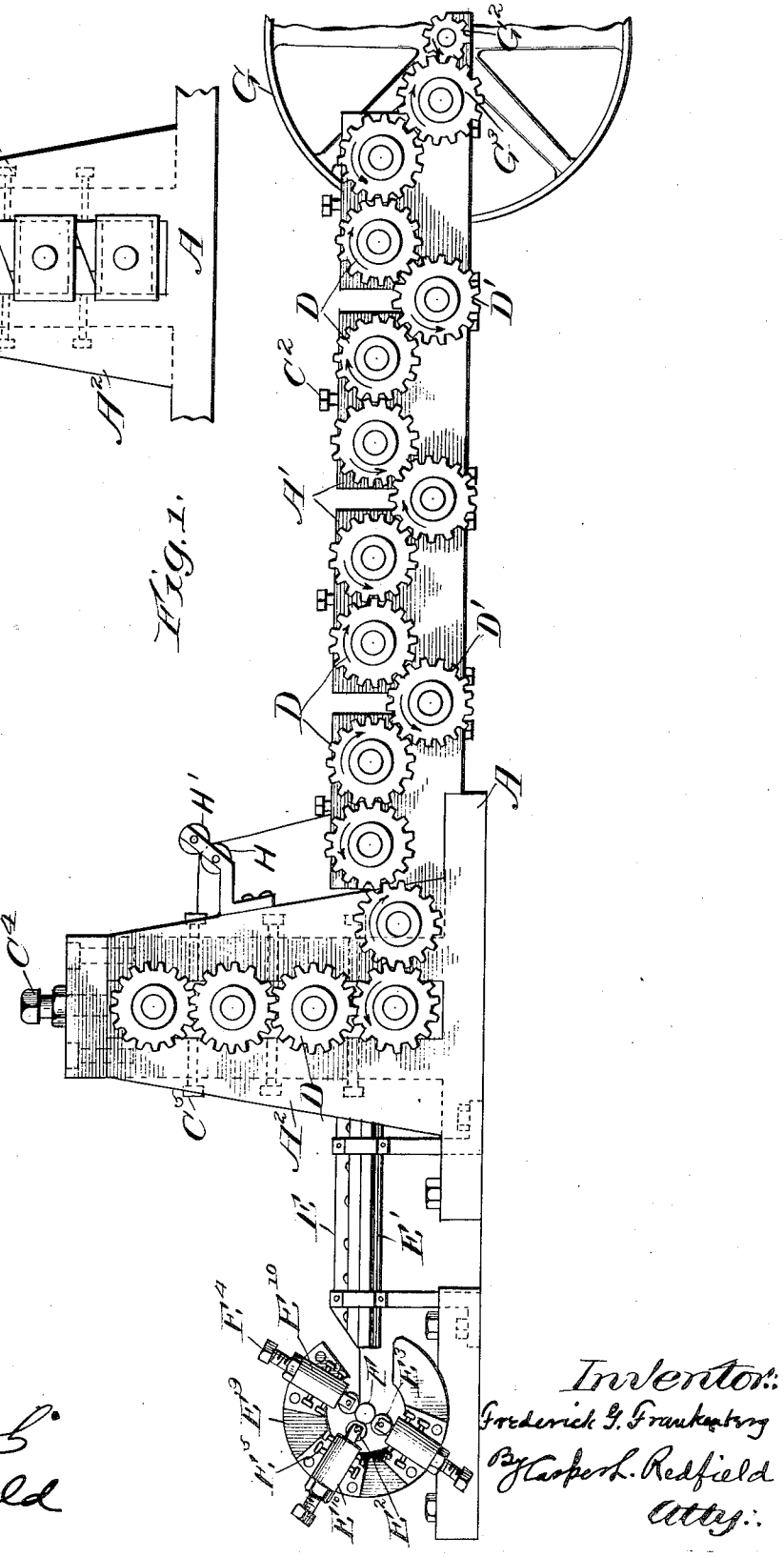

Fig. 1.

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4 SHEETS—SHEET 2.

Fig. 1.

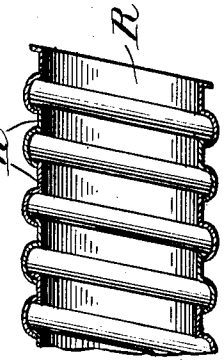
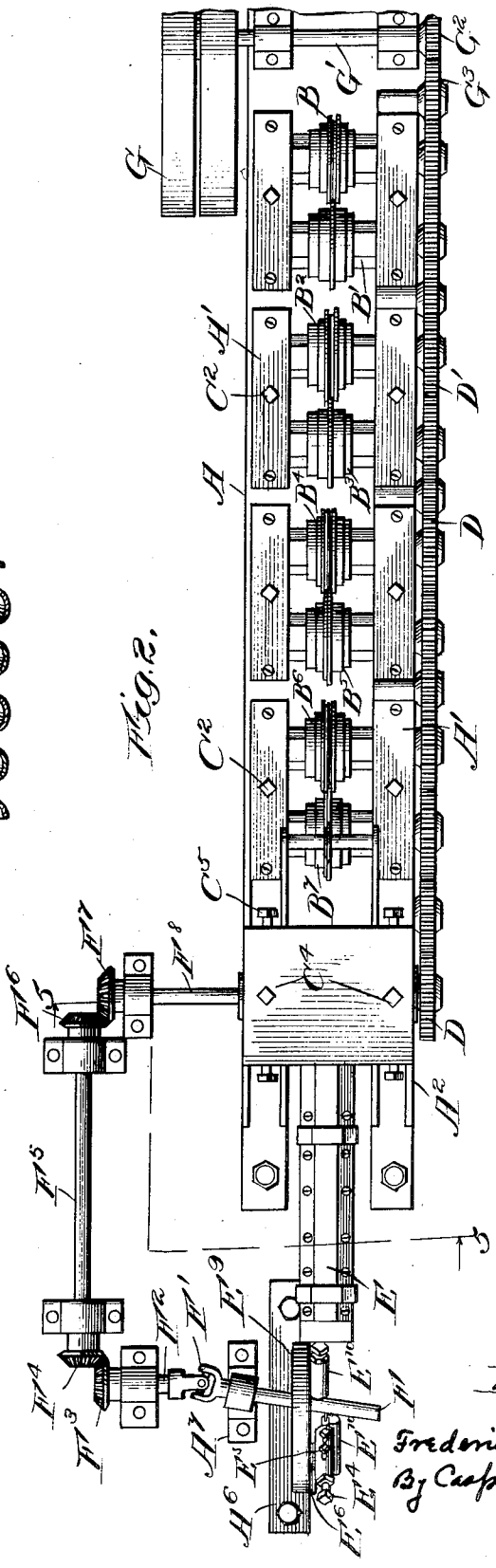



Fig. 2.

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4 SHEETS—SHEET 3.

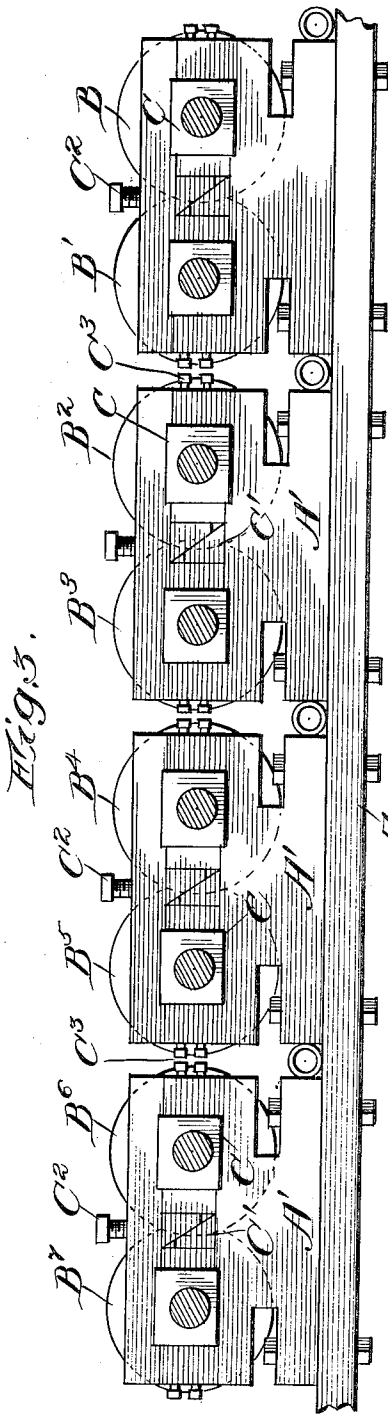
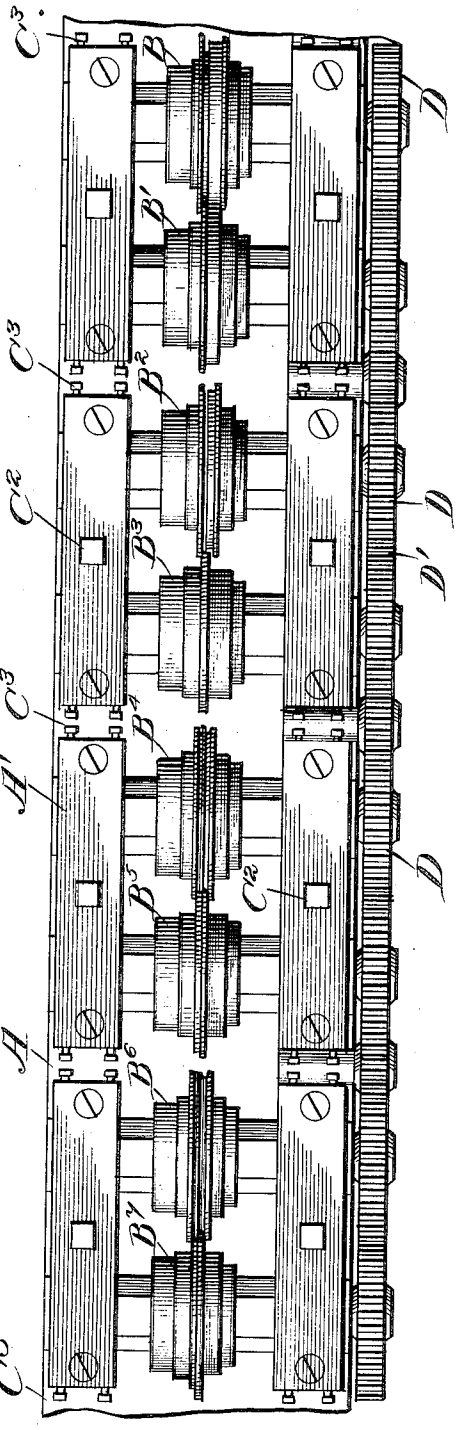


Fig. 5.



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4 SHEETS—SHEET 4.

Fig. 5

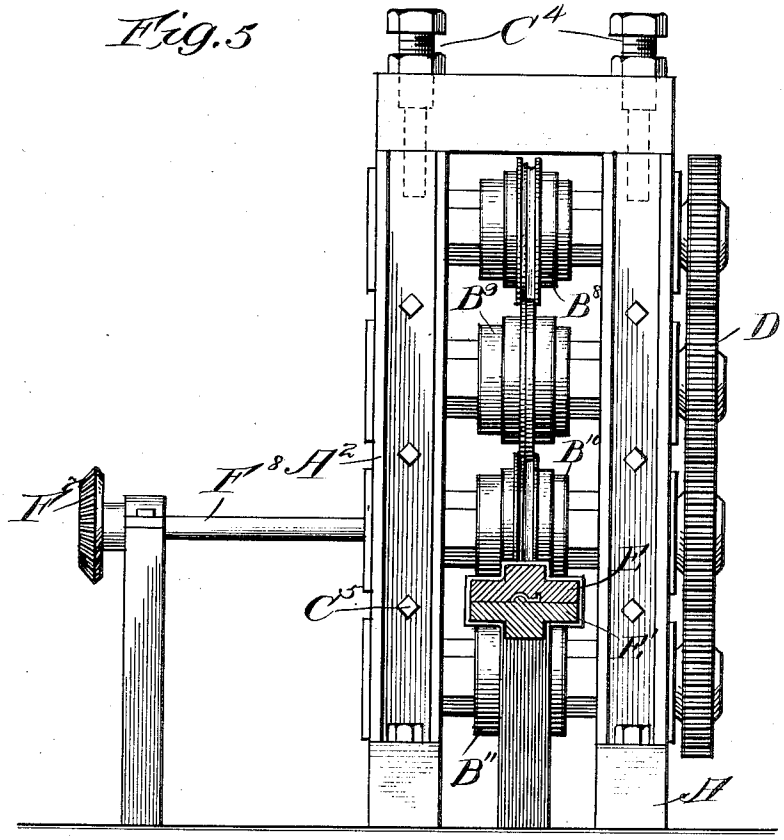
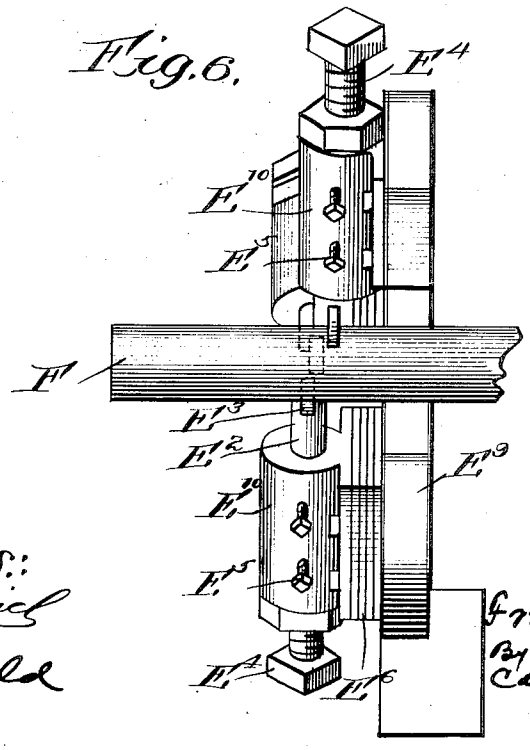



Fig. 6.

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# UNITED STATES PATENT OFFICE.

FREDERICK G. FRANKENBERG, OF CHICAGO, ILLINOIS.

## MACHINE FOR BENDING AND COILING METAL RIBBONS.

No. 828,732. Specification of Letters Patent. Patented Aug. 14, 1906.

Application filed October 20, 1905. Serial No. 283,565.

*To all whom it may concern:*

Be it known that I, FREDERICK G. FRANKENBERG, a citizen of the United States of America, and a resident of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Machines for Bending and Coiling Metal Ribbons, of which the following is a specification.

My invention relates to machines for bending and coiling metal ribbons to form flexible metallic tubing, and has for its object improvements in machines for performing these operations.

In the accompanying drawings, Figure 1 is a side elevation of the machine. Fig. 2 is a plan. Fig. 3 is an elevation, on an enlarged scale, of a part of the machine, the gears being removed. Fig. 4 is a plan of Fig. 3, the gears being in place. Fig. 5 is an enlarged section on line 5 5 of Fig. 2. Fig. 6 is an enlarged elevation of the coiling-head detached. Figs. 7, 8, 9, and 10 represent successive stages of the ribbon of metal as it passes through the machine. Fig. 11 represents a section of a tube made by coiling the ribbon after it is bent into the form shown in Fig. 10; and Fig. 12 is an elevation of the upright portion of Fig. 1, the gears being removed.

In the said drawings, A represents a frame or bed-plate, on which are mounted a series of standards A′. Supported in each pair of standards A′ are a pair of rolls B B′ $B^2$ $B^3$ $B^4$ $B^5$ $B^6$ $B^7$. Also on the bed-plate A are standards $A^2$, in which are supported the rolls $B^8$ $B^9$ $B^{10}$ $B^{11}$. All of these rolls are supported in adjustable boxes C, and all of these boxes, except those for the roll $B^{11}$, are provided with screws for adjusting them. Between each pair of boxes for the rolls from B to $B^7$ there is a pair of wedges C′, and back of one wedge of each pair there is a screw $C^2$. By screwing down on a screw $C^2$ the boxes C of a pair of rolls are forced apart. In the standards A′ and opposite the boxes C are set-screws $C^3$, by means of which the boxes C of a pair of rolls are forced toward each other. As a consequence of this construction a pair of rolls may be adjusted toward or from each other and be held securely at any desired adjustment. In the standards $A^2$ the set-screws $C^4$ operate to force all of the rolls carried thereby toward each other, and screws $C^5$, pressing wedges $C^6$ similar to C′, operate to separate them.

On the shaft of each of the rolls B to $B^{11}$ there is a gear D. The gears of each pair of rolls mesh with each other, and supported at convenient places are intermediate gears D′, which mesh with adjacent gears of adjacent pairs of rolls. By this arrangement there is a continuous train of gears connecting the entire series of rolls together. The direction of rotation of these gears, and consequently of the rolls B and $B^{11}$, is shown by the arrows in Fig. 1.

In line with the points of contact between rolls $B^{10}$ and $B^{12}$ is a ribbon-guiding channel made up of plates E and E′, and opposite the other end of this channel is a mandrel F. The mandrel F is connected to a short shaft $F^2$ by a universal joint F′, and on the shaft $F^2$ is a bevel-gear $F^3$, which meshes with another bevel-gear $F^4$ on one end of the shaft $F^5$. On the other end of the shaft $F^5$ is a bevel-gear $F^6$, which meshes with a bevel-gear $F^7$ on the shaft $F^8$. The shaft $F^8$ is an extension to one side of the machine of the shaft of the roll $B^{10}$. As a consequence of this construction the mandrel F is connected to and rotates with the rolls B to $B^{11}$.

Surrounding the mandrel F is a ring $E^9$, and on this ring are secured a series of boxes $E^{10}$, the axes of which radiate from the mandrel F. Supported in each box $E^{10}$ is a longitudinally-movable bar $E^2$, and on the end of each bar is an idle roll $E^3$ used for coiling and located closely adjacent to the mandrel F. Screws $E^4$ serve to force the bars $E^2$, and consequently their rolls $E^3$, toward the mandrel F, and set-screws $E^5$ serve to hold the said bars and rolls at the position at which they have been adjusted and also to hold said bars from rotation. Under the boxes $E^{10}$ are shims $E^6$, different amounts being under different boxes, by means of which the rolls $E^3$ are supported at different distances from the face of the ring $E^9$, and also by means of which these distances may be varied. The mandrel F lies at an angle, as shown in Fig. 2, and by adjusting the position of the frame $A^6$, which supports the ring $E^9$ and the boxes $A^7$ for the mandrel F, the angular position of the mandrel may be varied.

Power is delivered to the pulley G, and from here it is conveyed through shaft G′ and gears $G^2$ and $G^3$ to the train of gears D D′, and also, as previously described, to the mandrel F. This sets into operation all of the mechanism necessary for changing a flat ribbon of metal into coiled metallic tubing, such

as that illustrated in Fig. 11. The particular kinds of bends put into the ribbon, and consequently the particular structure of the tubing, will depend upon the particular formation of the rolls B to $B^{11}$, which act upon the ribbon. In the present case the particular style of rolls chosen for illustrating the operation of the machine results in the production of a form of tubing known as "armor," or a form of tubing which is not of itself water and steam tight, but is used as an outer or protecting covering for another piece of tubing. As the bends necessary for producing water and steam tight tubing may be made by the same process when using rolls of different conformation, it is evident that the present invention is not restricted to the production of a particular kind of coiled tubing, but relates to the manner in which longitudinal bends of any kind are formed on ribbons of metal and to the manner in which the bent ribbon is coiled into tubing.

The ribbon R, having a cross-section like that represented in Fig. 7, enters between rolls B and B′, which rolls bend a flange on the ribbon, giving it the form shown in Fig. 8. From the rolls B and B′ the flanged ribbon passes under rolls B′ and $B^2$ and up between rolls $B^2$ and $B^3$, where a flange is formed on the opposite edge, leaving it in the form shown in Fig. 9. From rolls $B^2$ and $B^3$ it passes over rolls $B^3$ and $B^4$ and down between rolls $B^4$ and $B^5$, where it is bent into the form shown in Fig. 10. From rolls $B^4$ and $B^5$ it passes under rolls $B^5$ and $B^6$ and up between rolls $B^6$ and $B^7$, thence between guide-rolls H and H′ to and between rolls $B^8$ and $B^9$, around $B^9$ and between $B^9$ and $B^{10}$, around $B^{10}$ and between $B^{10}$ and $B^{11}$, and thence through the guide formed by the plates E and E′ to the mandrel F.

It will be observed that the ribbon R in passing from roll to roll in the manner described is being continually bent transversely back and forth on radii corresponding to the radii of the rolls around which it passes. This continual bending acts to increase the flexibility of the ribbon, and consequently to facilitate coiling it about the mandrel F. Each act of bending the ribbon also stretches the outwardly-projecting flanges and compresses those that project inward. To counteract any tendency to distortion that may arise from this bending, the rolls $B^8$ to $B^{11}$ correspond to the rolls $B^6$ and $B^7$ and may be called "finishing-rolls."

As the mandrel F lies at an angle to the direction of movement of the ribbon and is driven, it is evident that if a coil be started around the mandrel the action will be to continue to wind the ribbon around the mandrel in the form of a helix. The angle at which the mandrel is set is such that it corresponds to the pitch required for the coiled tube, which pitch is in turn determined by the original width of the ribbon and the particular kinds of longitudinal bends that it is given. By adjusting the positions of the frame $A^6$ and the box $A^7$ this pitch may be varied. To cause the coils to unite properly and to insure proper driving action, the screws $E^4$ are adjusted so that the coiling-rolls $E^3$ will press lightly against the tubing at the points marked R′ in Fig. 11. This forces the ribbon against the mandrel F, the speed of which is such as will maintain a tension on the ribbon R.

The mandrel F and the parts directly associated therewith may be called a "coiling-head," and it will be evident from the previous description that this coiling-head may be adjusted to accommodate tubes of varying diameters and made of ribbons bent in different forms. Thus, if it is desired to coil a tube of a large diameter a mandrel F of corresponding diameter will be substituted for the one shown, it will be adjusted to an inclination corresponding to this diameter, the gears $F^3$ to $F^7$ will be changed to give it the proper speed, a greater or less number of shims will be placed under the boxes $E^{10}$, so as to bring the coiling-rolls $E^3$ to their appropriate places on the coiling-ribbon, and the screws $E^4$ will be adjusted so that the rolls $E^3$ will have the proper pressure on the forming-coil.

The operation of the machine may be briefly recapitulated as follows: A ribbon of some malleable and ductile metal, as copper or soft steel, is passed through a series of rolls, said rolls being so formed that they will, by successive stages, give the ribbon desired longitudinal bends, so arranged that during the process of producing these fixed bends they will bend the ribbon transversely back and forth so as to give it transverse flexibility. In addition to these rolls there are added other rolls, called "finishing-rolls," which continue the process of transverse bending while at the same time they operate to maintain the fixed longitudinal bends from distortion by transverse bending. From the finishing-rolls the ribbon passes through a guide to a coiling-head, where the ribbon is coiled into an interlocking helix.

What I claim is—

1. In a machine for making flexible metallic tubing from ribbons of metal, means for giving the ribbon of metal permanent longitudinal bends of a required form, and means for imparting flexibility to the longitudinally-bent ribbon by bending it transversely back and forth.

2. In a machine for making flexible metallic tubing from a ribbon of metal, means for giving the ribbon permanent longitudinal bends of a required form, means for bending the ribbon transversely back and forth a series of times during and after the formation of the longitudinal bends, and means for coil-

ing the ribbon upon a mandrel subsequently to giving it the transverse bends.

3. In a machine for making flexible metallic tubing from a ribbon of metal, means for giving the ribbon permanent longitudinal bends of a required form, means for bending the ribbon transversely back and forth a series of times substantially as described, a mandrel upon which the ribbon is coiled, and means for shifting said mandrel so as to vary its inclination with respect to said ribbon.

4. In a machine for making flexible metallic tubing, a series of rolls for giving longitudinal bends to a ribbon of metal, a mandrel upon which the bent ribbon is coiled, connections extending from said rolls to said mandrel for driving it, and a universal joint in said connections whereby the inclination of said mandrel may be adjusted.

Signed at Chicago, Illinois, this 13th day of October, 1905.

FREDERICK G. FRANKENBERG.

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C. L. REDFIELD.